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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 7

DAISY *TO* EDUCATIONAL PSYCHOLOGY

ENCYCLOPÆDIA BRITANNICA, INC.

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DAISY *TO* EDUCATIONAL PSYCHOLOGY

DAISY, the name applied to many species of plants with showy rays, of the family Compositae (*q.v.*). The word is derived from the Anglo-Saxon and means "day's eye." The genus *Bellis* contains ten species found in Europe and the Mediterranean region. The common daisy, *B. perennis,* is much cultivated in the United States as a summer bedding plant, especially in some of its finer forms with pink, white, red or quilled rays. It is the only representative of the genus in the British Isles. It is a perennial, abundant everywhere in pastures, lawns and on banks in Europe, except in the most northerly regions.

J. HORACE MCFARLAND CO.

SHASTA DAISY (CHRYSANTHEMUM MAXIMUM) IN BLOOM

The stem is short; the leaves, which are numerous and form a rosette, are slightly hairy, obovate-spatulate in shape, with rounded teeth on the margin in the upper part, and the rootstock is creeping and of a brownish colour. The flowers are to be found in England from March to November and occasionally in the winter months. The heads of flowers are solitary, the outer or ray florets pink or white, the disk florets bright yellow. The size and luxuriance of the plant are much affected by the nature of the soil in which it grows. It is often a pest in English lawns. The cultivated varieties bear finely coloured flowers and make very effective borders for walks. What is known as the "hen and chicken" daisy has the main head surrounded by a brood of sometimes as many as 10 or 12 small heads; *i.e.*, proliferous. The ray florets curve inward and "close" the flower head in dull weather and toward evening.

In French the daisy is termed *la marguerite,* and "herb margaret" is stated to be an old English appellation for it. In Scotland it is popularly called the gowan, and in Yorkshire it is the bairnwort, or "flower beloved by children."

The Christmas and Michaelmas daisies are species of *Aster;* the oxeye daisy is *Chrysanthemum leucanthemum,* a common weed; the Shasta daisy is *Chrysanthemum maximum;* and the African daisy is either *Arctotis* or *Gazania. B. perennis florepleno,* the double daisy, consists of dwarf, showy, three- to four-inch plants, flowering freely in spring if grown in rich light soil.

Among the varieties of *B. perennis* in the United States are Double-Quilled, Longfellow and the Bride, all widely planted in city parks. These are not frost hardy over much of North America and are grown as biennials. Seeds sown the previous year are wintered over in the cold frame and planted out the following spring. They do not tolerate great heat, but under proper conditions they bloom from late spring to frost. (N. TR.; X.)

DAJABÓN, formerly Libertador, a province in northwestern Dominican Republic (area 344 sq.mi.), occupies the foothills and part of the Cordillera Central on the Haitian border. Its main products are bananas (along the Massacre river), peanuts, rice, corn (maize), hides and skins, and hardwoods. The region was strongly disputed during the colonial struggles between Spain and France. Dajabón city, the capital (pop. [1960] 3,230), was founded between 1771 and 1776, but was abandoned during the War of Independence and resettled after the War of Restoration (1865). The province was created in 1938 from Montecristi under plans of development of the frontier regions; the name was changed to Dajabón in 1961. Pop. (1960) 40,822. (D. R. D.)

DAKAR, the capital of the Republic of Senegal (*q.v.*) and one of the chief seaports on the west African coast, is situated on the southeastern side of the Cape Verde peninsula, the westernmost extension of the African continent. It lies between the Senegal and the Gambia, the two rivers by way of which the western Sudan was opened to European explorers, and is the ocean terminal of the railroads which inherited most of the river-borne trade. Its position at a point midway between Europe and both South Africa and South America makes it a valuable port of call for ships and airplanes. It has one of the best harbours in west Africa, protected by the limestone cliffs of the cape and by a system of breakwaters, and a big airfield at Yoff on the opposite side of the peninsula. Dakar's strategic position led to its development as a naval and air base. It became one of the most important capitals of the French overseas empire and even after the independence

of Senegal in 1960 it remained the financial and commercial centre for much of the west African region.

Because of its position at the end of the peninsula it is cooled by ocean breezes and is one of the most comfortable sites on the coast for Europeans. In appearance and character it is more like a European city than any other in west Africa, and it has the largest European population—30,107 of a total of 230,887 in 1955. Seasonal migration of both Europeans and Africans increases the population during the dry season (November–June).

Dakar was founded in 1857 when the French built a fort on the site of the modern Place de l'Indépendance (formerly Place Protet) (so called after the founder, a naval captain) to safeguard the interests of merchants who had been settling there for 20 years and of residents of Gorée, a waterless island in the lee of the peninsula. By 1862 a short breakwater had been built in the lee of the point and a town laid out on the low limestone platform behind the sandy beach. Another generation elapsed, however, before Dakar gained its supremacy over Gorée (*q.v.*) and Rufisque, a settlement 13 mi. along the peninsula which had become an important export centre for the peanut trade. The decline of Gorée and Rufisque was hastened by the building of the railway line connecting Dakar's superior harbour with the Senegal river in 1885, and by improvements in Dakar's port facilities. In 1887 Dakar was made one of four communes in Senegal. In 1902 it was designated capital of French West Africa, replacing St. Louis, and by 1908 all government buildings had been concentrated in the peninsula. Further transfer of business houses to Dakar took place after the completion in 1923 of the Dakar-Niger railway line, which, with its later branches, connected Dakar with the upper Niger basin and the heart of the peanut country. Gorée became a suburb of Dakar in 1929. In 1924 Dakar and the neighbouring villages were withdrawn from Senegal and set up as a district (*circonscription*) administered by a governor.

In Sept. 1940, after the fall of France, Dakar's strategic importance caused it to be the object of an attack by a Free French force under Gen. Charles de Gaulle with the support of the British fleet. This failed, but in Nov. 1942, after the invasion of north Africa, all of French West Africa rejoined the Allies.

Dakar was the seat of the executive for French West Africa, of the *grand conseil* set up in 1946, which acted as a local parliament, and of the high court of appeal. With the granting of independence to the territories of French West Africa in 1960, Dakar became the capital of the short-lived Federation of Mali and, following the collapse of the federation, of the Republic of Senegal. It is the seat of a Roman Catholic archbishop.

The Town.—The business centre of Dakar is attractively laid out and stands about 25 ft. above the harbour on gently undulating ground. Southward the land rises in a long slope and narrows toward Cape Manuel. The centre of this area is the Place de l'Indépendance, where the war memorial stands. The streets radiating from it contain most of the government offices and business houses, including the presidential palace, one of the most conspicuous buildings in the town, on a bluff 100 ft. above the Bight of Gorée. Nearby is the imposing domed Roman Catholic cathedral, begun in 1923 and inaugurated in 1929. After 1950 many tall office buildings, up to 15 stories high, were erected, giving the town a very modern appearance.

To the northwest of this business area, which contains many excellent European shops, is Médina, the oldest and nearest of several outlying African settlements. Beyond it, toward the airport, and also on the coast, are large, well-planned residential areas known as Grand Dakar, Fann, Point E and Dagoudane Pikine. Between the harbour and Médina is the so-called Syrian quarter containing business houses, some patronized by Africans, run by merchants from Lebanon and Syria. In Médina and the outlying African settlements are African open-air markets. To the north is a large industrial area, bordering the port, and containing railway workshops, the naval yards and the power station. Manufacturing is confined chiefly to making perishable goods sold locally, although there are cotton, shoe, oil and soap factories. Handicrafts are carried on, chiefly garment making, cabinetwork and the making of jewelry. In the surrounding country most of the arable land is devoted to market gardening. At Hann, beyond the dockyards, there is a forest park and zoological garden, founded in 1903. The large sandy beaches at Hann bay and at Ngor on the opposite side of the peninsula are popular resorts during the hot season. Gorée Island with its old houses, museums and historical interest attracts tourists.

In planning Dakar, great attention was paid to health. The marshes round the city were drained for 12 mi. to reduce the danger of disease-carrying mosquitoes, and the water supply is brought from deep wells even farther away. The medical centre, the largest in middle Africa, includes hospitals, an outpatient clinic and a Pasteur institute. There are a university, founded in 1957 at Fann; colleges specializing in administration, the training of teachers and marine engineering; and two *lycées*. The Institut Français d'Afrique Noire promotes scientific research and also runs three museums (historical and marine biological) at Gorée and one at Dakar (ethnological).

Dakar is linked to Paris, Lisbon, Buenos Aires, New York and Johannesburg by air. Dry-season motor roads connect Dakar with several other African capitals, and there is a good tarred road to Ziguinchor through Gambia and others to St. Louis and Touba.

COURTESY OF FRENCH GOVERNMENT TOURIST OFFICE, CHICAGO

AERIAL VIEW OF A MODERN HOTEL ON THE COAST NEAR DAKAR, SENEGAL, IN WEST AFRICA

The Port.—Until about 1900 Dakar's chief function was to serve as a port of call for ocean shipping. The first jetty adequate to protect the anchorage from the surf and to withstand the storms of the rainy season (July–October) was finished in 1866, after which the Messageries Maritimes used Dakar instead of St. Vincent as a port of call for its liners. Between 1898 and 1912 this jetty was extended to 2,740 ft. Beyond an entrance 820 ft. wide a new breakwater was built to the opposite shore of the bay. The harbour formed by the new breakwater and another on the shoreward half is 555 ac. There is also a seaplane base. Before World War II the naval installations consisted of a marine arsenal and repair yard, a dry dock serving ships up to 10,000 tons and a basin for destroyers. Further improvements were begun in the late 1930s and in 1940–43 the region between Dakar and beyond Rufisque was so strongly fortified, to prevent landings and shelter a powerful fleet, that Dakar was nicknamed "the African Gibraltar." These fortifications were abandoned after the war.

Ships of most lines trading to west Africa call at Dakar, as do many in the South African and South American trade. Services from Yoff international airport (6 mi. N.W.) link west and south Africa with Europe and South America. By volume of traffic it ranked next after Le Havre and Marseilles in the former French Community, but most of this consisted of peanuts and phosphate exports and the importation of petroleum and coal, used mainly for servicing passing ships.

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DAKIN'S FLUID (CARREL-DAKIN FLUID) is an antiseptic containing available chlorine and designed for the treatment of infected wounds. First used during World War I, it was the product of long study by Henry Drysdale Dakin and Alexis Carrel in search of the ideal wound antiseptic. The stronger germicidal solutions, such as carbolic acid and iodine, damage living cells, or lose their potency in the presence of blood serum. Dakin's fluid avoids both these defects and in addition has a solvent action on dead tissue which hastens its separation from living tissue. It is prepared from bleaching powder and the carbonate and bicarbonate of soda, and must contain 0.45% to 0.50% of sodium hypochlorite and no free alkali. It is unstable and will not keep more than a few days.

The Carrel-Dakin treatment consists in flooding the entire wound surface every two hours, by means of small tubes connected with a reservoir. This treatment was replaced eventually by the use of sulfa drugs and antibiotics.

DAKOTA, a tribe, or confederation of tribes, of Siouan Indians (*q.v.*) in the northern plains of the United States. The name, now applied to two states, means "allies"; the popular designation is Sioux abbreviated from Nadowessioux, from Ojibwa via French.

As the largest tribe in the Siouan family, the Dakota have given their name to this group. In the 1960s the Dakota numbered about 40,000, more than 75% of them on reservations in North and South Dakota, Montana and Nebraska. There are three main divisions: Santee, Yankton, Teton, calling themselves respectively Dakota, Nakota and Lakota. The Santee comprise the Mdewakanton, Wahpeton, Wahpekute, Sisseton; the Yankton includes the Yankton and the Yanktonai. This makes seven divisions, recognized by the Dakota themselves as "seven council fires"; but the Teton outnumber the other six combined.

First encountered by the whites in Minnesota, the Dakota drifted westward, under pressure first from the Ojibwa, and later from the whites. During the 18th century the Teton established themselves west of the Missouri river. Tall in stature and picturesque in costume, they have in recent generations impressed civilized imagination perhaps more than any other American tribe. All the Teton and part of the other divisions adhered to the Plains Indian type of life: buffalo hunting, tepee dwelling, nomadic, non-agricultural, raiding and proud of their war exploits. Their greatest ceremony was the Sun Dance (*q.v.*). *See* also PLAINS INDIANS.

See S. Bleeker, *The Sioux Indians* (1962); R. M. Utley, *The Last Days of the Sioux Nation* (1963). (A. L. K.; X.)

DAKOTA RIVER: *see* JAMES RIVER.

DALADIER, ÉDOUARD (1884–), French statesman, premier at the time of the Munich crisis of 1938, was born at Carpentras, Vaucluse, on June 18, 1884. He was a schoolmaster until elected deputy for his native *département* in 1919. Throughout his life a Radical, he took office for the first time as minister of colonies in Édouard Herriot's government of 1924 and held seven other portfolios in different governments before serving as premier, Jan.–Oct. 1933. He was his own minister of war and continued to hold this office under the next two governments (Oct. 1933–Jan. 1934). He then resumed the premiership, but only for 11 days, until the violent riots of Feb. 6, 1934. Under his first premiership the Four-Power peace pact among France, Great Britain, Germany and Italy was concluded in June 1933.

Daladier led the Radical party into the popular front alliance with Socialists and Communists in 1935 and was minister of national defense in Léon Blum's first government (June 1936–June 1937), Camille Chautemps's (June 1937–March 1938) and Blum's second (March–April 1938). He then resumed the premiership which he retained until March 20, 1940. He signed the Munich agreement on Sept. 29, 1938, declared war on Germany on Sept. 3, 1939, and dissolved the Communist party on Sept. 26, 1939. He continued as minister of war under Paul Reynaud until May 18, 1940, and was minister of foreign affairs till June 16, 1940. He was interned by the Vichy government on Sept. 8, 1940, and sent for trial at Riom in Feb. 1942. The manly tone of his statements at the trial did something to restore his reputation. After the failure of the trial, he remained interned; he was handed over to the Germans and deported to Germany in 1943. Liberated in April 1945, Daladier was re-elected deputy in June 1946. He opposed the continuance of the Indochina war and the European Defense Community. (D. R. GE.)

DALAI LAMA, originally the abbot of the 'Bras-spuṅs (Drepung) monastery on the outskirts of Lhasa, Tibet. These abbots have acted as heads of the dGe-lugs-pa order of Tibetan Buddhism since the first abbot, dGe-'dun-grub-pa (1391–1474), gained this position by his great ability. In accordance with the Buddhist doctrine of rebirth, his successors were conceived of as reincarnating in an identifiable series. They were regarded as recurring manifestations of the saviour sPyan-ras-gzigs (in Sanskrit, Avalokiteśvara), and abbots of the important dGe-lugs-pa monastery of bKra-śis-lhun-po (Trashi Lhümpo) were regarded as representing the Buddha 'Od-dpa'-med (in Sanskrit, Amitābha). The members of this second series are known as Paṇ-c'en Rin-po-c'e (Great and Precious Sage) or, outside Tibet, as the panchen lama. (The nickname tashi lama, coined from the first part of Trashi Lhümpo by early western visitors, lacks all validity.)

The third abbot of 'Bras-spuṅs revived Buddhism among the Mongols, receiving from their leader the title whose first element has been corrupted into the English word dalai. The Tibetans themselves call the dalai lama rGyal-ba Rin-po-c'e (Precious Conqueror). The fifth abbot found himself unable to prevail upon the older orders of Tibetan religion and appealed to the Mongols, who, in effect, conquered the country for him in 1642. From then until the 1959 rising against the Chinese Communist occupation forces, the dalai lamas, or more often their active regents, were the effective rulers of Tibet. The 13th (1876–1933) ruled with extraordinary personal authority. The 14th dalai lama was born in Amdo in 1935. *See* also TIBET; TIBETAN BUDDHISM.

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DALÄLVEN (DAL RIVER), in Sweden is formed by two main tributaries, the Västerdalälven and Österdalälven, whose headstreams drained Norwegian territory. The total length is 323 mi. Österdalälven, before meeting the other main stream above Borlänge, flows through several lakes of which the largest is Siljan.

The Dalarna region centres on the agricultural basin of Siljan. Dissection has given it an attractive hilly appearance and, with lingering local customs, Dalarna is a tourist district. Downstream from Borlänge the river flows southeastward with rapids through the mineralized district of Bergslagen, but at Krylbo it turns northeast to Hedesundafjärden and a small estuary. There are many sites for power production, and copper, lead, zinc, iron and other ores have made this an industrial area with metallurgical centres at Borlänge and Krylbo. Skutskär, closed by ice (January–April), has a harbour depth of 18 ft. but most of the Bergslagen traffic goes by rail to Gävle. (A. C. O'D.)

DALARNA (DALECARLIA; "the Dales"), a west midland region of Sweden, extends from the Norwegian frontier mountains to within 25 mi. of Gävle on the Gulf of Bothnia. It forms a transition zone between the barren *fjäll* and the industrial region of Bergslagen. River valleys are deeply cut but generally do not provide through routeways. The region centres on the Silurian outcrop round the lake of Siljan and there the agricultural wealth is greatest with the growing of barley, oats and root crops, whereas transhumance lingers in the uplands. In the south is the Falun industrial area. (*See* KOPPARBERG.) The dales is characterized by local dialects and colourful costumes, by domestic textiles and woodworking industries and by local architectural styles and thus has become a noted tourist region. (A. C. O'D.)

DALAT, a hill station which after partition of Vietnam at the Geneva conference of 1954 was in South Vietnam. It was developed by the French colonial administration in the early 20th century as a health resort and centre for big game hunting for Europeans. At nearly 5,000 ft., the town, elegantly laid out with tourist facilities and fine residences, had a population estimated at 48,843 in 1962 when it still had many Indochinese refugees from the northern zone. Surrounded by heavily forested mountains containing some primitive hill tribes, Dalat has tea, coffee and rubber plantations within a few miles, and temperate-zone vegetables are grown for sale in Saigon to which there are good links by metaled road and by air. Its equable climate is cool yet free from frost, the annual rainfall being 70 in. with July–October as the wet season and December–January as the dry season. (E. H. G. D.)

DALBEATTIE, a small burgh of Kirkcudbrightshire, Scot. Pop. (1961) 3,104. It lies on Dalbeattie burn, 13 mi. N.E. of Kirkcudbright. The town, built largely of gray granite, owes its rise to the granite quarries at Craignair and elsewhere in the vicinity, from which came stone used for the Thames embankment, docks at Odessa and Liverpool. Other industries include grain and fertilizer milling, and hosiery and bobbin manufacturing. The wooded estuary of the Urr, known as Rough firth, is navigable by ships of 150 tons, and small vessels can go as far as the mouth of Dalbeattie burn, within a mile of the town. The estuary offers salmon and sea-trout fishing. The Mote or Moat of Urr, about 3 mi. N., the most notable Anglo-Norman earthwork in Scotland, is on a natural circular hillock, cone-shaped with an encircling trench, and is situated at one end of a base court, or bailey. It was once a river island. The former castle at nearby Buittle was the birthplace of John de Baliol (1249–1315). It was there that his mother, Devorguila, is said to have signed the charter for Balliol college, Oxford.

DALBERG, the name of an ancient German noble family, derived from the hamlet and castle (now in ruins) of Dalberg or Dalburg near Kreuznach. In the 14th century, the original house of Dalberg became extinct in the male line, the fiefs passing to Johann Gerhard, chamberlain of the see of Worms, who married the heiress of his cousin, Anton von Dalberg, about 1330. His own family was of great antiquity, his ancestors having been hereditary *ministeriales* of the bishop of Worms since the time of the chamberlain Ekbert, who founded in 1119 the Augustinian monastery of Frankenthal and died in 1132. By the close of the 15th century the Dalberg family was of such importance that, in 1494, the German king Maximilian I granted its members the honour of being the first to receive knighthood at the coronation; this part of the ceremonies being opened by the herald asking "Is no Dalberg present?" (*Ist kein Dalberg da?*). This privilege the family enjoyed till the end of the Holy Roman empire.

The elder line of the family of Dalberg-Dalberg became extinct in 1848, the younger, that of Dalberg-Herrnsheim, in 1833. The male line of the Dalbergs was then represented only by the family of Hessloch, descended from Gerhard von Dalberg (*c.* 1239), which in 1810 succeeded to the title and estates in Moravia and Bohemia of the extinct counts of Ostein.

JOHANN VON DALBERG (1445–1503), bishop of Worms from 1482, was born on Aug. 14, 1445, at Oppenheim. He studied at Erfurt and in Italy, where he took his degree of doctor of laws at Ferrara but devoted himself especially to the study of Greek. Returning to Germany, he became privy councilor to the elector Philip of the Palatinate, whom he assisted in bringing the University of Heidelberg to the height of its fame, helping to found the first chair of Greek (filled by his friend Rodolphus Agricola) and establishing the library and a college for students of civil law. A humanist, he was president of the *Sodalitas Celtica* founded by the poet Conradus Celtis and the patron and correspondent of many leading scholars. He died at Heidelberg on July 27, 1503.

KARL THEODOR VON DALBERG (1744–1817) was born at Herrnsheim on Feb. 8, 1744. After studying canon law at Göttingen and Heidelberg he entered the church, becoming administrator of the bishopric of Erfurt in 1772. An advocate of German unity, he supported the league of princes (*Fürstenbund*) formed under Frederick II of Prussia in 1785 and, through Prussian influence, became coadjutor of Mainz and Worms in 1787 and of Constance soon after. In 1802 he became archbishop elector of Mainz and so arch-chancellor of the Holy Roman empire. In 1803 he received the principality of Aschaffenburg and Regensburg, and Regensburg now became the seat of his diocese. Dalberg, in fact, thanks to Prussian influence, was the only ecclesiastical prince to survive the reorganization of the empire effected in 1803, from which he emerged as chancellor of the empire and primate of Germany, with ecclesiastical jurisdiction over Mainz, Cologne and Trier. He hoped to proceed to the establishment of a national German Church, but in 1805 the pope restricted him to the secular administration of his dioceses. Through Napoleon's influence, however, Frankfurt and the countships of Lowenstein-Wertheim and Rieneck were added to Dalberg's territories. He had already turned to Napoleon as the only hope for a unified Germany, and in 1806 he was appointed prince primate of the Confederation of the Rhine. In 1810 Regensburg was ceded to Bavaria, but in compensation Dalberg received the principalities of Fulda and Hanan and the title of grand duke of Frankfurt. He had, however, to accept a French resident, and in 1811 Eugène de Beauharnais was nominated to succeed him as grand duke. On the fall of Napoleon the grand duchy was dismembered at the Congress of Vienna. Dalberg then retained of all his dignities only the archbishopric of Regensburg. He died in Regensburg on Feb. 10, 1817.

WOLFGANG HERIBERT VON DALBERG (1750–1806), Karl Theodor's brother, was born at Herrnsheim on Nov. 18, 1750. As intendant of the theatre at Mannheim (1778–1803), he was the first to stage plays by Friedrich Schiller (*q.v.*), a number of whose letters to him are extant. Dalberg himself also wrote several plays, including adaptations of Shakespeare. He died at Mannheim on Sept. 27, 1806. Another brother, JOHANN FRIEDRICH HUGO VON DALBERG (d. 1812), canon of Trier and Worms, was a composer and musicologist.

EMMERICH JOSEPH VON DALBERG (1773–1833), duc de Dalberg from 1810, Wolfgang Heribert's son, was born in Mainz on May 30, 1773. As Baden's envoy in Paris from 1803 he became a close friend of Talleyrand. Entering the French service in 1809, he was made a duke and a privy councilor by Napoleon in 1810. A member of Talleyrand's provisional government (1814), he accompanied Talleyrand to the congress of Vienna as minister plenipotentiary. After the second Restoration (1815) he was made a minister and a peer of France by Louis XVIII. In 1816 he was French ambassador in Turin. He died at Herrnsheim, which he had inherited from his uncle Karl Theodor, on April 27, 1833. Herrnsheim then passed to his daughter MARIE LOUISE PELLINE DE DALBERG (d. 1860), who by her marriage with Sir Ferdinand Richard Edward Acton (1801–37) became the mother of John Emerich

Edward Dalberg-Acton, the future English historian and 1st Baron Acton (*q.v.*).

DALE, SIR HENRY HALLETT (1875–), British physiologist who, for his work on the chemical transmission of nerve impulses, was awarded the Nobel prize for medicine and physiology together with Otto Loewi in 1936. Dale was born in London on June 9, 1875, and was educated at Cambridge university and at St. Bartholomew's hospital, London. The scientific researches to which he devoted his life had a profound effect not only on the development of physiological theory but also on the progress of practical medicine.

His earliest research, carried out while he was pharmacologist at the Wellcome Physiological Research laboratories, was concerned with the chemical composition and effects of ergot of rye. From this work developed his researches on the action of histamine (one of the constituents of ergot extracts) on surgical shock and on anaphylaxis. In 1914 he was appointed head of the department of biochemistry and pharmacology of the Medical Research council, and from 1928 to 1942 he was director of the National Institute for Medical Research. Among the offices that he held were the presidency of the Royal society, of the British Association for the Advancement of Science and of the Royal Society of Medicine. During World War II he was chairman of the Scientific Advisory committee to the cabinet and a member of the Advisory Committee on Atomic Energy. He was knighted in 1932 and was awarded the Order of Merit in 1944. (W. J. Bp.)

DALE, RICHARD (1756–1826), U.S. naval officer, was born in Norfolk county, Va., Nov. 6, 1756, and went to sea at the age of 12. During the early months of the American Revolution he led a checkered career as a lieutenant in the Virginia provincial navy, a prisoner of war on Gov. John Dunmore's British fleet in the Chesapeake and a mate in a Tory brig. The brig was taken by John Barry on July 27, 1776, and that same day Dale entered on board Barry's Continental brig "Lexington" as a master's mate. He served on the "Lexington" under three captains, and went to Mill prison, Plymouth, Eng., along with the rest of the crew when the brig was taken by the British cutter "Alert" in the English channel on Sept. 19, 1777. Escaping to France more than a year later, Dale entered on board the "Bon Homme Richard," Capt. John Paul Jones commanding. As first lieutenant of that famous ship Dale distinguished himself at the taking of the "Serapis" off Scarborough in Sept. 1779. He followed Jones's fortunes as first lieutenant on the "Alliance" and the "Ariel," and, in Aug. 1781 was on board the "Trumbull" when that frigate was captured by two British ships. After the war, Dale engaged as a shipmaster in the London and East Indies trades until he was appointed fourth ranking captain in the United States navy in 1794. Later, in a dispute over rank, he secured a leave of absence and went back to the merchant marine. In May 1801 he was recalled to duty and appointed to the command of a squadron of observation sent to the Mediterranean. With limited powers and a small force, Dale maintained a successful blockade of Tripoli, and prevented the piratical depredations of the Barbary powers for a period of six months. He returned to the United States in 1802. That same year he refused to take out a second squadron, when the navy department would not allow him a captain for the frigate "President" upon which he was to hoist his broad pennant, and he resigned from the navy on Dec. 17, 1802. Dale lived in retirement in Philadelphia, Pa., until his death on Feb. 26, 1826.

See "Biographical Memoir of Richard Dale," *The Port Folio* (June 1814); *Quasi-War With France and Barbary War Documents*, 11 vol. (1935–42). (W. B. Ck.)

DALE, SIR THOMAS (d. 1619), British naval commander and colonial deputy governor of Virginia. From about 1588 to 1609 he was in the Netherlands with the English army, originally under Robert Dudley, earl of Leicester, and in 1606 he was knighted by James I. From 1611 to 1616 he was actually, though not always nominally, in chief control of the colony of Virginia, either as deputy governor or as "high marshal," and he is best remembered for the energy and the extreme rigour of his administration there, which established order and in various ways seems to have benefited the colony. Under him began the first real expansion of the colony with the establishment of the settlement of Henrico on and about what was later known as Farrar's Island; about 1614 he took the first step toward abolishing the communal system by the introduction of private holdings, and it was during his administration that the first code of laws of Virginia was effectively tested. This code, entitled "Articles, Lawes, and Orders—Divine, Politique, and Martiall," but popularly known as Dale's code, was notable for its pitiless severity, and seems to have been prepared in large part by Dale himself. He left Virginia in 1616. Shortly after his return to England he was given command of a fleet sent against the Dutch; he defeated the enemy near Batavia in the East Indies late in the year 1618, arrived at Masulipaṭam in July 1619, and died there on Aug. 9.

DALÉN, NILS GUSTAF (1869–1937), Swedish inventor who in 1912 was awarded the Nobel prize in physics, was born at Stenstorp, Nov. 30, 1869. After passing his examination as an engineer at Göteborg in 1896 he completed his studies at Zürich. On his return home he invented improved hot-air turbines, milking and other machines. In 1906 he became chief engineer to the Gas Accumulator Co., which was exploiting in Sweden the French invention of dissolved acetylene. In 1909 he was appointed managing director of this company and then succeeded in composing a product called "Agamassan" which has the property of absorbing acetylene without any danger of explosion. Dalén's cleverest invention was what is called Solventil, which is capable of kindling a flame automatically when twilight sets in and extinguishing it at daybreak; it was particularly useful for automatic lighting in unmanned lighthouses. During an experiment in 1913 he became blind in consequence of an explosion, but nevertheless he continued to conduct his experiments until his death at Stockholm Dec. 9, 1937.

DALGARNO, GEORGE (*c.* 1626–1687), Scottish author of an early and practical book on education of the deaf and dumb, was born about 1626 in Old Aberdeen, and was a schoolmaster for 30 years. In *Ars Signorum* (1661) he attempted to formulate a universal philosophical language in which ideas were represented by letters. His *Didascalocophus* (1680) contained a manual deaf and dumb alphabet. Dalgarno died at Oxford on Aug. 28, 1687.

DALHOUSIE, FOX MAULE RAMSAY, 11TH EARL OF (1801–1874), English statesman who, as a secretary for war (1855–58), shared the blame for the conduct of the last stage of the Crimean War, was born on April 22, 1801, at Brechin castle in Forfarshire. Educated at Charterhouse, he served as a regular officer for 12 years before retiring from the army in 1832 with the rank of captain. Maule entered parliament in 1835 as a Liberal member for Perthshire, which he represented until 1837, becoming member for Elgin Burghs in 1838–41. During Lord Melbourne's administration he was undersecretary at the home office and then vice-president of the board of trade; under Lord John Russell he was secretary at war from 1846 to 1852, when he became president of the board of control for India shortly before the ministry's fall. In 1852 Maule, who had sat for Perth between 1841 and 1852, succeeded his father as 2nd Baron Panmure. On the formation of Lord Palmerston's first government in 1855, he became secretary of state for war, which he remained for three years. In 1860 he succeeded as 11th earl of Dalhousie (taking the Dalhousie surname, Ramsay, in 1861). He died at Brechin castle on July 6, 1874.

Panmure's nickname, "the Bison," reflected his temperament as well as his physique; he was a forceful but often clumsy and insensitive politician and administrator. During the concluding phase of the Crimean War his conduct came under heavy criticism, much of it justified; Palmerston's loyalty protected him until the government's defeat in 1858, but he played no part in politics thereafter. His correspondence, the *Panmure Papers*, published in 1908, forms an important source on the mismanagement of the Crimean War. (A. F. T.)

DALHOUSIE, JAMES ANDREW BROUN RAMSAY, 1ST MARQUESS OF and 10TH EARL OF (1812–1860), British statesman, one of the greatest governors general of India, was born at Dalhousie castle, Scot., on April 22, 1812, the third son of George Ramsay (1770–1838), 9th earl. His father was one of Wellington's

generals and later became governor of Canada and commander in chief in India. James Ramsay, who became 10th earl in 1838, was made vice-president of the board of trade in 1843 and succeeded Gladstone as president in 1845. He therefore had to cope with the railway "mania" of 1845–46. Over the repeal of the corn laws he supported Sir Robert Peel, whose second cabinet he entered in Dec. 1845. He refused Lord John Russell's offers of a cabinet post in 1846, but in 1847, when promised "personal independence with reference to party politics," he accepted the governor generalship of India, assuming office in Jan. 1848.

Territorial Expansion.—Dalhousie found India apparently peaceful, but in April 1848 two British officers sent to install a new Sikh governor in Multan were murdered there. Failure to strike at once permitted Sikh uncertainty and alarm to express itself in wider outbreaks. Full-scale war, half expected, half hoped for by Dalhousie, followed in November. By March 1849 the Sikhs had surrendered and Dalhousie had coerced the boy maharaja and the council of regency into accepting his annexation of the Punjab. For his services Dalhousie was created marquess. In 1852 commercial disputes at Rangoon, badly handled on the spot, led to the second Burmese War. "We can't afford," Dalhousie said, "to be shown to the door anywhere in the East." His care prevented any repetition of the losses of the first Burmese War, and after success had been cheaply achieved within the year, he wisely limited British acquisitions to the province of Pegu. Further acquisitions were peacefully secured. Dalhousie firmly believed in the superiority of western administration and had little hope of Indian self-improvement. He therefore systematically pursued the policy, earlier enunciated though only fitfully applied, of annexing dependent states, by lapse, whenever male heirs failed. Accordingly Satara lapsed in 1848, Jaitpur and Sambalpur in 1849, Baghat in 1850, Udaipur in 1852, Jhansi in 1853 and Nagpur in 1854. The first and last of these additions made British communications between Bombay and Madras and Bombay and Calcutta easier; besides, Dalhousie valued Nagpur as a cotton-growing area.

Two great Indian states, Hyderabad and Oudh, remained outside British rule, but from 1848 Dalhousie was writing about taking over their administration. The nizam of Hyderabad was constantly in arrears with his payments for the Hyderabad contingent. In 1853 he was persuaded to assign to the East India company, in lieu of other payment for the contingent, the revenues—and administration—of Berar. Oudh was more difficult. The king, repeatedly warned, had failed to introduce reforms and repress internal disorders; yet, as Dalhousie said, he would take any amount of kicking without rebelling. The reports of James Outram, the resident at Lucknow, and Hindu-Muslim riots in Oudh in 1855 provided the occasion for action. Dalhousie proposed British administration in the king's name, but the directors of the company insisted on annexation and in Feb. 1856, when the king refused to abdicate, annexation was proclaimed. In 1855 Dalhousie had signed a short treaty of peace and friendship with the Afghan ruler Dost Mohammed, who was glad to have his part in the Sikh War forgotten. Since the subordinate alliance of the khan of Kalat had the previous year been bought by annual subsidies, the northwest frontier had been secured.

Internal Administration.—By conquest, lapse and annexation Dalhousie had expanded and knit together British territories, drawing the modern map of India. He also began the creation of a modern unitary state. The new acquisitions remained directly under his control, and upon them he imposed an administrative system of Benthamite vigour and directness. "Uniformity of management and unity of authority" were his guides; he therefore placed his districts under a hierarchy of authority and gave to his deputy commissioners the combined function of revenue collector, magistrate and civil judge. Both promptitude of action and real responsibility were thus secured. Besides imposing a rigid system of reports and records—the annual administrative report was his creation—Dalhousie was indefatigable in personal tours and inspections. John Lawrence in the Punjab and Col. Arthur Phayre in Burma were administrators of outstanding ability; nevertheless, by his tours, Dalhousie maintained close personal control of both these provinces. He also invented the all-India department—for public works, the post office, public instruction—each under a single authority; and he swept away such dilatory bodies as the military board, replacing them with new unitary departments. He appointed a lieutenant governor for Bengal, hitherto administered by the governor general, and reorganized the Calcutta secretariat.

Dalhousie also provided the physical instruments for vigorous central control. The road system was rapidly expanded, especially in the Punjab; a half-anna letter post was successfully introduced; cities were closely linked by the telegraph; and the framework of the railway system was designed by his experienced and masterly hand. Improved communications made centralized administration possible and facilitated troop movements and, along with the abolition of hampering duties and customs barriers, stimulated trade. Peace and orderly administration, the execution of the first great irrigation works and Dalhousie's fostering of tea planting encouraged production. Exports and imports doubled during his governor generalship. By entrusting railway construction to private companies he encouraged the first large-scale movement of investment capital into India. Within India, ignoring the court of directors' fears, he began the fruitful process of government borrowing for productive works. Dalhousie also found time to write at length on educational policy and to introduce the reforms prepared by Sir Charles Wood. Fresh emphasis was given to primary education, while grants-in-aid encouraged high schools and colleges. Dalhousie himself paid much attention to expanding the engineering colleges, of whose products he foresaw the coming need.

Only a driving, masterful man could have completed such a program, and Dalhousie, in imposing civilian, central control over army and administration, could be ruthless. Sir Charles Napier, the commander in chief, resigned; Henry Lawrence was pushed aside; picked men like John Jacob, H. B. Edwardes and Phayre suffered for overindependence. His utilitarian contempt for anachronistic princes, sirdars or talukdars could be coarsely brutal. Yet he did much for the peasantry of Oudh and the Punjab, he sought to utilize the experience and intellectual qualities of Indians in the legislative council and from many of his officers he secured devoted service. If his inability to see with other men's eyes and feel with other men's hearts may have played a part in provoking the Indian mutiny, his ability to use other men's hands and brains for broad, creative purposes was certain.

Dalhousie left India in 1856, a very sick man; he died at Dalhousie castle on Dec. 19, 1860. By his marriage (1836) with Lady Susan Hay, daughter of the marquess of Tweeddale, he left two daughters but no sons. The marquessate therefore died with him.

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DALHOUSIE, a hill station in Gurdaspur district, Punjab, India, is 52 mi. N.E. of Pathankot at an elevation of 6,678 ft. Pop. (1961) 8,583. Its population fluctuates, there being many summer visitors. The scenic beauty of Dalhousie is typical of the Himalayan summer hill resorts. It is a quiet hill station, where Punjab university maintains a vacation centre for the teachers of the colleges affiliated to it. (O. P. B.)

DALÍ, SALVADOR (1904–), Spanish Surrealist painter, sculptor and illustrator, was born on May 11, 1904, in Figueras, Catalonia, Spain, and studied in Barcelona and Madrid, where he was expelled from the Academy of Fine Arts. He was influenced by Giorgio de Chirico, Yves Tanguy and Max Ernst, *art nouveau* and Dutch painting. The *enfant terrible* of Surrealism, he joined the younger or neo-Surrealist branch of that movement in Paris in 1929 and thereafter was its best-known exponent. With Luis Buñuel he produced two Surrealist films, *Le Chien andalou* ("The Andalusian Dog") (1929) and *L'Age d'Or* ("The Golden Age") (1931), which was closed down by the Paris police. From 1932 his works were shown throughout Europe, in the United States and in the orient. He went to the United States in 1940, gave a retrospective exhibition at the Museum of Modern Art, New York city, in 1941 and published his autobiography, *Secret Life of Salvador Dali,* in 1942. He projected a "psychoanalytical" art

which, in very naturalistic terms, gives symbols from his dream life, hallucinations and fetishes. Dalí's work should be contrasted with that of Joan Miró, André Masson and other more abstract Surrealist artists. *See* PAINTING: *Surrealism;* STILL-LIFE PAINTING; SURREALISM.

See James T. Soby, *Salvador Dali* (1946); Alfred H. Barr, Jr. (ed.), *Fantastic Art, Dada, Surrealism* (1936). (B. S. Ms.)

DALIN, OLOF VON (1708–1763), leading Swedish writer of the mid-18th century, was born Aug. 29, 1708, in the parish of Vinberg, Halland, where his father was pastor. After studying at the University of Lund he became, in 1727, a tutor in a noble family in Stockholm, where he soon won favour as the witty author of occasional verse, a talent for which he exercised throughout his life. From 1732 to 1734 he published the weekly *Then swänska Argus,* modeled on Joseph Addison's *Spectator.* Dalin's periodical was one of the means by which the ideas of the Enlightenment were introduced into Sweden, but its language and style were of even greater importance than its matter. It is regarded as ushering in the age of modern Swedish prose. Dalin also attempted to create a Swedish drama of the French classical type, but his plays are unreadable.

Dalin lived in a period of political upheaval and often commented on the points at issue. His most famous work, *Sagan om hästen* ("The Story of the Horse," 1740), an allegory in the style of Swift, was a fruitless effort to influence opinion against war with Russia. When the misfortunes of the war accumulated, he wrote his didactic epic *Swenska friheten* ("Swedish Liberty," 1742), in which he saw salvation in the abolition of the party system and in increased royal power.

In 1750 Dalin became tutor to the crown prince, afterward Gustavus III. He held this post until 1756, when, as the queen's favourite, he was exiled from court until 1761, on suspicion of having taken part in the so-called court revolution. Dalin's greatest interest was the study of history; and he wrote three volumes of a lively *Svea rikes historia* ("History of the Swedish Kingdom"; 1747–62). He had early become a civil servant, but royal favour was the real foundation of his social career. Dalin was ennobled in 1751. Before he died (Aug. 12, 1763, at Drottningholm, Stockholm), he had regained his high position at court and in the administration.

BIBLIOGRAPHY.—Dalin's literary works were published in 6 vol., *Vitterhetsarbeten i bunden och obunden skrifart* (1767). *See* also K. Warburg, *Olof Dalin* (1884); M. Lamm, *Olof Dalin* (1908); A. Blanck, "Sagan om hästen och finska kriget" in *Ur samma synvinkel* (1935); L. Breitholtz, *Våra första fransk-klassiska dramer* (1944) and "Dalin och den politiska propagandan" in *Studier i frihetstidens litteratur* (1956); M. von Platen, "Dalins politiska satirer" in *Samlaren* (1958). (L. G. Bz.)

DALKEITH, a small burgh of Midlothian, Scot., between the North and South Esk, 7 mi. S.E. of Edinburgh by road. Pop. (1961) 8,865. It is an agricultural centre and the chief milling town for a county famous for its oatmeal. The corn exchange (1854) is now used by the electronics industry. Other industries are the manufacture of sausages, carpets, brushes and papermaking machines, and brass founding. Near Eskbank, the residential quarter with the railway station, coal mining is carried on and market gardening flourishes. The parish church of St. Nicholas was originally the castle chapel, and was restored in 1852. A park was presented by the duke of Buccleuch in 1909. Melville castle, completed in 1788 to the designs of John Playfair, is now a hotel, though still belonging to the Douglases. Dalkeith palace, rebuilt and redesigned by Sir John Vanbrugh about 1700, was the residence, during visits to Edinburgh, of George IV, Victoria and Edward VII. The picture gallery, gardens and park are well known. Extensive central redevelopment was in hand in the mid-1960s.

About 1 mi. S. is Newbattle abbey, seat of the marquess of Lothian, on the site of an abbey founded by David I, the ancient crypt being incorporated in the mansion; it is now a residential college for adult education. Two miles farther south lie Cockpen, immortalized by Baroness Nairne (*q.v.*), and Dalhousie castle. About 6 mi. S.E. of Dalkeith is Borthwick castle (restored) where Mary, queen of Scots, spent three weeks after her marriage with Bothwell; it was besieged by Cromwell in 1650. Also nearby are the ruins of Crichton castle (14th–16th centuries).

DALKEY (DEILGINIS), a small port and seaside town of County Dublin, Republic of Ireland, lies 9 mi. S.E. of Dublin by road. Population in 1961 was 5,754. It is situated on and about Sorrento point, the southern horn of Dublin bay. Ruins remain of two of the seven castles which once guarded the town. On Dalkey Island are a Martello tower and the remains of St. Begnet's oratory. The island was noted in the 18th century for the periodical election of the mock "King of Dalkey"; originated by students, this election developed significant political overtones until banned by Lord Clare in 1797. The family of George Bernard Shaw had a cottage (Torca cottage) on Dalkey hill from 1866 to 1874.

DALLAS, ALEXANDER JAMES (1759–1817), U.S. lawyer and financier who served as secretary of the United States treasury during the difficult years 1814–16. He was born of Scottish parents in Jamaica on June 21, 1759, and was educated in Scotland and England. In 1780 he went to Jamaica where he became acquainted with the actor, Lewis Hallam, who induced him to go to Philadelphia. Dallas immediately took up the study of law, and gained admission to practice in 1785. With Hallam he indulged his literary and theatrical inclinations, editing the *Columbian Magazine* from 1787 to 1789 and helping Hallam in the establishment of the theatre in Philadelphia. In 1791 he was appointed secretary of the commonwealth of Pennsylvania, a post he held for the next ten years.

In 1795 he gained much influence in the Democratic-Republican party by the publication of an able pamphlet against the Jay treaty; and when Jefferson became president in 1801, Dallas was appointed U.S. attorney for the eastern district of Pennsylvania, a position he held continuously until Madison called him to be secretary of the treasury in 1814. Within two weeks he made recommendations to congress that eventually led to the establishment of the second bank of the United States. Meanwhile, Dallas had made recommendations regarding the tariff and a system of protection which became the basis of the Tariff act of 1816. He left the treasury in March 1816 and died the following year on Jan. 16.

DALLAS, GEORGE MIFFLIN (1792–1864), U.S. vice-president (1845–49) and minister to Great Britain at the outbreak of the American Civil War, was born in Philadelphia on July 10, 1792, the son of Alexander J. Dallas, then a young lawyer, who later became secretary of the treasury. Dallas graduated from Princeton (1810), studied law in his father's office and gained admission to the bar in 1813. He went abroad for a year as private secretary to Albert Gallatin, who was on a diplomatic mission for the United States. He worked with his father in the U.S. treasury department for a short time and then joined the legal staff of the Second Bank of the United States. In the years that followed he became an influential figure in Pennsylvania politics. Dallas filled out an unexpired term as U.S. senator (1831–33), was minister to Russia (1835–39) and U.S. vice-president under James K. Polk. After leaving the senate he aided Robert J. Walker, a former U.S. senator, in promoting in England the financial interests of the Illinois Central railroad. In 1856, when Dallas's political rival, James Buchanan, returned from London to run for the presidency, President Pierce appointed Dallas to be his successor as minister to Great Britain. Buchanan retained Dallas at the London post throughout his term as president. Dallas was an amiable, cultured gentleman and skilful diplomat. He and Lord Clarendon on Oct. 17, 1856, signed a treaty for the settlement of the Central American questions arising from the Clayton-Bulwer treaty (*q.v.*) but it was not ratified.

See G. M. Dallas, *Letters from London* (1869); I. D. Spencer, *Life of Marcy* (1959). (T. P. MA.)

DALLAS, principal city of northern Texas, U.S., seat of Dallas county, is an important financial, merchandising and light manufacturing city and one of the control centres of the world's petroleum industry.

Dallas is situated 45 mi. S. of the Oklahoma border and 174 mi. W. of Louisiana. A city largely rebuilt after World War II, its business towers and residential districts occupy about 280 sq.mi. astride the Trinity river near the junction of that river's three forks. It is an area of prairie and gentle hills with low bluffs

along the watercourses. Dallas winters are mild, the January normal temperature being 45.7° F., but the summers are long and hot. As a result, Dallas has become a city almost wholly air-conditioned. Some of its shopping villages have air-conditioned malls connecting the stores.

The population of Dallas in 1960 was 679,684; the standard metropolitan statistical area (Collin, Dallas, Denton and Ellis counties) had a population of 1,083,601. (For comparative population figures *see* table in TEXAS: *Population.*) Included in the metropolitan area are Garland, Grand Prairie, Highland Park, Irving, Mesquite, Richardson and University Park.

The city lavishes on dress and fashion the attention that some cities do on fine food. It is one of the largest producers of women's fashions in the United States and one of the largest women's sportswear markets. It is a large insurance centre.

History.—In 1841, John Neely Bryan built the first cabin on the riverbank site. The hamlet which grew up around it took the name of George Mifflin Dallas, then vice-president of the United States. The town profited in 1858 from the failure of the Fourier socialist colony at La Réunion, which had been built three years earlier on the limestone hills west of Dallas. Some of the skilled French and Swiss artisans moved across the river to the rude village. They gave it carriage makers and bakers as well as such frontier naturalists as Julien Reverchon. The town was first shaped toward a commercial destiny, however, by the arrival with the railroads in the 1870s of the "terminal merchants." Some of these men, who moved their stores on to each new railhead as the railroads lengthened, stayed in Dallas and founded wholesale and retail houses. From these beginnings grew a $3,000,000,000 wholesale market. Buyers regularly come to the four yearly apparel shows from more than 20 states. Many of the city's retail stores have customers all over the southwest and one, Neiman-Marcus Co., is internationally known.

Cotton fed the town's growth at first, then insurance and oil. Before the Dallas Cotton exchange was organized in 1907, buyers had set up a street market on lower Elm street. In the 1920s, 40% of the nation's cotton crop came from the black clay fields around Dallas, and the city still makes more than half of the world's ginning machinery. For years it was the world's largest inland cotton market, but Memphis, Tenn., had surpassed it by 1960.

In Nov. 1963 international attention was focused on Dallas when Pres. John F. Kennedy was assassinated by a sniper as he rode in a motorcade through crowds welcoming him to the city.

Commerce, Industry and Transportation.—Dallas is the leading banking centre of the southwest and the federal reserve bank of the 11th district is there. It was an important financial centre when Texas in 1908 passed the Robertson act requiring insurance companies doing business in the state to headquarter there. The major national companies quit the state, though most returned when the laws were modified many years later. The home-grown insurance companies which sprang up to fill the void tended to concentrate in Dallas. The home offices of about 200 legal reserve life insurance companies, and agencies of 500 more companies are located there.

On Sept. 30, 1930, C. M. ("Dad") Joiner tapped the great east Texas oil field for the first time. Though Dallas had had natural gas and fuel oil since 1915 and Magnolia Petroleum company had set up headquarters there in 1917, the east Texas field made the city an oil centre. Producers and suppliers moved into the city for more than a decade.

The world's three largest oil well supply firms make their headquarters in Dallas, and Dallas geophysical firms operate all over the world. Dallas banks pioneered in financing oil exploration and the large ones have their own staffs of geologists.

The city began a period of spectacular growth in 1946. Its area quintupled. In the post-World War II period, it did a great amount of downtown building and built 147,651 units of housing in one ten-year period. In part, this growth started from the location of two large aircraft firms in the suburbs of Grand Prairie to the west and Garland to the north. Airframes and missiles are produced in the city's plants, but the varied manufactures include auto accessories, cement, food products, clothing, chemicals, fabricated metal products, gun cases and electrical machinery. One electronics firm is one of the world's largest makers of transistors. Another suburb, Richardson, also shares the city's manufacturing plants.

The other two leading fringe suburbs, Mesquite on the east and Irving on the northwest, and the two enclosed suburbs of Highland Park and University Park are mainly residential.

Dallas is served by several railroads. It is headquarters for the Texas and Pacific railroad and regional headquarters for Western Union Telegraph Co. and Southwestern Bell Telephone Co. Most major airlines operate from the city's rebuilt Dallas Love field. Dallas operates Redbird airport for private fliers and leases Hensley field, at Grand Prairie, to the U.S. navy.

Cultural, Educational and Recreational Facilities.—The city supports a symphony orchestra, a civic opera season, a flourishing resident theatre movement and school, several museums of art, history and natural history and a summer-long season of musical shows.

It is the home of Southwestern medical school of the University of Texas and the Baylor dental and nursing colleges. Southern Methodist university, founded in 1911, is in University Park, and the University of Dallas (Catholic) began operations in 1956 in Irving.

Among the many churches, the First Baptist, Highland Park Presbyterian and Highland Park Methodist are the largest.

It has more than 100 parks of about 8,000 ac. They include a zoo and fair park, the site of the state fair of Texas which draws more than 2,500,000 visitors annually. In addition, there are large recreation areas around the three large lakes of Grapevine, Garza-Little Elm and Lavon, north of Dallas, from which the city draws

BY COURTESY OF DALLAS CHAMBER OF COMMERCE

SKYLINE OF DALLAS, TEX.

its water supply. Dallas has a council-manager form of government established in 1931. (E. P. Cr.)

DALLIN, CYRUS EDWIN (1861–1944), U.S. sculptor, best known for his plastic representations of the North American Indian, was born at Springville, Utah, on Nov. 22, 1861. He was a pupil of Truman H. Bartlett in Boston, Mass., of the École des Beaux-Arts, the Académie Julien and the sculptors Henri Chapu and Jean Dampt in Paris, and on his return to America became instructor in modeling in the state normal art school in Boston.

As a boy Dallin had lived among the Indians, and his most notable works are of Indian subjects: "The Signal of Peace" in Lincoln park, Chicago; "The Medicine Man" in Fairmount park, Philadelphia; and "The Appeal to the Great Spirit" in the Museum of Fine Arts, Boston. His statue of the Indian chief Massasoit, at Plymouth, Mass., was completed in 1921.

His later works include "Pioneer Monument," Salt Lake City; "Sir Isaac Newton," Library of Congress; and "Paul Revere," Boston. He won a silver medal at the Paris Exposition, 1900, and in 1906 the first prize in the competition for the soldiers' and sailors' monument at Syracuse, N.Y.

Dallin died in Boston, Nov. 14, 1944.

DALLING AND BULWER, WILLIAM HENRY LYTTON EARLE BULWER, Baron (1801–1872), English diplomat who was highly regarded both by Aberdeen and by Palmerston as a negotiator of exceptional skill. He was born in London on Feb. 13, 1801, and educated at Harrow school and at Trinity and Downing colleges, Cambridge. Leaving the army for the diplomatic service in 1829, Bulwer was sent by Lord Aberdeen as observer during the Belgian revolution of 1830, and received the congratulations of the cabinet on his reports. Entering parliament for Wilton in 1830 as an advanced Liberal, Bulwer sat first for Coventry and then for St. Marylebone between 1831 and 1837, establishing a reputation as a debater and a prolific and versatile writer.

Bulwer returned to diplomacy in 1835 as chargé d'affaires in Brussels. Three years later, while secretary of embassy at Constantinople, he negotiated the Ponsonby treaty with Turkey, which secured important advantages for British trade and was described by the foreign secretary, Lord Palmerston, as "a masterpiece." Chargé d'affaires in Paris during the crisis of 1839–40, Bulwer was appointed ambassador to Spain in 1843. He exercised great influence at Madrid, notably during the Franco-British tension in 1846–47 over the marriage alliances made by the Spanish royal family with that of Louis Philippe of France. Strongly sympathetic to the constitutional cause throughout his embassy, Bulwer was expelled by the dictator Ramón Narváez in 1848; Britain broke off diplomatic relations with Spain, and Bulwer received parliament's thanks for his services. From 1849 to 1852 he acquired considerable popularity as ambassador to the United States, which assisted his conclusion of the Clayton-Bulwer treaty (*q.v.*); and between 1852 and 1855 he acted as minister plenipotentiary to the grand duchy of Tuscany at Florence. After playing a major part in the negotiations at the close of the Crimean War, Bulwer ended his diplomatic career by succeeding Stratford Canning as ambassador in Constantinople from 1858 to 1865. In retirement, he was elected member for Tamworth in 1868, raised to the peerage in 1871 and died at Naples on May 23, 1872.

Brother of the novelist Lord Lytton, whose taste for literary and fashionable society he shared, Bulwer is best remembered as an author for his *Life of Viscount Palmerston.* (A. F. T.)

DALLMEYER, JOHN HENRY (1830–1883), Anglo-German optician and manufacturer of lenses, was born on Sept. 6, 1830, at Loxten, Westphalia, the son of a landowner. On leaving school at the age of 16, he was apprenticed to an Osnabrück optician, and in 1851 he went to London, where he obtained work with an optician and later with Andrew Ross, a lens and telescope manufacturer. After a year spent in a commercial post, he was reengaged by Ross as scientific adviser. He married Ross's second daughter, Hannah, and inherited, at Ross's death (1859), a third of his employer's large fortune and the telescope-manufacturing portion of the business. Turning to the making of photographic lenses (*see* Photography), he introduced improvements in both portrait and landscape lenses, in object glasses for the microscope and in condensers for the optical lantern. In connection with celestial photography he constructed photoheliographs for the Wilna observatory in 1863, for the Harvard college observatory in 1864, and, in 1873, several for the British government. Dallmeyer's instruments took the highest awards at various international exhibitions, and he received many honours from governments and learned societies. He died on board ship, off the coast of New Zealand, on Dec. 30, 1883.

His second son, Thomas Rudolphus Dallmeyer (1859–1906), introduced telephotographic lenses into ordinary practice (patented 1891) and wrote a standard book on the subject (*Telephotography,* 1899).

DALMATIA, a geographical region of the Balkan peninsula, comprising the central stretch of the Yugoslav littoral and a fringe of islands on the eastern coast of the Adriatic. Its greatest breadth, on the mainland, is about 45 mi. and its length, from the Gulf of Kvarner (Quarnero) to the narrows of Kotor (Cattaro) about 233 mi. The major islands are Krk (Veglia), Cres, Rab (Arbe), Pag (Pago), Dugi (Isola Lunga), Brac (Brazza), Hvar (Lesina), Korcula (Curzola), Mljet (Meleda), Vis (Lissa) and Lastovo (Lagosta). Politically, Dalmatia is included in Croatia (*q.v.*) within federal Yugoslavia.

A rugged and barren range of mountains, the Dinaric Alps, divides Dalmatia from Bosnia-Hercegovina. This barrier, with peaks from 3,000 ft. to more than 8,700 ft., offers only two main passes: the Krka river canyon, prolonged on the Bosnian side by the Una river; and the Neretva valley leading to central Bosnia. The coast, both on the mainland and on the islands, has many natural bays and harbours. The climate is mild, with dry summers, abundant rain in autumn and winter and very little snow.

Five-sixths of the population of Dalmatia in the 1960s were Roman Catholic Croats, the remainder Orthodox Serbs, though there was a small Italian minority living mainly in Zadar (Zara). Zadar, Split (Spalato), Sibenik (Sebenico), Dubrovik (Ragusa), Trogir (Trau), Korcula and Kotor (Cattaro) are the principal cities. Zadar is a Roman Catholic archbishopric, and there are Roman Catholic bishoprics at Sibenik, Split, Hvar, Dubrovnik and Kotor. There are also Orthodox bishoprics at Zadar and Kotor.

The soil is not suitable for the cultivation of bread grains but favours olive trees, vegetables and, above all, vines. Dalmatian vineyards supply one-third of the total Yugoslav wine production. There are rich deposits of bauxite, exploited by the aluminium foundry near Sibenik. Abundant reserves of limestone account for the fact more than one-third of Yugoslavia's cement output comes from the neighbourhood of Split. There are also chemical factories as well as food-processing plants. The major shipbuilding yards are at Split. The rivers, except for a few miles on the Krka and on the Neretva, are unsuitable for navigation, but their precipitous fall makes them a natural source of hydro-electric power.

Its picturesque coastline, its romantic islands, its ancient cities with their historic monuments and its delightful climate combine to make Dalmatia one of the most frequented summer tourist areas in Europe.

History.—The first historically recorded inhabitants of Dalmatia were Illyrians, an Indo-European people who overran the northwestern part of the Balkan peninsula (*see* Illyria). Of this people the Delmatae or Dalmatians were a tribe. The Greeks, however, began to settle in the area from the 4th century B.C., founding a number of colonies on the islands, the most famous of which were Issa (Vis), Pharos (Hvar), Corcyra Melaina (Korcula), and a few towns on the mainland coastline, the most renowned of which were Epidaurum (Cavtat), Iadera (Zadar), Tragurion (Trogir) and Salona (Solin, near the modern Split). Coming into conflict with the Illyrians, the Greek colonists appealed for protection to the Romans, who also had grievances against the Illyrians, and a long series of Roman-Illyrian wars ensued from 229 B.C. onward. The Dalmatians had to acknowledge Roman supremacy in 155 B.C. after the fall of their capital, Delminium, but continued to revolt sporadically until A.D. 9.

Roman occupation introduced classical civilization to Dalmatia. Administration, justice and trade were organized on the Roman

model, and new towns were built in accordance with Roman city planning. At the end of the 3rd century A.D. the emperor Diocletian, himself a native of Dalmatia, divided the country into two provinces: Dalmatia and Praevalitana. On his abdication (305) he went to reside in his new palace near Salona (in modern Split) till his death. The Christian Church, after the bloody persecutions under Diocletian, was reorganized: metropolitan sees at Salona and Iadera were founded.

In the second half of the 5th century Dalmatia became a fighting ground for ambitious generals. In the 460s Marcellinus founded an independent state of Dalmatia. It was in this state that his nephew, the Roman emperor Julius Nepos (*q.v.*) took refuge after being driven from Italy in 475. On the collapse of the Western Roman empire Dalmatia fell under the power of Odoacer in 481 and later under that of Theodoric, to become a battlefield during the wars waged between the Goths and the emperor Justinian.

This period was also one of ever-growing incursions by barbarian tribes—Huns, Bulgars, Avars and Slavs. The Croats, a branch of the Slavs from beyond the Carpathian mountains, invited by the Eastern Roman emperor Heraclius, expelled the Avars and settled down in the old Illyrian province. The cities of Salona, Scardona (Skradin), Iadera, Narona (or the Norin) and Epidaurum were destroyed in the course of fighting. In southern Dalmatia, likewise on the invitation of Heraclius, another tribe of Slavs settled, namely the Serbs. The original inhabitants, however, Romans, romanized Illyrians and Greeks, survived in restricted areas along the coast, mainly in the towns. Former citizens of Epidaurum settled in the newly built Ragusium (Dubrovnik); refugees from Salona found shelter in the abandoned palace of Diocletian. The Slavs formed themselves first into small autonomous units, *zupas,* with a *zupan* as head and then into groups or *banovinas,* administered by a *ban.* Those formations acknowledged, however, the over-all sovereignty of the Byzantine emperor.

In the struggle between Charlemagne and the Byzantines, early in the 9th century, Dalmatia, after a short period under the Franks, returned to Byzantine sovereignty. Then neighbouring Slav peoples began to exercise a more lasting pressure, against which the Byzantine emperor could give Dalmatia no efficient help. Accordingly the Dalmatian towns agreed to pay tribute to the Slav rulers of the interior. Later these rulers assumed the title of kings of Croatia and Dalmatia. (*See* CROATIA.) In fact coastal Dalmatia retained its language, its laws and civil and religious autonomy.

It was in the dramatic period between the emergence of the Croatian kingdom in Dalmatia and the establishment of permanent Venetian rule that Dalmatia acquired its specific physionomy. During that time it passed through about 30 changes of over-all sovereignty: Byzantine Greeks, French, Croatian and Serbian princes, Venetians, Sicilian Normans, Magyars and Tatars were each masters of Dalmatia for a short period. During the fourth crusade, Zadar was razed to the ground in 1204 by the French and Venetians. Tatars in 1241–42 ravaged some of Dalmatia's towns and laid waste the nearby agricultural land. Underlying all these changes, however, was the permanent struggle between the Slav princes and the Venetian republic. The Croatian kings and the Venetian doges were the only rulers who held power long enough to leave a permanent mark on the Dalmatian character and consciousness. At the end of the Roman period Dalmatia had been divided into two zones, one coastal and prevalently Roman, the other Slav in character, but subsequently the two elements began to interpenetrate one another. For the liturgy of the churches the Glagolitic rite, inherited from Cyril and Methodius, the apostles of the Slavs, made its appearance, and a long struggle ensued between the Latin and the Glagolitic clergy. Roughly at the same time, the Bogomil sect from Bosnia appeared on the scene. To combat it, the Franciscan and Dominicans were sent by Rome to Dalmatia. Their influence, as well as that of the Benedictines, had a great effect on cultural development, to which humanistic schools, various forms of brotherhoods of craftsmen, libraries and archives bear witness. Public notaries began to be appointed and city statutes drawn up in the course of the 12th and 13th centuries. At the beginning of the 15th century the republic of Poljica, in the neighbourhood of Split, was one of the first cities to have its statute in Slavonic. The 15th and 16th centuries also saw the birth of secular literature in Slavonic, as well as a revival of a scientific literature—mostly in Latin and some in Italian.

Venetian rule over Dalmatia (1420–1797) was established when the king of Croatia, Ladislas of Naples, ceded the country to the republic—a period marked by warfare against the Turks. After the fall of Constantinople (1453) Serbia, Bosnia-Hercegovina and Albania fell under Turkish Moslem domination. Dalmatia seemed likely to be the next victim. To face this threat, a Croatian knight, Petar Kruzic formed a corps of guerrillas called *uskoki* at his stronghold of Klis, near Split. The Venetians, meanwhile, created an efficient militia out of a mass of Slav refugees in Dalmatia. In the 1460s the first Turkish incursion took place. The environs of Zadar and Sibenik were ravaged, but the citizens of Split and Trogir built a chain of fortifications against the invaders. As long as they attacked the Turks, the *uskoki* were regarded with sympathy by Venice and the Dalmatian cities: the Turks, in fact, accused Venice and Austria of supporting the *uskoki.* In 1536, however, the Turks beat the *uskoki* and took Klis, whereupon the Holy Roman emperor Ferdinand I gave the *uskoki* the city of Senj. The *uskoki* then went on with their exploits and soon became remarkably able mariners, attacking not only the Turks but also the Venetians. In the Venetian wars against the Turks, moreover, from 1515 to 1540, Dalmatia was left to its own resources, so almost the whole country except the coastal cities fell to the Turks. The cities indeed would probably have suffered the same fate but for the Christian victory in the battle of Lepanto (*q.v.*) in 1571. Subsequently attacks by the *uskoki* on Venetian vessels and cities led to war between Venice and Austria (1615). Under the treaty of Madrid (1617) the question was settled: the *uskoki* were finally removed from Senj, a number of them were hanged and their vessels were burned.

During later wars, from 1645 onward, Dalmatia's frontier with Turkey was changed continually until in 1699, with the peace of Karlowitz, all Dalmatia came under Venice; and the treaty of Passarowitz (1718) confirmed Venetian sovereignty. When the French gave Venice to Austria under the treaty of Campo Formio (1797) Dalmatia became Austrian also, but in 1805, under the treaty of Pressburg, Austria had to cede Dalmatia to Napoleon. By joining Dalmatia, Istria and Slovenia to form the Illyrian provinces of the French empire, Napoleon gave a powerful impulse to the idea of Yugoslav unity. In 1815, after the fall of Napoleon, Dalmatia was assigned to Austria again. It remained an Austrian crownland till 1918.

During World War I, by the secret treaty of London (1915) the Allies had promised large territories, including northern Dalmatia, to the Italians in return for Italian support. This treaty embittered negotiations for a peace settlement. Finally the treaty of Rapallo (Nov. 12, 1920) between Italy and Yugoslavia gave all Dalmatia to the Yugoslavs except Zadar and four islands, which went to Italy. During World War II, when Yugoslavia was partitioned by the Axis powers, Dalmatia was annexed by Italy, but it passed to Yugoslavia in its entirety (*i.e.,* including Zadar and the four islands) in 1945.

See also references under "Dalmatia" in the Index volume.

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DALMATIC, a liturgical vestment, the distinctive garment of deacons of the Roman Catholic, Eastern and Anglican Churches. In the Eastern Churches, the *sakkos* of the bishops is similar in form. *See* VESTMENTS, ECCLESIASTICAL.

DALOU, JULES (1838–1902), French sculptor, noted both for his extravagant, allegorical group compositions and for his unaffected studies of common people, was born in Paris on Dec. 31, 1838. He was a pupil of J. B. Carpeaux and of F. J.

Duret. His earlier reliefs and his large public monuments are in an enlivened classical style learned from Carpeaux rather than the sober academic style taught at the École des Beaux-Arts. But his later smaller sculptures reveal his increasing sympathy with the compassionate attitude to human life and toil found in the paintings of J. F. Millet. His several mother and child groups and the simple realistic figures of workers (terra cottas in the Petit Palais, Paris) for a projected "Monument aux Ouvriers" (*c.* 1889–98) also find parallels in work done by C. Meunier in Belgium and by Dalou's friend A. Legros in England, where Dalou himself took refuge in 1871 following the commune. His most notable Parisian monuments include the allegorical bronze "Triomphe de la République," projected in 1879 and put up in the Place de la Nation in 1899; and the Delacroix memorial in the Jardin du Luxembourg (1890). He died in Paris April 15, 1902.

See H. Caillaux, *Aimé-Jules Dalou, 1838–1902* (1935).

DALRIADA, the name of a Gaelic kingdom which at least from the 5th century A.D. extended on both sides of the North channel (which divides Ireland from Scotland) and comprised the northern part of the present County Antrim, and part of the Inner Hebrides and Argyll. Tradition and language indicate that in still earlier times Argyll had received extensive immigration from the Irish (known as *Scotti*) of northern Ireland, and had already become an Irish (*i.e.*, "Scottish") area. In the latter half of the 5th century the ruling family of Irish Dalriada, already Christians, crossed into Scottish Dalriada, but continued to rule the kingdom on both sides of the channel. In Scottish Dalriada branches of this dynasty ruled in various districts, the chief strongholds being Dunadd and Dunolly. St. Columba, cousin of the Irish high king, settled on the island of Iona in Scottish Dalriada in the 6th century and converted the northern Picts to Christianity. Irish Dalriada gradually declined, while Scottish Dalriada, under Columba's protégé, King Aidan MacGabrain of Dunadd (d. *c.* 608), and his successors, extended its territory at the expense of the Picts. Early in the 9th century the Viking invasions isolated Irish Dalriada which soon lost its political identity. Despite heavy onslaughts from the Picts, the Dalriada of the Scottish mainland continued to expand. In the mid-9th century its king, Kenneth I MacAlpin (d. 858), brought the Picts permanently under Dalriadic rule. Henceforth the country was known as Scotland and the name Dalriada ceased to be used.

See W. F. Skene, *Celtic Scotland,* 3 vol. (1876–80); H. M. Chadwick, *Early Scotland* (1949). (N. K. C.)

DALRYMPLE, ALEXANDER (1737–1808), Scottish geographer, writer and hydrographer who collected and published a large number of charts for the admiralty, was born on July 24, 1737, at New Hailes, near Edinburgh, Scot., and in 1752 joined the East India company's service at Madras. He spent most of the years from 1757 to 1764 in the East Indies trying to open up trade, with little success; nor did he get support from the company in London in 1765. He returned to Madras as member of council in 1775, but after two years was recalled on a groundless charge of misconduct. In 1779 he became hydrographer to the company, and from 1795 to 1808 was hydrographer to the admiralty. His services were valuable, in spite of his difficult personality. His best work as a scholar was probably his *Historical Collection of the Several Voyages and Discoveries in the South Pacific Ocean,* 2 vol. (1770–71). He died on June 19, 1808, shortly after his retirement. (J. C. Be.)

DALTON, JOHN (1766–1844), English chemist and physicist, best known for his development of the modern atomic theory, was born about Sept. 6, 1766, at Eaglesfield, near Cockermouth in Cumberland. Joseph Dalton, his father, was a weaver who belonged to the Society of Friends and Dalton received his early education from his father and from John Fletcher, teacher of the Quakers' school at Eaglesfield. When Fletcher retired in 1778 young Dalton succeeded him. In 1781 he left his native village to become assistant to his cousin George Bewley, who kept a school at Kendal. He remained at Kendal till, in the spring of 1793, he moved to Manchester, where he spent the rest of his life. Mainly through the influence of John Gough (1757–1825), a classical and mathematical scholar, he was appointed teacher of mathematics and natural philosophy at the New college in Moseley street (which was in 1889 transferred to Manchester college, Oxford), and that position he retained until the college was moved to York in 1799, when he became a "public and private teacher of mathematics and chemistry."

Encouraged by Gough, Dalton, while he was at Kendal, had contributed solutions of problems and questions on various subjects to the *Gentlemen's* and *Ladies' Diaries,* and in 1787 he began to keep a meteorological diary in which during the succeeding 57 years he entered more than 200,000 observations. He made his own instruments. His first separate publication was *Meteorological Observations and Essays* (1793), which contained the germs of several of his later discoveries; but in spite of the originality of its matter, the book met with only a limited sale. In 1794 he was elected a member of the Manchester Literary and Philosophical society, and a few weeks after election he communicated his first paper on "Extraordinary Facts Relating to the Vision of Colours," in which he gave the earliest account of the optical peculiarity known as Daltonism or colour blindness, and summed up its characteristics as observed in himself and others. In 1803 he published a paper on the "Absorption of Gases by Water and Other Liquids," containing his law of partial pressures. (*See* Dalton's Law.) Independently of Joseph Louis Gay-Lussac he discovered that all gases have the same coefficient of expansion. (*See* Heat: *Thermal Properties of Gases.*)

Dalton was a crude experimenter; a good many of his results have since been disproved. None of his investigations compares with those concerned with the atomic theory, with which his name is inseparably associated. For a description of the atomic theory *see* Atom: *Dalton's Theory;* Chemistry: *The Development of the Theory of Molecular Structure.* It is clear from the notes prepared for his lectures that in his long series of meteorological experiments he was feeling his way toward the atomic theory. A study of these papers by H. E. Roscoe and A. Harden (*A New View of the Origin of Dalton's Atomic Theory,* 1896) shows that the idea of atomic structure arose in his mind as a purely physical conception forced upon him by study of the physical properties of the atmosphere and other gases.

The first published indications of this idea are to be found at the end of his paper on the "Absorption of Gases" (Oct. 21, 1803), published in 1805. There he says: "Why does not water admit its bulk of every kind of gas alike? This question I have duly considered, and though I am not able to satisfy myself completely I am nearly persuaded that the circumstance depends on the weight and number of the ultimate particles of the several gases." He proceeds to give what has been described as his first table of atomic weights, but on page 248 of his laboratory notebooks for 1802–04, under the date Sept. 6, 1803, there is an earlier one in which he sets forth the relative weights of the ultimate atoms of a number of substances, derived from analysis of water, ammonia, carbon dioxide, etc., by chemists of the time. Confronted with the "problem of ascertaining the relative diameter of the particles of which, he was convinced, all gases were made up, he had recourse to the results of chemical analysis. He thus arrived at the idea that chemical combination takes place between particles of different weights, and this differentiated his theory from the historic speculations of the Greeks. The extension of this idea to substances in general necessarily led him to the law of combination in multiple proportions, and the comparison with experiment brilliantly confirmed the truth of his deduction" (*A New View,* etc., pp. 50, 51).

Dalton communicated his atomic theory to Thomas Thomson of Glasgow university, who, with Dalton's permission, included an outline of it in the third edition of his *System of Chemistry* (1807), and Dalton gave a further account of it in the first part of the first volume (1808) of his *New System of Chemical Philosophy.*

In 1804 Dalton gave a course of lectures at the Royal institution, London, where he delivered another course in 1809–10; in 1822 he became a fellow of the Royal society. He was a corresponding member of the French Academy of Sciences and in 1830 was elected one of its eight foreign associates. In 1833 Lord Grey's government conferred on him a pension of £150, which was raised in 1836 to £300.

He lived for more than a quarter of a century with his friend the Rev. W. Johns (1771–1845) in George street, Manchester, where his daily round of laboratory work and teaching was broken only by annual excursions to the Lake district and occasional visits to London. In 1822 he paid a short visit to Paris, where he met many of the distinguished men of science then living in the French capital, and he attended several of the earlier meetings of the British association at York, Oxford, Dublin and Bristol. He rarely went into society and his only amusement was a game of bowls on Thursday afternoons. He died in Manchester on July 27, 1844, where a statue was erected to his memory. Most of the collection of Dalton relics was lost during the air raid on Manchester in World War II.

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DALTON'S LAW states that the total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual constituent gases. The partial pressure is the pressure which each gas would exert if it alone occupied the same total volume of the mixture at the same temperature. This law is true only for perfect or ideal gases. *See* KINETIC THEORY OF MATTER; DALTON, JOHN. (J. B. Ps.)

DALY, (JOHN) AUGUSTIN (1838–1899), U.S. playwright and theatrical manager, was born in Plymouth, N.C., July 20, 1838. Although his childhood was spent in amateur performances of the romantic blank-verse drama of the period, it was as a writer of more realistic melodramas that he enjoyed his greatest influence. Beginning in 1859 he was dramatic critic for several New York newspapers. *Leah the Forsaken*, adapted from the German in 1862, was Daly's first success as a playwright. His first important original play, *Under the Gaslight* (1867), was popular for years. In 1869 he formed his own company and later developed such outstanding actors as John Drew, Fanny Davenport, Maude Adams and Anne Gilbert. Daly's best play, *Horizon* (1871), drew heavily upon the western-type characters of Bret Harte and gave important impetus to the slowly developing nationalistic drama. *Divorce* (1871), another of his better plays, ran for 200 nights. After opening Daly's theatre in New York in 1879, he confined himself to adaptations and management. He died in Paris, June 7, 1899. (S. W. H.)

DALY, REGINALD ALDWORTH (1871–1957), one of the leading North American geologists in the first half of the 20th century, was born in Napanee, Ont., on May 19, 1871. He was noted for his research on the shape of igneous bodies and the emplacement, average chemical composition and evolution of igneous rocks. Equally valuable were his investigation of the origin of coral reefs and submarine canyons through the fluctuations of sea level during the waxing and waning of the Pleistocene icecaps, and his studies of isostasy and the interior of the earth.

Daly was geologist for the Canadian International Boundary survey from 1901 to 1907, professor of geology at Massachusetts Institute of Technology, Cambridge, from 1907 to 1912 and Sturgis Hooper professor of geology at Harvard university from 1912 to 1942. He died in Cambridge, Mass., on Sept. 19, 1957. (M. P. B.)

DALY CITY, a residential city of San Mateo county, Calif., U.S., adjoins San Francisco on the south. In the 1850s speculators unsuccessfully struggled to wrest the land from settlers such as dairyman John Daly, after whom the community was named. San Franciscans, who fled from the earthquake in 1906, incorporated the town in 1911. After growing slowly along electric-car lines, the small community of wage earners suddenly expanded after 1945 when immigration into California began on an unprecedented scale. Alongside, rather than within, the older suburb large, privately financed tracts of homes arose for upper middle-class residents, half of them newcomers after 1950. New neighbourhood retail and service centres, churches, public schools, libraries and recreation facilities, as well as a long-established weekly newspaper, *The Record* (1905), met local social needs of the expanded population, while numerous highways carried traffic to and from the metropolitan economic and cultural institutions which gave the major impetus for the city's continued growth. For comparative population figures *see* table in CALIFORNIA: *Population.* (J. H. St.)

DAM, (CARL PETER) HENRIK (1895–), Danish biochemist, 1943 Nobel laureate in medicine, jointly with E. A. Doisy (*q.v.*), for his discovery of vitamin K, was born at Copenhagen on Feb. 21, 1895. After graduating from the Copenhagen Polytechnic institute in 1920, he taught in the School of Agriculture and Veterinary Medicine and later in the physiological laboratory of Copenhagen university, where he was appointed associate professor of biochemistry in 1929, holding this post until the outbreak of World War II. From 1940 to 1945 he carried on his research work and lectured in the United States. In his absence, he was in 1941 appointed professor of biochemistry at the Polytechnic institute, Copenhagen. In 1956 he became head of the biological division of the Danish Public Research institute. Between 1929 and 1934 Dam and his associates drew attention to a deficiency disease of chicks characterized by a tendency to bleed and by a greatly retarded clotting time of the blood. Dam ascribed the disease to lack of a particular antihemorrhagic factor in the diet. In 1934–35 he showed that this hitherto unknown factor was a fat-soluble vitamin which he named vitamin K (Koagulations-Vitamin). The isolation of the vitamin in an almost pure state was reported by Dam in 1939 and, independently, by R. W. McKee and his co-workers in the United States (*see* VITAMINS). The discovery and purification of the antihemorrhagic vitamin found important applications in clinical medicine. Dam also contributed to other aspects of vitamin research and to the biochemistry of fats and sterols. (W. J. Bp.)

DAM, a barrier built across a river or stream to control the flow of water. Such a structure may serve one or more functions: diverting the flow into a canal, pipeline, or other channel; raising the water level to a height sufficient to produce power or to form a pool for navigation, recreation, or the elimination of tidal or seasonal fluctuations; storing water for human consumption or irrigation; or providing a means for flood, erosion, and silt control.

From time immemorial dams have been constructed for some or all of these purposes. There are records of a huge earthen dam on the Tigris and a large masonry dam on the Nile, both built almost in prehistoric times, and the early Romans built numerous massive masonry dams in Italy and northern Africa.

With the advance of the industrial age, dams were required to supply water to operate waterwheels. The development of electric power increased the use of dams for this purpose, and the perfection of facilities for the transmission of power over long distances made the construction of dams at remote sites economically attractive.

As property in river valleys increased in value, damage from floods brought about demands for dams to hold back the floodwater (*see* also RIVER AND RIVER ENGINEERING).

With continued economic development it frequently became desirable to utilize single dams for several purposes. By allocating portions of the cost to various uses it was possible to build projects not previously justifiable for single-purpose use. During the first half of the 20th century, in order to expand the economic growth of some less-developed areas, governments throughout the world began investing public funds extensively in large multipurpose dams.

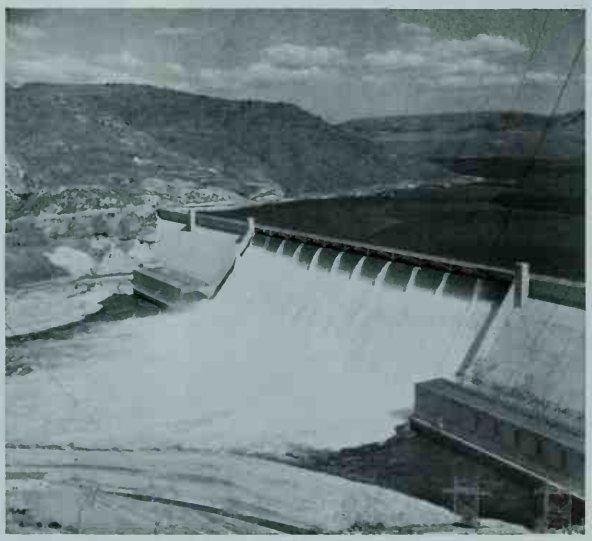
The principal types of dams are earth fill, rock fill, solid masonry gravity, solid masonry arch, arch-gravity, structural masonry, and steel or timber. The first three types have been used from antiquity; the others are products of the 19th and 20th centuries.

The type and height of a dam depend upon the geology and configuration of the site, the purpose for which the dam is to be used, and its cost as affected by the availability of construction materials and other factors. All types except steel and timber are

Roosevelt dam, Salt River irrigation project, Arizona. A masonry arch-gravity storage dam with spillways at both ends and discharge pipes at base. Reservoir capacity 1,381,600 ac.ft., volume 355,800 cu.yd. Height 280 ft., crest length 723 ft.

U.S. DAMS

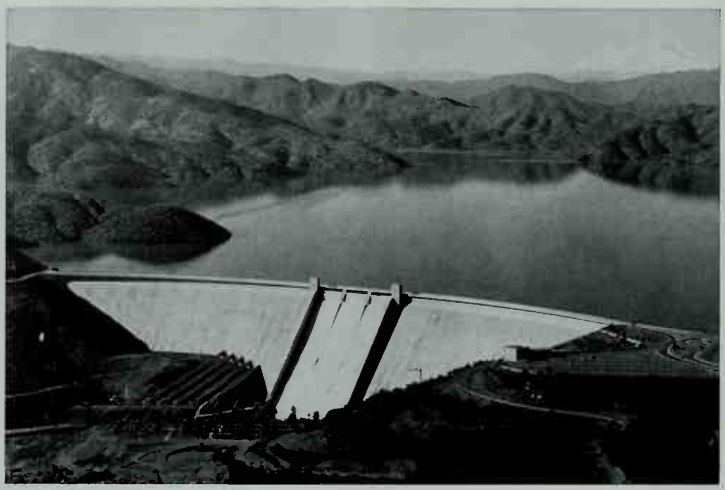
Hoover dam, Colorado river, on the border of Arizona and Nevada. A concrete arch-gravity dam with a reservoir capacity of 29,827,000 ac.ft. and a volume of 4,400,000 cu.yd. Height 726 ft., crest length 1,244 ft.



Grand Coulee dam, Columbia river, Washington. A masonry gravity dam with a reservoir capacity of 9,402,000 ac.ft. and a volume of 10,585,000 cu.yd. Height 550 ft., crest length 4,173 ft.

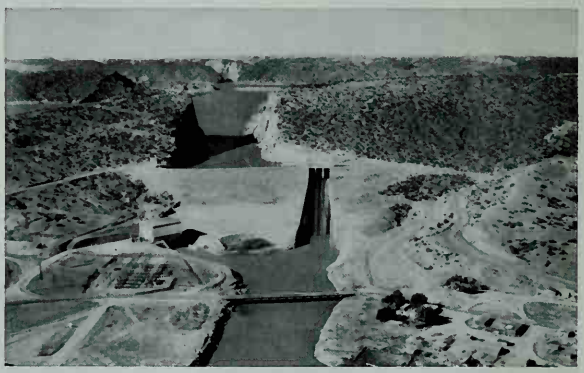
BY COURTESY OF U.S. BUREAU OF RECLAMATION

DAM

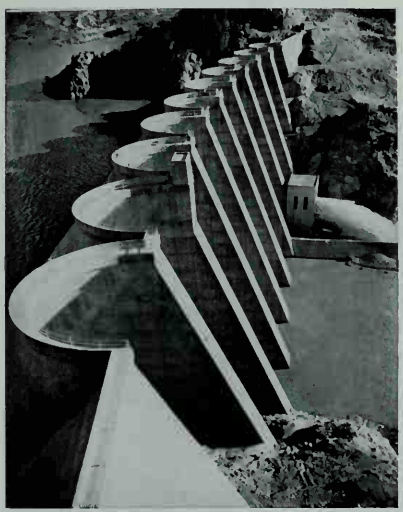


Downstream face of Shasta dam, Sacramento river, California. A curved concrete gravity dam with a reservoir capacity of 4,500,000 ac.ft. and a volume of 8,711,000 cu.yd. Height 602 ft., crest length 3,460 ft.

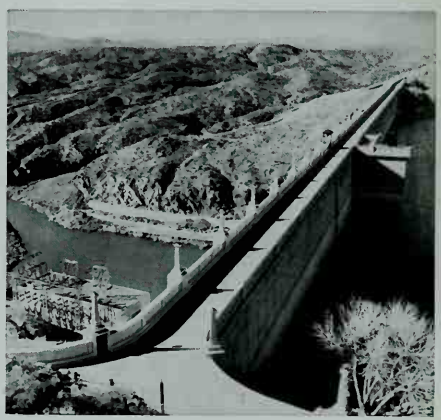
U.S. DAMS



Alcova dam, North Platte river, Wyoming. An earth- and rock-fill dam with a reservoir capacity of 190,500 ac.ft. and a volume of 1,635,000 cu.yd. Height 265 ft., crest length 763 ft.



Bartlett dam, Verde river, Arizona. A concrete multiple-arch dam with a reservoir capacity of 179,000 ac.ft. and a volume of 182,000 cu.yd. Height 287 ft., crest length 800 ft.



Elephant Butte dam, Rio Grande irrigation project, New Mexico. A concrete gravity storage dam, 301 ft. high, crest length 1,674 ft. Reservoir capacity 2,185,400 ac.ft., volume 629,500 cu.yd.

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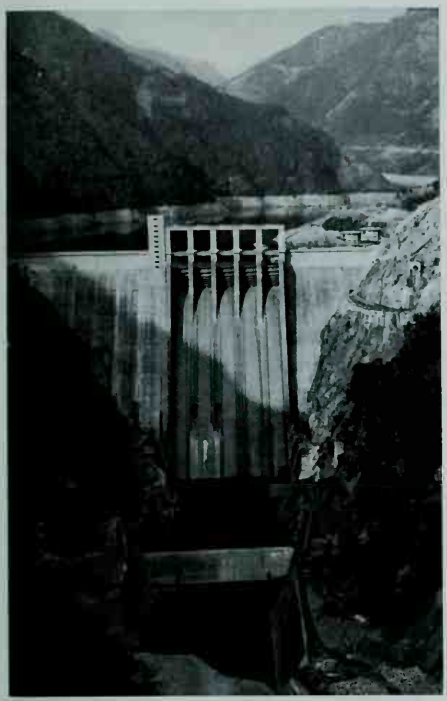
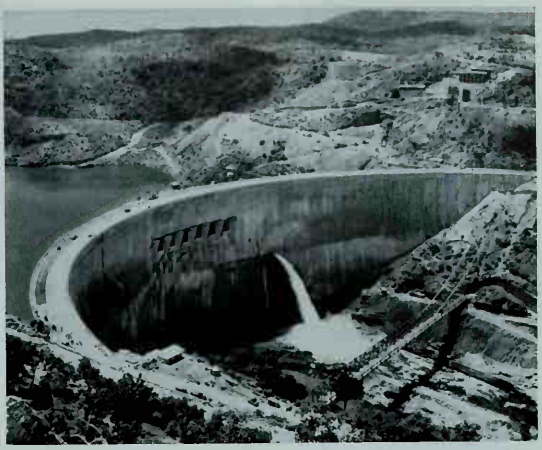
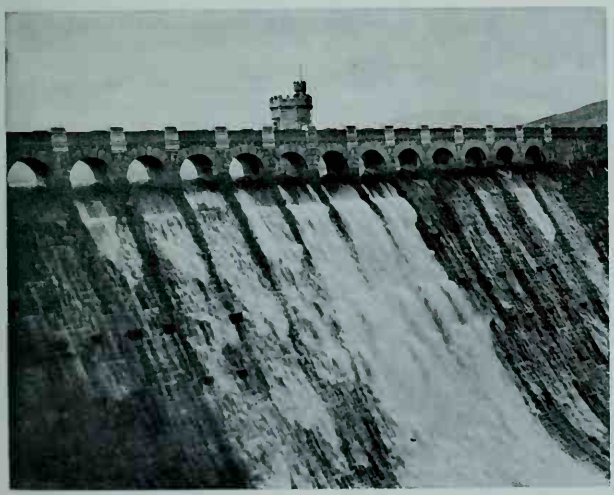


Sakuma dam, Tenryu river, Japan. A concrete gravity dam with centre spillway and a reservoir capacity of 268,690,000 cu.yd. Height 492 ft., crest length 955 ft.

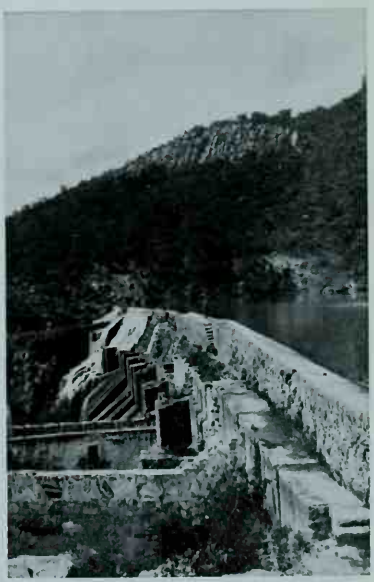


Kariba dam, Zambezi river, Southern Rhodesia. A concrete arch dam; height 420 ft., crest length 2,025 ft.

DAMS OF THE WORLD



Face of Angram dam, Yorkshire, Eng. A concrete gravity dam completed in 1916. Height 130 ft., crest length 195 ft.



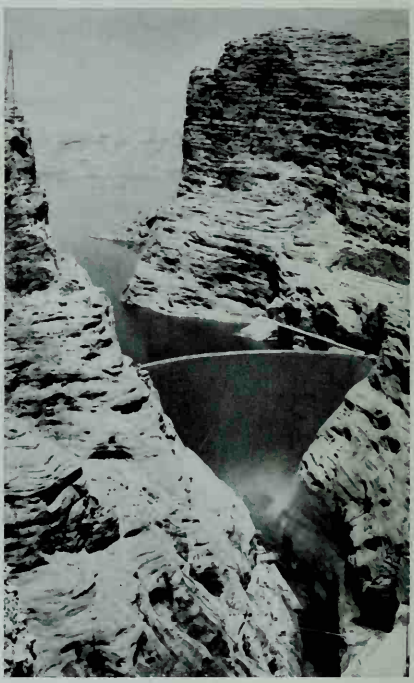
Pabellon, a masonry gravity dam believed to date from the early 18th century. Aguascalientes, Mex.

BY COURTESY OF (TOP LEFT) CONSULATE GENERAL OF JAPAN, NEW YORK CITY, (BOTTOM LEFT) THE BRADFORD WATER WORKS, (BOTTOM RIGHT) JULIAN HINOS, PHOTOGRAPH, (TOP RIGHT) CAMERA PRESS —PIX FROM PUBLIX

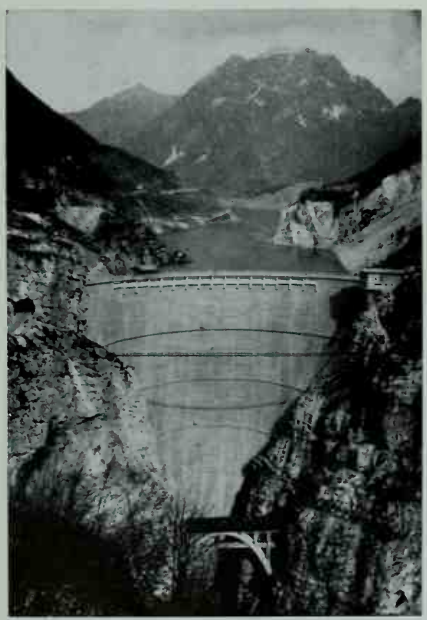
DAM

Mauvoisin dam, Drance de Bagnes river, Switzerland. A concrete arch dam; height 777 ft., crest length 1,780 ft.

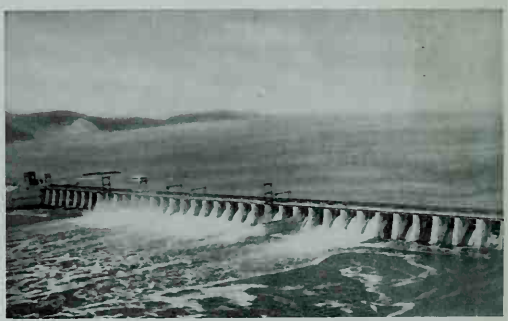
DAMS OF EUROPE AND ASIA



Mohammed Riza Shah Pahlavi dam, Dez river, Iran. A concrete thin-arch dam; height 668 ft., crest length 690 ft.



Vaiont dam, Vaiont river (tributary of the Piave river), Italy, damaged in 1963 by a massive landslide into the reservoir. The concrete arch dam's height was 858 ft., crest length 625 ft.



Kuibyshev dam, Volga river, Soviet Union. A concrete gravity dam; height 100 ft., crest length 19,140 ft.

BY COURTESY OF (TOP LEFT) ELECTROWATT S. A., ZURICH, (TOP RIGHT) DEVELOPMENT AND RESOURCES CORPORATION, (BOTTOM LEFT) PIERRE BOULAT, "LIFE" MAGAZINE, © 1963 TIME INC., (BOTTOM RIGHT) NOVOSTI PRESS AGENCY (APN)

considered permanent if well constructed, requiring little maintenance.

When a dam is built across a flowing stream, provision must be made for handling floodwaters during construction. For masonry dams on good rock, facilities for this purpose may be required only to protect the works against interruption or minor damage. For fill dams or other types on soft foundations, flood-diversion works may be as important as the final spillway, if failure by overtopping of the partially completed structure could cause a disaster.

Perhaps the most usual type of diversion facility is a tunnel around the end of the dam, the flow being forced into it and kept out of the foundation area by small temporary structures called cofferdams upstream and downstream from the site.

For small streams the floods may be handled through pipes, flumes, or other such devices. For masonry structures, an opening may be left in the dam to pass floods, to be plugged later at a time of low flow.

The design of bypass facilities is usually a matter of importance, demanding the same careful planning as any other vital parts of the project.

EARTH-FILL DAMS

The early history of earth-fill dam construction is lost in antiquity. The remains of ancient works still existing in India and Ceylon bear evidence that the construction of reservoirs for storing water dates from very remote times. The usual manner of forming these basins, some of which were of vast extent, consisted of closing valleys with dams of earth, but not until comparatively recent times were walls of masonry extensively employed.

It is natural that the earliest dams should have been predominantly of earth, the most abundant and easily handled material. However, the ancient dam builders had no scientific knowledge of soil mechanics or flood flows, and hence their construction methods were haphazard and failures were no doubt frequent. Consequently, earth dams fell into a state of disrepute for a long period of time.

However, the earth dam has regained a position of importance as a result of several factors: the science of soil mechanics (*q.v.*) has progressed greatly; knowledge of flood flows has advanced; many of the sites suitable for masonry dams have been utilized, leaving for future use sites more suitable for earth structures; and the costs of masonry and concrete construction have risen generally, while improvements in earth-handling equipment have held the costs of earthwork construction relatively constant.

The security of earth dams depends on many factors, among which are the following:

1. Ample spillway capacity for passing floods around the dam is essential because any appreciable amount of water passing over the top of an earth dam will destroy it.

2. The height above the highest water level (freeboard) must be sufficient to prevent overtopping by waves.

3. Leakage through or under the dam must be reduced to an amount that will not move the materials of which the dam and its foundation are composed. If these materials are not inherently watertight, a continuous impervious earth core or other type of cutoff extended to an impervious foundation is required. As an alternative a stream-bed blanket of impervious materials may be used. Cores of stone masonry, concrete, puddle clay, wood, or steel-sheet piling were formerly used, but after about 1920 these were largely abandoned because of cost, difficulty of installation, and occasional unsatisfactory performance. Drains under the downstream portion of the dam, consisting of filter blankets or other devices, are frequently used to collect and dispose of leakage.

4. The slopes of the dam must be flat enough to prevent sloughing of the fill or overstressing of the foundation. The required degree of slope depends upon the nature of the materials, the degree of compaction, and the influence of any water that may seep through or under the dam.

5. The downstream slope must be protected from rainwash and the upstream slope from damage by waves. Grass or other vegetation or gravel may be used on the downstream slope, whereas a layer of rock fragments (called riprap), or a slab of concrete, or soil-cement asphalt may be used on the upstream slope.

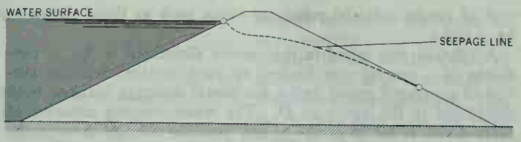


FIG. 1.—HOMOGENEOUS DAM WITH AN IMPERMEABLE FOUNDATION

No doubt the earliest earth dams were built of a single class of material, of fine-grained or clay texture, selected for its watertightness. Such dams, known technically as homogeneous dams, are still built, and thousands of structures of this kind are in use. However, homogeneous dams of large size, as illustrated in fig. 1, require certain precautions in their construction. After long subjection to water pressure such a structure becomes completely saturated below the seepage line shown in the figure. This saturation and possible outflow of water near the bottom of the fill weaken the structure. A similar situation can occur on the upstream face if the water level is suddenly reduced. The supersaturated material may slide out before it has time to drain.

Hence, precautions must be taken to ensure safety. The simplest remedy is to flatten the slopes; this decreases the tendency to slough but adds to construction costs. A possible remedy for the downstream slope is illustrated in fig. 2, where a filter-protected gravel drain pulls the seepage line away from the face. If the required materials are readily available at reasonable cost, an ideal solution for both faces is represented by fig. 3. In this design watertightness is provided by the impervious central core, and the outer shells of compacted gravel provide stability. Slight seepage through the core is harmlessly removed by the pervious downstream shell. When the reservoir level is drawn down, the upstream gravel shell drains at once, removing the danger of an upstream slide. The filter layers shown in the figure prevent the fine core material from being washed into the shells.

The details shown on fig. 3 may be varied according to the abundance and cost of available materials. If gravel is scarce or expensive, the core may be made thicker and shells thinner, as long as the combination is stable. If available materials are varied it may be desirable to tailor the section to fit, increasing porosity gradually from the core to the outer slopes. An example of such a tailored section is that of the Trinity Dam in California, shown in fig. 4. Its crest is 465 ft. above the stream bed and 537 ft. above the lowest point in the foundation.

If free-draining materials are unavailable for either of the types shown in fig. 3 or 4, internal drainage may be used to take percolating waters away from vital parts of the structure. An elementary drained section is illustrated in fig. 2.

A more complex example of a drained structure is the Swift Dam on the Lewis River in Washington (fig. 5). As designed, this dam was of unprecedented height for an earth-fill structure, reaching more than 400 ft. above the stream bed, 512 ft. above the bottom of the excavated cutoff trench, and over 600 ft. above the bottom of a steel cutoff sunk to bedrock. Whether Swift is higher or lower than Trinity depends on the base used for measuring.

Fine-grained local materials suitable for an impervious fill were abundant for construction of the Swift Dam, but gravel was scarce and expensive. Because of the necessity for gentle outer slopes, the estimated cost of a homogeneous dam was high. Scarcity and

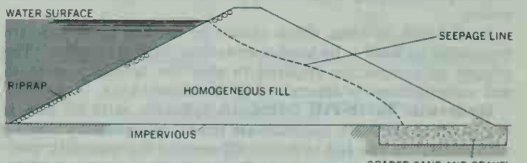


FIG. 2.—HOMOGENEOUS DAM WITH FILTER DRAIN

cost of coarse material ruled out types such as those shown in fig. 3 and 4.

A solution was found in the section illustrated in fig. 5, consisting of a central core backed up by a vertical drainage curtain of processed gravel and a horizontal drainage blanket, both designated in the figure as D. The water-carrying capacity of these drains is far in excess of any possible seepage through the core. This protects the downstream portion of the dam from saturation, assuring its full strength and permitting it to be constructed of random local materials, with reasonable outer slopes. The percolation of fine materials into the drainage system is prevented by graded filters.

The stability of the upstream slope in the event of a sudden lowering of the reservoir level is assured by a free-draining rock fill, fig. 5E, extending from the top of the dam down to the minimum operating reservoir level. The rock came from adjacent structure excavations. The rock underneath the core was grouted with a cement-water mixture to close any possible paths of leakage under or around the dam. Dams of the types shown in fig. 1 to 5 depend upon the presence of a core or other watertight connection to an impervious foundation. Where the depth of pervious foundation precludes this, underflow can be controlled by an impervious core connected to an impervious blanket.

The extent of the blanket is made sufficient to reduce the under-

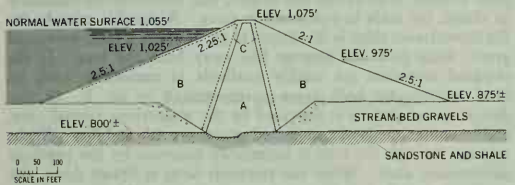


FIG. 3.—CROSS SECTION OF SANTA FELICIA DAM, PIRU CREEK, CALIFORNIA
Contents of embankment: (A) impervious core; (B) pervious gravel shell; (C) graded filters

flow to harmless amounts and velocities. Underflow may be further controlled by a downstream filter and porous blanket.

Compaction of Earth-Fill Dams.—To ensure stability and watertightness the materials of an earth-fill dam must be adequately compacted. In ancient dams the earth was carried onto the embankment in baskets, and the trampling of the workers' feet provided compaction. Later, animals were used to bring the materials onto the fill, and there was still sufficient trampling to assure compaction.

With the introduction of mechanical earth-moving equipment, normal traffic ceased to provide adequate compaction. Consequently, special types of rollers were devised. An early and popular form, still in use, is known as the sheep's-foot roller. It consists of a hollow steel cylinder fitted with blunt spikes. The cylinder is filled with water, sand, or concrete to give it weight, and the roller is pulled over the surface by tractors.

Another type more recently developed is the pneumatic or rubber-tired roller, consisting usually of four large pneumatic-tired wheels mounted side by side, each carrying an independent load of about 25,000 lb.

The earth to be rolled is spread in even layers, usually 6 to 12 in. thick, and moistened according to precise laboratory standards before rolling. Moistening may be accomplished on the site, or preferably by irrigation of the "borrow area" before excavation.

Small areas, or areas which cannot be reached by rollers, are compacted by hand or by hand-operated mechanical tampers. The amount of compaction required to give the necessary strength and watertightness is determined by laboratory tests.

Hydraulic Earth-Fill Dams.—A hydraulic earth-fill dam is one in which the earth materials are moved into place by sluicing with water. In the full-hydraulic fill method the materials, preferably a mixture of coarse and fine particles, are excavated by powerful jets from deposits above the dam and sluiced to the upstream and downstream edges of the fill. The finer particles are then washed toward the centre of the fill where they settle to form an impervious core, leaving the coarser portions to form the outer pervious slopes. Surplus water is drawn off through pipes, and no compaction is required.

If suitable materials are not available to permit direct sluicing, the semihydraulic procedure is used. The materials are brought to the edges of the fill by conventional means, after which the fine particles are washed toward the centre.

Several failures of hydraulic earth-fill dams and the concurrent improvement of rolled fill procedures reduced the popularity of hydraulic fills. Most failures occurred during construction. The fine materials in the central pool consolidate slowly, particularly if composed largely of clay. As a result, the partially completed dam contains a central core of heavy semifluid material which may cause the fill or the foundation to fail. However, except in cases where some imperfection is known to exist, there is no reason to suspect the stability of hydraulic fill dams that have had ample time for core consolidation.

ROCK-FILL DAMS

Rock-fill dams are embankments composed of rock fragments dumped into place and made watertight by an interior impervious zone or a surface blanket or membrane. The fragments may be selected quarry rock, quarry-run, clean boulders, or coarse clean gravel. The last classification may blend imperceptibly with the gravel shell types of fig. 3 and 4.

Perhaps the earliest examples of rock-filled dams consisted of hand-dumped rock, stanched on the upstream face with earth or sod. More finished shapes, with more formal provision for watertightness began to appear in early 19th century. Around 1950 compaction equipment suitable for use on rock fills began to appear, dividing rock-fill dams into two classes, dumped and compacted.

The first extensive development of rock-fill dams came about in California, about the time of the gold rush (1849). They were useful in remote locations where equipment and materials for other types were expensive.

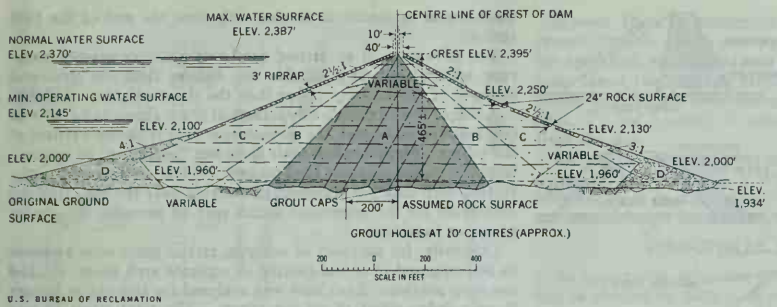
Dumped Rock Fills.—Typical sections illustrating the gradual evolution of formalized rock-fill dams with impervious upstream facing are shown in fig. 6. In the earliest examples, both faces consisted of hand-laid dry rubble, the central portion being dumped, as in fig. 6A. This permitted the use of steep face slopes, thus reducing the total volume of material. With the gradual increase in the cost of hand labour and the improvement of mechanical quarrying and hauling equipment, the overall section was increased and the handwork reduced, as in fig. 6C and D. The introduction of derrick handling for the larger pieces of rubble further reduced costs. A late example (1958) is illustrated in fig. 6E.

A simple dumped rock fill is subject to appreciable and sometimes irregular settlement which causes the impervious membrane to crack, especially up the sides of the canyon; it also may cause other difficulties. Damage to the facing can be partially controlled, although not completely eliminated, by careful installation of the upstream hand-placed rubble layer. Nevertheless there is still need for reduction of settlement.

For the large-sized rocks and the high lifts commonly used for dumped rock fills, mechanical compaction is impracticable. As an alternative, such fills may be "settled" during construction by copiously sluicing the rock, as it is dumped, with high-pressure streams of water. This markedly reduces post-construction settlement.

Rolled Rock-Fill Dams.—The most available fill material at a dam site, or the yield of an available quarry, may contain an excess of small pieces that are unsuitable for a dumped rock fill. Such materials, if sound and permeable, may make an excellent rolled rock fill.

For reasonably small rock fragments, spread in layers 12 to 18 in. thick, compaction may be accomplished with rubber-tired rollers, as for earth or gravel dams. But with rock fragments of increasing coarseness, such rollers become ineffective, and heavy



U.S. BUREAU OF RECLAMATION

FIG. 4.—CROSS SECTION OF TRINITY DAM, TRINITY RIVER, CALIFORNIA

Contents of embankment: (A) selected weathered rock (clay, silt, sand, and gravel) compacted by tamping rollers to 6-in. layers; (B) selected weathered rock (silt, sand, gravel, and cobbles) compacted by tamping rollers to 12-in. layers; (C) alternating layers of selected dredger tailings (gravel, cobbles, and boulders) and selected dredger screenings and selected undredged sand and gravel (silt, sand, gravel, cobbles, and boulders) compacted by crawler-type tractors in 18- and 12-in. layers respectively; (D) rock fill placed in 3-ft. layers

tractors or vibratory rollers must be used for compaction.

Membranes and Cores.—A variety of impervious facings can be used for rock-fill dams, the commonest being concrete. Laminated timber facing, widely used on early dams in the western U.S., may still be used for a temporary installation. Steel facings are used occasionally, also asphaltic concrete.

Alternatively, watertightness may be secured by an interior impervious earth core or an earth facing. Simple examples of interior cores are illustrated in fig. 7. The relative merit of vertical and inclined cores remained moot in the mid-1960s, with each having strong advocates. In either case migration of the fine-core material into the rock is prevented by graded filters, as in the case of earth fills.

The earthen core may be moved entirely to the upstream face, where it is referred to as a blanket. When so placed it must meet the stability requirement for the upstream face of an earth dam and also must provide wave protection. An example of a rolled rock fill is the 440-ft. (1 ft. = 0.3048 m.) high Round Butte Dam on the Deschutes River in Oregon.

Requirements for Stability.—The essential stability requirements for a rock-fill dam are as follows: (1) a spillway adequate to prevent overtopping by any possible flood; (2) a sufficient height above highest water level (freeboard) to prevent overtopping by waves; (3) a strong, durable rock in the fill to resist the loads and weathering to which it will be subjected; (4) a thoroughly settled fill, obtained by sluicing or compacting during construction; (5) a foundation able to withstand imposed loads without appreciable settlement and able to resist erosion from possible leakage; if upstream facing is used, the foundation must afford adequate tie-in possibilities; (6) sufficient weight and strength of the fill at all levels to resist the lateral force of the water; (7) stable outer slopes; and (8) a grout curtain, if required.

SOLID MASONRY GRAVITY DAMS

Solid masonry dams, which resist the forces coming against them primarily by their weight, are generally referred to as gravity dams. The term "masonry" is used to include both stone masonry and concrete. The forces tending to move the dam include water pressure, silt pressure if any silt accumulates in the reservoir, ice pressure, earthquake forces, and the buoyant effect of water seeping through the dam and its foundation.

For stability against overturning or sliding, gravity dams rely on their weight, the vertical component of water and silt pressures on their faces, and the back pressure of water against the downstream face. The strength and roughness of the foundation also have an important influence on stability. The bases of high dams must be spread to keep stress within safe limits in the dam and the foundation.

The earliest masonry dams were no more influenced by scientific considerations than were the early earth fills, but, being built of firmer materials, they were more resistant to damage. Their earliest extensive use seems to have occurred about the 16th century in the southern part of Spain, where large reservoirs for irrigation were constructed. Two old Spanish structures are illustrated in fig. 8.

The Almanza Dam, fig. 8A, is reported to be the oldest existing masonry dam, built perhaps in the early 16th century. This slender structure, built of cut-stone facing with rubble masonry interior, has been in service for more than 400 years. The Alicante Dam, fig. 8B, is of more ample proportions. It was built in the late 16th century and has operated as an overflow structure for more than 300 years with no evidence of serious damage. A comparison of these two examples with modern dams clearly illustrates the absence of any definite theory of design.

Despite their lack of scientific knowledge, the early Spanish dam builders were far in advance of their contemporaries. The wonder is that, with so little to work with, they accomplished so much.

The foregoing examples show how the art of masonry dam construction started. Once begun, it continued to advance and spread. Both French and Spanish dams early developed a regularity of form and a finished architectural appearance. However, until well into the 19th century there was no indication of any understanding of the underlying engineering principles.

This picture began to change in the latter part of the 19th century when several writers, principally French and English engineers, proposed some basic rules for the design of gravity dams. These rules were neither exhaustive nor in all respects accurate, but they did lay the foundation for the much improved, although still imperfect, procedures of the present day. Typical modern sections are illustrated in fig. 9. Reduced to their simplest essentials, the design rules for a gravity dam are as follows:

1. The dam shall be safe from overturning, and there shall be no tension in the masonry under any condition of loading, including earthquake effects. This requires that the combined resultant of weight of dam and the water pressure and other forces against and within it shall cut the base at any horizontal section within its middle third. This is the classical "law of the middle third."

2. The dam shall be safe, at any elevation, against sliding (that is, against being displaced downstream by water pressure and other forces). This requires that the frictional force holding the dam in place, plus any shearing strength, must exceed the horizontal thrust.

3. The true compressive stress in the masonry must be less than the crushing strength of the masonry by a safe margin, at either face. Above a limited height this supersedes the law of the middle third.

4. The crushing strength of the foundation must exceed the maximum pressures against it by a reasonable margin. Broken

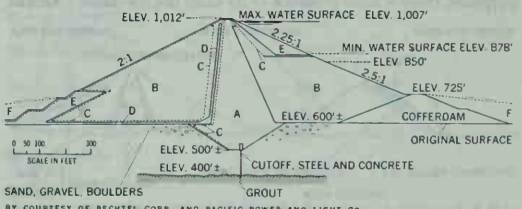


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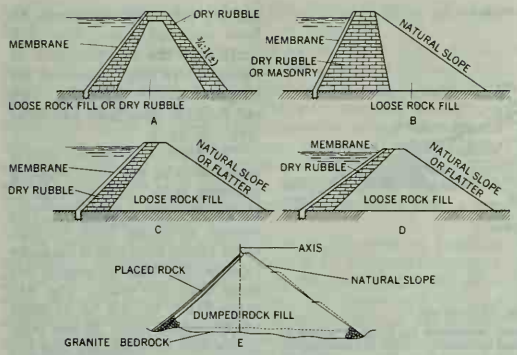
FIG. 5.—CROSS SECTION OF SWIFT DAM, LEWIS RIVER, WASHINGTON

Contents of embankment: (A) impervious core; (B) impervious random; (C) graded filters; (D) processed drain; (E) rock fill; (F) waste



(A–D) FROM EDWARD WEGMANN, "THE DESIGN AND CONSTRUCTION OF DAMS," 1927; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.; (E) FROM J. B. COOKE, "ROCK-FILL DAMS; WISMON AND COURTRIGHT CONCRETE FACE DAMS," IN "JOURNAL OF THE POWER DIVISION, PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS," 1958

FIG. 6.—CROSS SECTIONS OF EARLY DAMS, SHOWING (A–E) THE GRADUAL EVOLUTION OF ROCK-FILL DAMS

areas of otherwise sound rock in the foundation may be consolidated by grouting. Masonry dams are usually founded on solid rock, but low structures, especially diversion dams, are sometimes built on earth or gravel. Adequate provisions are required in such cases to spread the load and to prevent underseepage and downstream scour.

5. A grout curtain, consisting of holes drilled in the foundation at the upstream side of the dam and filled with grout under pressure, is used for high dams to prevent too much leakage through the foundation and to reduce the uplift pressure; drainage holes are then drilled just downstream from the grout curtain.

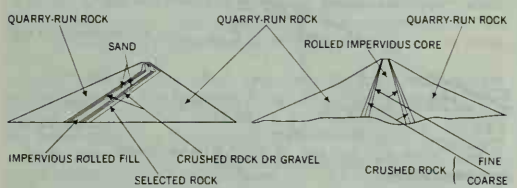
6. The dam must be provided with a spillway and freeboard.

To reduce the tendency of concrete in large dams to crack because of shrinkage when hardening, modern practice may require any or all of the following: (1) use of the least possible amount of cement in the concrete consistent with required strength and durability; (2) the use of special "low-heat" cement; (3) construction lifts of moderate height; and (4) cooling of the concrete before or after it is placed to reduce the temperature rise during setting. Sometimes gravity dams are arched upstream in plan in order to fit the contours of the site, but unless the curvature is sharp, very little of the load can be carried by arch action.

An outstanding example of a straight gravity structure is the Grand Coulee Dam on the Columbia River in Washington. It has a volume of 10,585,000 cu.yd. and a height of 550 ft. above the lowest point in its foundation. This multiple-purpose dam provides water storage for the irrigation of new land and generation of electrical energy. Flood control and navigation benefits are also derived. The dam consists of an overflow spillway section 1,650 ft. long, with adjoining abutment sections giving a total crest length of 4,173 ft. The spillway is capable of passing a flood of 1,000,000 cu.ft. per second.

SOLID MASONRY ARCH DAMS

Although the arch was widely used by the ancients for other purposes, there is little evidence of its early use for dams. Arched



FROM R. W. CLOUGH, D. PIRTZ ET AL., "EARTHQUAKE RESISTANCE OF ROCK-FILL DAMS," IN "TRANSACTIONS, AMERICAN SOCIETY OF CIVIL ENGINEERS," 1958

FIG. 7.—CROSS SECTIONS OF (LEFT) INCLINED CORE AND (RIGHT) VERTICAL CORE ROCK-FILL DAMS

dams began to appear in number only near the end of the 19th century.

The advantage of an arched dam over a simple gravity structure, when placed on a suitable site, derives from the structural strength of the masonry rather than the sheer weight of the dam.

A simple arched dam in a hypothetical site is shown in fig. 10. In this hypothetical figure the downstream face is shown vertical at the crown. Many modern arch dams are "overhung" to secure a better fit to the adjacent land masses. Where an otherwise satisfactory arch dam site broadens excessively near the top, artificial abutments for the uppermost arches may be provided by gravity wings, or buttresses.

Originally, for purposes of analysis, arched dams were assumed to be composed of a multiplicity of separate arch slices, stacked one atop another. Each slice was analyzed for stresses as though it were independent of all the others. The total stress in any particular slice, and consequently its required thickness in the direction of the stream, is approximately proportional to its radius. Consequently, it is advantageous to use the shortest practical radius. However, the radius must be great enough so that the arch spans the canyon. These opposing considerations must be balanced to give the best results for each assumed arch slice.

For a U-shaped canyon a constant radius for each arch slice from top to bottom of the dam may suffice. For a V-shaped canyon the best solution requires that the radius be constantly decreased from top to bottom to approximate the optimum shape at each level. For very wide canyons, the arch must have a long radius; however, this necessitates greater wall thickness and thus puts the arch dam at an economic disadvantage.

Twenty Highest Dams

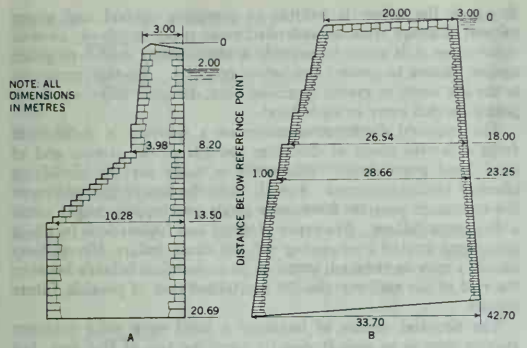
Name	Material	River	Country	Height (in ft.)*
Inguri†	C‡	Inguri	U.S.S.R.	988
Nurek†	E§	Vakhsh	U.S.S.R.	984
Grande Dixence	C	Dixence	Switzerland	932
Vaiont	C	Vaiont	Italy	888
Mauvoisin	C	Drance de Bagnes	Switzerland	777
Oroville†	E	Feather	U.S.	770
Contra†	C	Verzasca	Switzerland	754
Bhakra	C	Sutlej	India	740
Manicouagan Nn. 5†	C	Manicouagan	Canada	740
Hoover	C	Colorado	U.S.	726
Glen Canyon	C	Colorado	U.S.	710
Luzzone	C	Brennn di Luzzone	Switzerland	682
Portage Mountain†	E	Peace	Canada	675
Keban†	E	Euphrates	Turkey	673
Dworshak (Bruces Eddy)†	C	Clearwater	U.S.	670
Pahlavi	C	Dez	Iran	668
Kurobegawa No. 4	C	Kurnbe	Japan	610
Shasta	C	Sacramento	U.S.	602
Tignes	C	Isère	France	592
Mossyrock†	C	Cowlitz	U.S.	590

*Heights of dams under construction are estimated.
†Under construction. ‡Concrete. §Earth or Rock Fill.
Source: T. W. Mermel, Member, Executive Committee, U.S. Commission on Large Dams.

Early arch-stress computations were based on the theory that each of the assumed individual arch rings performs as a portion of a full cylinder, subject to a uniform radial load equal to the water pressure at its particular depth. This theory makes no allowance for the bending stresses caused by abutment resistance, elastic shortening, temperature changes, and other factors; hence its use is permissible only in simple cases and with conservative factors of safety.

Early attempts to compute more accurately the stresses in the arches of dams followed the procedures available for fixed-end bridge arches. Although valid, these methods require laborious arithmetical integration. In the 1920s William Cain and B. F. Jakobsen developed algebraic approaches to simple cylindrical arches, with restrained abutments, under uniform radial loads. Other writers devised tables and diagrams that further facilitated computation.

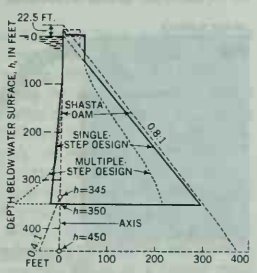
Unfortunately, however, a simple cylinder is not the ideal shape for the arch of a dam. Stresses in such an arch are appreciably greater at the abutments than at the crown, so that arches of variable thickness are preferable. This requires a return to the laborious arithmetical integration. Another difficulty is that the assumed arch slices actually are not free to act independently



FROM EDWARD WEGMANN, "THE DESIGN AND CONSTRUCTION OF DAMS," 1927; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 8.—EARLY SPANISH MASONRY DAMS: (A) ALMANZA DAM; (B) ALICANTE DAM

but are restrained by their neighbours as well as by the foundations. This causes a redistribution of loads between the arches and vertical and inclined elements, or cantilevers. The loads carried by specific arches are no longer uniform. In very thin dams, this interference may be ignored by allowing an arbitrarily increased safety factor. However, for thick arches, required in wide or deep canyons, these effects must be considered, and full analysis of the resulting complexities is necessary. Two methods of analysis are generally used: a trial-and-error procedure, usually referred to as the trial-load method, is generally followed in the United States; the modeling method, widely used in Europe, uses a scale model of the proposed structure, loaded proportionally to the full-sized dam, to measure deflections and stresses. Each method requires skilled technicians and considerable labour, though electronic computers greatly reduce the labour of the trial-load method.



FROM W. P. CREAGER, JOEL D. JUSTIN, AND JULIAN HINDS, "ENGINEERING FOR DAMS," 1945; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 9.—COMPARATIVE SECTIONS OF GRAVITY DAMS

For a time there was a lull in the incidence of new arch dams in the U.S., as the best sites within prevailing dam heights were utilized and as economic competition with fill dams increased. But with economic pressure for ever-higher dams, these handicaps assumed less importance. In the mid-1960s, several American arch dams were under construction or in final study status. In other parts of the world, where conditions are different, there was no lull, and arch dams have continued to increase in number, height, and variety of design.

ARCH-GRAVITY DAMS

If an arch dam is high and the bottom arches are thick, arch action is restricted near the base, and vertical and horizontal beam actions become predominant. The loads near the top are taken largely by the arches, and those near the bottom largely by a combination of gravity and horizontal beam action. Such a structure is called an arch-gravity dam; it can be analyzed either by the trial-load method or by modeling.

An outstanding example is the Hoover Dam on the Colorado River in the southwestern United States, one of the highest dams in the Western Hemisphere, rising 726 ft. above the lowest point of its foundation. A total of 3,250,000 cu.yd. (1 cu.yd. = 0.7646 cu.m.) of concrete was used to form the dam, which has a crest of 1,244 ft. and thickness ranging from 45 ft. at the crest to 660 ft. at the base.

Hoover Dam is a multiple-purpose structure that provides protection from floods, power generation, and water conservation for irrigation, recreation, and preservation of fish and wildlife. Lake Mead, the reservoir created by Hoover Dam, is the largest in the U.S., with a total storage capacity of 31,047,000 ac.ft. (1 ac.ft. = 1,233.5 cu.m.); it extends 115 mi. (185 km.) upstream from the dam.

Although Hoover Dam was not the first arch type to be designed by the trial-load method, it led to great advances in its use. It is looked upon as the "father" of the present trial-load system of analysis, although the stresses were also checked by model.

STRUCTURAL MASONRY DAMS

An appreciable reduction in the volume of masonry in a dam can be effected by using it in its structural forms. Dams of this type are usually composed of multiple concrete or stone masonry buttresses to which the water load is carried by a deck composed of either reinforced-concrete slabs or arches at the upstream face, as shown in fig. 11. The flat-slab type is sometimes called the Ambursen dam, and its buttresses are spaced on 18- to 40-ft. centres. On multiple arches the buttress spacing can be increased.

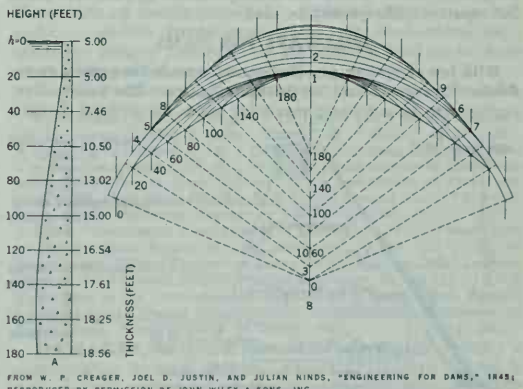
Other types are the round or polygonal-head buttress dam, with buttresses relatively closely spaced and expanded at the upstream face to provide contact between adjacent units, thus eliminating the deck, and the domed dam, where the canyon is closed by single or multiple domes. For wide-V canyons the domes may be flanked by Ambursen or multiple-arch wings.

When structural dams are designed so that water overflows across the crest, a reinforced-concrete slab is placed also on the downstream face to support the spilling water; otherwise, spillways are provided as for other dams.

Overall stability depends upon the same factors as those described for solid masonry gravity dams. The upstream face, being inclined usually about 45°, provides a vertical component of water pressure to promote stability, thus reducing the weight of masonry required. However, because structural concrete dams require steel reinforcement, more form work, and more skilled labour in their construction, their cost per cubic yard is greater. They have an advantage over solid masonry gravity dams only where the ingredients for concrete are expensive and where lumber for forms and skilled labour are relatively cheap.

The Lake Pleasant Dam in Arizona, fig. 11, illustrates the use of the cellular buttress, with double walls, to increase stiffness. Fig. 12 shows a cross section of the Tirso Dam in Sardinia, 200 ft. high. Its unique features are stone masonry buttresses and a hydroelectric plant between buttresses.

Structural masonry dams were quite popular in the first quarter of the 20th century, but afterward lost ground in the U.S. to other types on an economic basis. However, the highest of such dams



FROM W. P. CREAGER, JOEL D. JUSTIN, AND JULIAN HINDS, "ENGINEERING FOR DAMS," 1945; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 10.—SIMPLE ARCHED DAM SHOWING: (A) THE SECTION ON THE CENTRE LINE; (B) THE PLAN VIEW

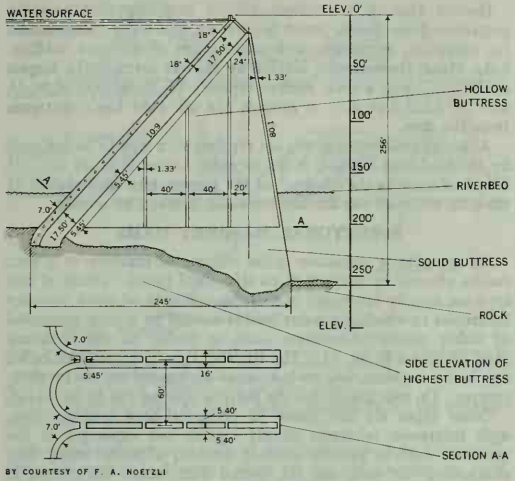


FIG. 11.—PLAN OF MULTIPLE-ARCH DAM, LAKE PLEASANT, ARIZONA, SHOWING: (TOP) SIDE ELEVATION OF HIGHEST BUTTRESS; (BOTTOM) SECTION THROUGH ARCHES AND HOLLOW BUTTRESSES

in the United States, the 330-ft. multiple-arch Alder Dam in Washington, was completed in 1945.

STEEL AND TIMBER DAMS

The relatively uncommon dams of steel and timber must meet all of the stability requirements prescribed for other dams. The steel dam is in general similar to the structural masonry dam, but with a steel-plate deck and steel-frame buttresses. Few steel dams have been built, probably because of cost and lack of confidence in their permanence. Three large steel dams were constructed about 1900, but after one of these failed, although its destruction was attributed to a foundation failure and not in any way to the fact that it was built of steel, it was replaced by a concrete dam.

Small timber dams may consist of framed wooden buttresses with tongue-and-groove wood plank facing, but the most usual type is the rock-filled timber crib, with plank decking. Timber crib dams are numerous, but usually small. Although under favourable conditions they may last more than 50 years, they require considerable maintenance and are seldom tight after a few years of use. They are used frequently as cofferdams in construction work. Their stability requirements are similar to those for gravity dams. Floods are usually allowed to pass over them, but separate spillways may be used.

SPILLWAYS FOR DAMS

With few exceptions provision must be made for passing excess floodwater over, around, or through all dams. The principal exceptions are dams forming regulating basins for artificial channels

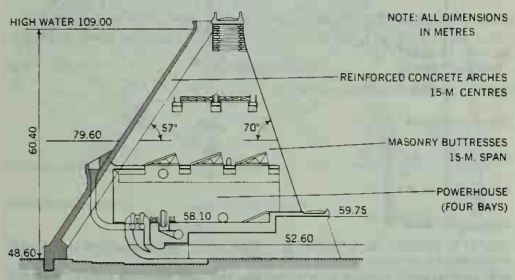


FIG. 12.—CROSS SECTION OF THE TIRSO DAM, SARDINIA

in which the inflow is subject to complete control and where natural drainage from uncontrolled areas is not involved; even in these cases it is usual to provide a small safety outlet to guard against failure to control the inflow properly. Another exception is the low earth or gravel diversion dam, designed to be wholly or partly carried away in each flood.

The required discharge capacity of a spillway is determined from a careful study of discharge records of the stream and of local flood possibilities. Allowance is made for the modifying effect of available storage. For fill dams the capacity should equal the maximum possible flood, as a single overtopping might cause a disastrous failure. For types of dams and foundations in which occasional limited overtopping will not cause failure, the spillway capacity may be reduced, based on an economical balance between the cost of the spillway and the capitalized cost of possible future repairs.

The simplest means of handling a flood at a solid masonry gravity dam is to pass it directly over the top of the dam, but there must be room at the base for the flood overflow and for any required powerhouses or other appurtenant facilities. The downstream rock must be sufficiently sound to withstand the impact of the water, or it must be protected by paving or stilling devices to ensure that the foundations of the dam will not be undermined.

The crest of a dam is shaped to fit the overpouring stream so as to avoid possible damage to the structure. The flow may

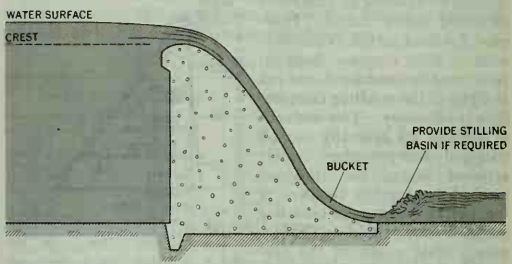


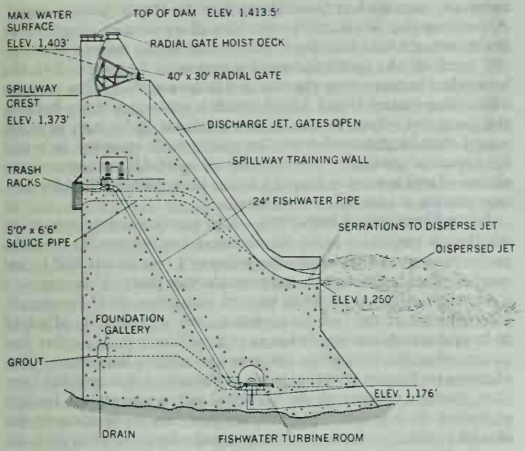
FIG. 13.—OVERFLOW GRAVITY DAM WITHOUT STILLING BASIN OR CONTROL GATES

be uncontrolled or gated. A curved "bucket" is usually provided at the base of the dam to prevent direct impingement on the foundation, and, unless the rock is of excellent quality, a stilling pool or baffles may be required. An uncontrolled example, without a stilling basin, is shown in fig. 13. A stilling basin, with or without baffles, may be required. An alternative to the stilling basin is the ski jump, shown in fig. 14. Here the stream leaves the spillway in a slightly upturned direction, above the tail-water level. The ski-jump spillway, also adaptable to the arch dam, is widely used in Europe.

For fill dams and for all others where direct overflow is not permissible, a preferred type is a simple, uncontrolled chute around the end of the dam. This spillway may be lined with concrete, but, if the rock is sufficiently sound and overflows are small or infrequent, the lining may be omitted, except that a leveling sill is usually provided at the top to spread the flow evenly over the width of the chute. The flow over the crest of a chute spillway may be unobstructed or controlled by gates or other devices. The chute must be carried downstream to the point where its discharge will not impinge upon the dam or its foundation.

If the rock is of poor quality the chute may require lining all the way to the river bed, and in some cases a plunge basin, baffles, or other stilling devices may be required to avoid erosion. Otherwise the lining may be terminated, preferably in a "ski jump," at any convenient point where the rock is sound.

In an uncontrolled spillway useful storage behind the dam is limited by the elevation of the spillway crest, but the dam must continue above that elevation to provide the depth required to push the floods into the spillway. Since this extra height is ex-



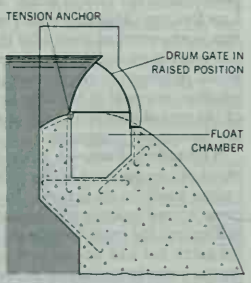
BY COURTESY OF SOUTHERN CALIFORNIA EDISON CO.

FIG. 14.—CROSS SECTION OF DAM NO. 7, BIG CREEK PROJECT NO. 4, EMPLOYING THE SKI-JUMP SPILLWAY (SAN JOAQUIN RIVER, CALIFORNIA)

pensive, uncontrolled spillways are made as wide and shallow as physical conditions and economics permit.

In some cases the benefits of a long crest may be secured by extending the intake channel leading to the chute or tunnel a considerable distance upstream, with the waterside lip at the elevation that would be used for the crest of a wide shallow chute. This is called a side-channel spillway. A special type of spillway, known as the "morning glory," consists of a vertical shaft connecting to a horizontal tunnel at the downstream water level. The top of the shaft is belled out to afford a long inflow lip.

Spillway Control Devices.—Where the canyon walls are steep to a considerable height above the top of the dam, a wide shallow chute is not feasible, and a deep narrow chute or a tunnel must be used. The entrance to such a spillway still can be left open, but the necessary increase in the height of the dam greatly increases its cost. As a result, it is necessary to resort to gates, which permit useful storage to be held above the bottom of the spillway inlet. Gates may also be required, particularly on large rivers and even on wide spillways, where it is necessary to control floodwater levels closely to avoid upstream damage.



FROM W. P. CREAGER, JOEL D. JUSTIN AND JULIAN HINDS, "ENGINEERING FOR DAMS," 1945; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 15.—DRUM-GATE CONTROL DEVICE

The simplest floodgates for controlling spillway flows consist of flashboards supported against pins designed to fail at predetermined flood levels. Another form of simple floodgate consists of needles or vertical beams seated on the spillway crest and supported at the top by horizontal beams. Shutters or panels of wood or steel are also used, supported by movable frames, or hinged and supported by collapsible or removable struts. A form of the latter known as the "bear trap" or "roof weir" consists of two panels inclined toward each other and arranged to be raised or lowered by water admitted to or emptied from the space between them. Such gates have been built as high as 17 ft. and for openings up to 120 ft. wide. Hinged panels may also be arranged to be raised or lowered automatically with changes in water level.

Another form of control for wide openings is the drum gate, illustrated in fig. 15. The rigid steel structure, hinged at its upstream corner, is raised or lowered by admitting water under reservoir pressure into the chamber below the gate. In the type shown the top plate is curved to match the shape of the overflow dam when in the lowered position. The perimeters of the lower face of the drum and the ends of the upper face are provided with sealing devices to control leakage. The gate sometimes is installed in the reverse position, with the hinge at the downstream side.

A rolling gate, consisting of a large cylinder resting on the crest of the dam, is also used for wide openings. The gate is raised by rolling the cylinder up inclines on the faces of the piers. Such gates have been built up to 115 ft. long and up to 20 ft. in height.

Large openings may also be provided with vertical sliding or rolling gates. Such gates have been used up to 50 ft. square, power operated. The rollers may "float" between the gate and its frame, attached to neither, or may take the form of wheels fixed to the gate and riding on tracks in the gate groove.

Spillway openings may also be closed by means of radial (Taintor) gates, in which the gate is a segment of a cylinder supported by radial struts hinged at the piers, the gate being lifted clear of the water for passing floods. Sealing devices are required at the ends and bottom of the gate to control leakage. Lifting of the gate involves only its weight, the small drag of the end seals, and the bearing friction at the hinge. Operation is accomplished by chains or cables at the face of the gate. These gates are very versatile and are used in a variety of sizes, from 2 or 3 ft. to over 50 ft. high. Hand-operated hoists may be used for small gates, but larger sizes are power operated. A large gate of this type is illustrated in fig. 14

Outlets From Reservoirs.—Whatever the purpose of storing water behind a dam, means must be provided for withdrawing it as needed. In masonry dams this is frequently accomplished by pipes imbedded in the concrete that are controlled by valves. Usually two valves are used in tandem on each outlet tube. The downstream valve is usually an expensive and somewhat complicated device designed to withstand the damaging effect of operation at partial openings, when close regulation is required. The upstream valve, used only as a safety device, can be of simple design. It may be located near the upstream face, or at least upstream from the watertight element of the dam. The control valve may be placed anywhere downstream from the safety valve. A copious supply of air is required at its downstream face to cushion the damaging effect of turbulence. For fill dams the conduit between the two valves must be watertight under full reservoir pressure.

For fill dams conduits through the fill, especially conduits built along the foundation, may be used, but with extreme care. A collapse or leak may cause great damage. For such dams, and also for many masonry dams, a preferred outlet conduit is a tunnel through an abutment. Outlets may be at or near the base of the dam, near the top, or at various intermediate levels in the dam. Their inlets are usually protected by grids of bars, known as trash racks, to exclude troublesome debris. In flood-control dams where the primary purpose is the reduction of flood peaks, some or all of the outlets may be ungated.

See also RESERVOIR; and references under "Dam" in the Index.

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DAMAGES, the body of law that governs awards of money as compensation for legal damage. Although it is often difficult to separate the question of whether legal liability exists from the question of how much should be paid as compensation for a particular wrong, the word damages is used in law to designate the

system of rules, standards and formulas which have been developed in relation to questions of the latter type.

Although there was a developed system of money compensation for wrongs in Roman law, and although the remedy appeared early in the development of English law and became the primary remedy of the common-law courts, the growth of the modern law of damages is a function in large part of the importance of the jury in Anglo-American legal procedure. In the United States particularly, the process of passing on the evidence that may be submitted to juries, of instructing juries on the law they are to apply and of reviewing the amounts awarded by juries for particular wrongs has built up a large body of doctrine. The somewhat narrowed scope of the jury in civil actions in the legal system of England in the 20th century as compared with the vigorous survival of the jury system in the United States has undoubtedly been a factor which has made the law of damages somewhat less complex in England than in the United States.

Basic Concepts.—Terms which frequently occur in discussions of money awards in the United States are value, certainty and avoidable consequences.

Value.—When an object of property is evaluated for the purpose of compensating its owner for its loss or injury, the usual standard to which reference is made is market value. If the item involved is of a type that has been the object of a great number of commercial transactions, so that evidence of a fairly definite price at the time and place of injury can be produced, the problem presented is relatively simple. If, however, the item to be valued is of a kind which is rarely the subject of sale, the concept of market value is of little value as a standard for determining what the just compensation should be. In such cases the courts often use the term actual value to describe the amount that is to be awarded. Compensation for the loss of a quantity of grain would be discussed in terms of market value, while the loss of an industrial machine would be approached in terms of actual value in the light of such factors as the original cost, the cost of replacement and the depreciation which the machine has been subjected to in use. Again, clothing or furniture acquired for personal use may have an ascertainable market value, but may be worth more in use to the owner than a similar item purchased on the second-hand market. Juries are frequently allowed to consider the value of an item to the owner although they are usually instructed that any sentimental value which an owner attaches to a personal item should not be a part of the compensation awarded. Substantial awards are sometimes approved, however, for lost family portraits and other keepsakes under the value-to-owner formula.

Certainty.—As used in the law of damages, certainty means that there is a sufficient basis in the evidence presented to enable a jury to reach a reasoned conclusion of fact regarding the amount of the loss. The strictness of this standard has varied considerably in its application to different kinds of cases. The idea that certainty is required has had its most frequent application and its strictest formulation in cases involving the recovery of profits lost by virtue of a wrongful act. The frequent use, however, of the idea that it is the fact of loss and not the amount of loss which must be certain has lessened the rigour of the standard of certainty even in this class of cases. The English judges have not developed methods of controlling the award of damages by a jury to the same extent as have judges in the U.S.; and the English cases tend to handle problems, which in the U.S. would fall under the rubric of certainty, in terms of the still less precise idea of remoteness.

Avoidable Consequences.—Many questions which arise concerning amounts to be awarded for particular wrongs can be resolved only with reference to the doctrine of avoidable consequences: the principle that one who is injured by another's wrong cannot passively allow losses to accumulate but must take reasonable steps to protect himself or be denied a recovery for the losses which could have been thus avoided. The damages resulting from a personal injury, for example, cannot be recovered if the person injured will not submit to routine medical treatment when the evidence shows that the injuries would have responded to such treatment. The question of the reasonableness of the injured person's actions will arise as more complicated, dangerous methods of treatment are suggested as possibilities that he should have pursued. A doctrine that is related to the idea of avoidable consequences is the concept that benefits which accrue to the injured party as the result of the particular legal wrong must be credited to the wrongdoer in computing the damages to be awarded. The expense of building materials and labour which a contractor saves because the party for whom he was to work refuses to let him perform would thus be deducted from the contractor's recovery in a suit for breach of contract. The doctrine of avoidable consequences is discussed and applied in England under the somewhat broader concept known as mitigation of damages.

Some Elements of Recovery.—The questions constantly recur whether in particular cases the claimant can recover, in addition to the basic award: interest; the attorney's fees he has had to expend to effect his recovery; and exemplary or punitive damages.

Interest.—The granting of interest as an element of damages is a recognition of the fact that when a sum of money is adjudged to be appropriate compensation as of a particular date, further loss occurs when the amount is not received until a later time. The effective realization of this concept in the law of damages has been slow, perhaps because of the historical policy against the lending of money on interest. The first common-law recognition of the idea of interest as damages came in cases where the obligation asserted the right to the payment of a fixed sum on a given day (*Wood* v. *Robbins*, 11 Mass. 503 [1814]). The requirement that the basic liability be a liquidated sum or a sum which can be computed with the aid of readily ascertainable market values is still an important part of the modern law of interest as damages. Surviving, too, is the attitude that an award of interest should be at the discretion of the court or jury rather than following as a matter of law when the prerequisites are established. These ideas have persisted with more vigour in cases involving recoveries for wrongful acts other than breaches of contract; that is, in cases involving torts. In contract cases the idea is being accepted that if it is determined after litigation that a claimant was injured in a pecuniary way at a particular time, then complete compensation should include an award of simple interest on the amount of the basic award from the time of the injury until the date of judgment (*Prager* v. *New Jersey Fidelity & Plate Glass Insurance Co.*, 245 N.Y. 1 [1927]). The rate which is utilized in cases where interest is awarded has most often been the "legal rate" fixed by statute, although there is evidence in a few decisions of a judicial willingness to utilize a rate more attuned to the ultimate end of proper compensation in the case at hand. In England, by virtue of s. 3 of the Law Reform (Miscellaneous Provisions) act, 1934, in any proceedings in any court of record for the recovery of any debt or damages, the court may order that there shall be included in the sum for which judgment is given interest at such rate as it thinks fit on the whole or any part of the debt or damages for the whole or any part of the period between the date when the cause of action arose and the date of the judgment.

Attorney's Fees.—A basic difference in English and U.S. law exists on the question of the recovery of attorney's fees by the prevailing party in an action. In U.S. law statutory costs have become a fixed amount which does not include attorney's fees, while in England the costs include such part of the fees which a successful party has had to pay to a solicitor and barrister as the taxing master considers reasonable (*see* Costs). Strong policy arguments can be made for each of these approaches. It is clear that, unless the professional fees which must be incurred if a suit is to have a reasonable chance to succeed can be recovered by the injured party, he is not actually made whole by his recovery of a sum measured only by the injury which is the basis of his action. On the other hand, the possibility of having to pay the fees incurred by one's adversary if a suit is not successful may be a strong deterrent to the bringing of actions which appear to be just. U.S. statutes in some states have made provision for the recovery of attorney's fees in cases such as the suit of a wife for divorce or the foreclosure of a mechanic's lien; further, the case law in the U.S. has developed a rule which allows recovery of attorney's fees in cases where the defendant's conduct has involved the plaintiff in litigation with a third party.

Exemplary or Punitive Damages.—Although most of the law of damages revolves around an attempt to devise a system which will compensate individuals for the harm they have suffered, the concept of punitive or exemplary damages is quite different. Exemplary damages are awarded to the injured person as a means of punishing the wrongdoer. Normally, of course, punishment is the result of the application of the criminal law, and if fines are exacted the proceeds go to the state and not to an individual who happens to have been injured by the criminal act. The use of a private award which is not geared to compensation is, of course, a means of encouraging individuals to sue even when they have not suffered great pecuniary loss if the acts of the wrongdoer have been, as is required for an award of exemplary damages, wanton or malicious. However, it is not ordinarily a defense to a claim for exemplary damages that the wrongdoer has been punished previously in a criminal action. There are other anomalies in the law of exemplary damages. Although, in theory, the size of a punitive award should depend on the nature of the conduct which it is sought to punish without regard to the amount of injury caused by that conduct, some jurisdictions require the size of the exemplary award to bear a reasonable relationship to the compensatory award granted. On the other hand, the punitive function of an exemplary award is recognized in some states by a rule which admits evidence regarding the wealth of the defendant in order that the jury may decide how large an award is necessary for punishment in his case.

The Measure of Damages for Various Legal Wrongs.—The personal-injury action, most often arising out of an automobile accident, has become more prevalent in the courts than any other kind of litigation. The elements of recovery that can be considered in such an action include: the loss of time as a result of the injury, frequently measured by the loss of wages that has occurred; the amount that has been expended for medical services; and a sum designed to compensate the injured person for the pain and suffering that has resulted from the injury. These elements of recovery relate to the past, looking at the situation from the time of the trial. Since only one award is made in the common-law system for an injury resulting from a single wrongful act, it is necessary also to include in this award the damages which will occur in the future as a result of the injury. These future losses are obviously far more speculative in nature than are the losses which have already occurred. They include: the loss of earning capacity; the reasonable cost of the medical services that the injured person will incur; the future pain and suffering that the injured person is reasonably certain to undergo. If the injury is of a disfiguring sort, the recovery may also include a sum to compensate the embarrassment and humiliation of the injured party. The English courts have gone beyond these elements into awards compensating the loss of enjoyment of life brought about by the injury and even into a consideration of the loss of the happiness the injured person would have had in the years of life denied him because of the reduction in his life expectancy. The common law did not recognize a right to recover for death itself, but with the passage in England of Lord Campbell's act in 1846 the concept of such a recovery became a general subject of legislation in the United States. Under most of these statutes the damages are based on the economic benefits that the decedent's family could have expected to receive from him if he had lived.

The theory of an award of damages in a personal-injury or other tort case is that the injured party should be placed in the position he would have been in if the injury had not occurred, so far as this can be done with a money award. The possibility of achieving this goal is obviously far greater where the injury has been to a property interest rather than to the person. Where the legal wrong sued for is the breach of a contract, the theoretical end of the damages remedy is to give the injured contracting party the benefit of his bargain by putting him in the position he would have enjoyed if the contract had been performed. Applied, for example, to a contract to build a house which has been breached by the owner, this formula would give the builder the contract price less what it would cost to finish the job.

Contract recoveries are limited in one respect by the principle of the landmark case of *Hadley* v. *Baxendale*, 9 Exch. 341 (1854), which allowed recovery only for those injuries which were reasonably foreseeable at the time the contract was entered into. This usually means that notice of the possibility of any unusual consequences of failure to fulfill a contractual obligation must be brought to the attention of the contracting party if these unusual consequences are to be the subject of a recovery of damages for breach of contract.

The many complex problems that surround the determination of damages in a lawsuit encourage contracting parties to stipulate at the time of entering into a transaction what the damages shall be for a breach. Such a clause in a contract is known as a liquidated-damages clause. There are safeguards surrounding the enforcement of such clauses designed for the most part to carry out a policy against the use of penalty provisions as a mechanism for the enforcement of obligations. Thus, if the amount stipulated as liquidated damages is unduly large in relation to the injury to be expected from breach, it will be unenforceable and the parties will be relegated to the ordinary process of proving damages.

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(R. C. M.)

DAMANHUR, a town of lower Egypt and capital of the delta governorate of Al Buhayrah (Beheira) which supplies cotton and rice, lies 38 mi. E.S.E. of Alexandria. Pop. (1957) 110,521. A triennial fair is the chief event. Damanhur is situated on the ancient site of Time-en-Hor ("city of Horus"), earlier called Behdet, once capital of lower Egypt in predynastic times. Behdet contributed the winged disk of Horus (*q.v.*) to Egyptian symbolism. In Ptolemaic times it was capital of a nome and was known to the Romans as Hermopolis Parva. Little remains of the earlier buildings at this place. (A. B. M.; M. V. S.-W.)

DAMÃO (DAMAN), previously capital of the Damão settlement in former Portuguese India, was taken over by India in Dec. 1961 (*see* GOA: *History*). It lies on the east side of the entrance of the Gulf of Cambay within Gujarat state. It has a station on the broad-gauge Western railway. Pop. (1950) 9,027. The settlement had an area of 211 sq.mi. and a population of 69,005, and was divided into three parts: Damão proper along the coast, separated from the tiny enclave of Dadrá and the larger one of Nagar Aveli (Nagar Havili) from both of which the Portuguese administrators were ousted in 1954. Damão has a little fishing and shipbuilding but no foreign trade.

Damão town was sacked and burned by the Portuguese in 1531. It was subsequently rebuilt, and in 1558 was again taken by the Portuguese who made it a permanent settlement. The territory of Damão proper was conquered by the Portuguese in 1559; that of Nagar Aveli was ceded to them by the Marathas in 1780 in indemnification for piracy. The settlement was subject to the governor general of Goa as part of the Portuguese overseas province, Estado da Índia. (L. D. S.)

DAMARALAND, the part of South-West Africa formerly occupied by the Herero (*q.v.*) people who were called by the Nama (Hottentots) the Gomacha (*i.e.*, cattle-breeding) Dama. "Damara" is the feminine plural form which has been used in error to designate the group as a whole. In the Nama language *dama* means "black people," a derogatory name. Many authorities reject the word "Damaraland" in favour of "Hereroland."

The area designated corresponds to no present administrative unit but to the area roamed over by the Herero before the German occupation. Roughly this extends from the Etosha pan (about 19° S.) in the north to the Khomas highlands to the south of Windhoek, and between the Kalahari sand veld in the east and the Namib desert in the west (*see* SOUTH-WEST AFRICA: *Physical Geography*). Damaraland is well-grassed bush country with an annual rainfall of between about 16 and 24 in., constituting the best cattle country in the territory. The area is occupied by whites, the Herero having been allocated reserves mainly on the borders of the Kalahari sand veld. (J. H. WN.)

DAMASCENING: *see* METALWORK, DECORATIVE: *Techniques of Metalworking.*

DAMASCENUS, JOHN: *see* JOHN, SAINT, of Damascus.

DAMASCENUS, NICOLAUS: *see* NICHOLAS OF DAMASCUS.

DAMASCIUS (5th–6th century A.D.), Neoplatonist philosopher, the last in the succession of Platonic scholarchs at Athens (*see* ACADEMY, GREEK), was born about A.D. 480. A pupil and close friend of Isidore of Alexandria (*q.v.*), whose biography he wrote in the customary enthusiastic manner of Athenian Neoplatonism (part of it is preserved in Photius's *Bibliotheca*), he became head of the school himself about 520 and was still in office when Justinian closed the Academy in 529. Damascius, with Simplicius and five other members of the school, went to Persia to the court of Chosroes I. By a clause in the treaty of 533 between Justinian and Chosroes they were allowed to return and seem to have been glad to do so, as they found the atmosphere of the Persian court uncongenial to philosophy. The date of Damascius' death is not known, but is unlikely to have been much later than the middle of the 6th century.

Damascius' chief surviving work is entitled *Problems and Solutions About the First Principles* (ed. by C. A. Ruelle, 1889; Fr. trans. by A. Chaignet, 1898). In this he retains and still further elaborates the whole vast system of Proclus: the hairsplitting logic and theosophical fantasy of Athenian Neoplatonism are still there. But he opens a way to genuine mysticism by his insistence (in the spirit of Plotinus) that our speculation can never attain to the ineffable first principle (which he will not even call "the One") or describe adequately the relation to it of derived reality. This first principle is beyond the reach of human thought and language and utterly outside the hierarchy of reality; and, because it is outside, everything, and, especially, the soul of man can participate in it directly and without intermediary, though in an unspeakably mysterious way. The last of the pagan Greek philosophers points the way forward to the Christian mystics of the "Dionysian" tradition.

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DAMASCUS (DIMASHQ), an administrative district (*muhafaza*) of Syria. Pop. (1960) 978,000. Area 7,540 sq.mi. Situated north of the governorates of Dar'a and As Suweida and south of Homs, its western and eastern limits are the borders with Lebanon and Jordan. It includes portions of three geographical regions: (from west to east) the mountains of Hermon (9,232 ft.) and Anti-Lebanon; the fertile plain of the Ghutah; and the Syrian desert. The city of Damascus, situated in the western Ghutah, is administratively separate. There are numerous villages and some small towns in the mountains. Zabadani and Baludan are popular summer resorts. Irrigation from springs and small streams creates oases of fertility in an otherwise barren mountain region. The Ghutah, where 40,000 ac. are irrigated by the waters of the Barada and A'waj (the biblical Abana and Pharpar), is intensively cultivated and produces cotton, wheat, maize and a great variety of vegetables and tree fruits. The local breed of cattle are excellent milk producers. Excess winter floodwater drains into seasonal lakes ('Ateibe and Hij) at the eastern limit of the oasis. The manufacture of cement, glass, textiles, matches and preserved foods is pursued in settlements near Damascus. The small towns of Al Nabk, Qutayfah, Duma, Qatana and Al Qunaytarah are situated on or near the main north-south road along the desert border. The desert contains no settlements of importance, but its poor winter and spring pasture supports the flocks and herds of nomadic Bedouin tribes.

See R. Thoumin, *Géographie Humaine de la Syrie centrale* (1936). (C. G. Sm.)

DAMASCUS (DIMASHQ), the capital of Syria and of Damascus *muhafaza*, is the country's largest city but not its commercial centre which is Aleppo (*q.v.*). Pop. (1960) 529,579. The majority of the inhabitants are Arabs, coexisting with Druses, Kurds, Turks and Persians. There is a large Christian Maronite minority.

Damascus (Arab. *Dimashq as Sham*, meaning Damascus of Syria) has had many other names, including "pearl of the east," "the city of many pillars" and "the gate of Mecca." The city is situated in the Ghutah, a depression and oasis at the foot of Mt. Qasyun, about 2,264 ft. above sea level and 57 mi. S.E. of Beirut. It owes its importance and prosperity to its position commanding both the waters of the Barada and A'waj rivers and the transdesert routes and has long been a valuable market for the desert tribes. Formerly it was the starting place for the overland pilgrimage to Mecca; the annual influx of pilgrims added considerably to the wealth of the city. Damascus is connected by all-weather roads with Aleppo and with Beirut, Lebanon; Amman, Jordan; and by desert track to Baghdad, Iraq. There is also a rail service to Beirut, Aleppo, and Dar'a on the Jordan frontier. At Al Mazzah, on the outskirts, there is an airport within 30 minutes' drive from the centre of the city.

The modern town of Damascus is cut in two by the Barada. The old city, partly walled, lies south of the river and contains the principal mosques, khans and markets, the Meidan quarter settled by tribesmen, the Christian quarter to the northeast of the city, and next to this the Druse quarter. North of the river the new town was greatly extended during the years 1940–60, with imposing government buildings including ministries, hospitals, a large general post office, modern hotels and factories. The new northern residential quarters are built largely of stone with shady avenues and gardens and include many large blocks of flats. In the western sector is the Syrian university established in 1924 by the French authorities and one of the leading educational establishments in the middle east. Damascus is set among gardens and orchards and is famous for its grapes, melons and apricots. The best view of the city is to be obtained from the Salahayih quarter in the northwest, whence splendid vistas extend to Mt. Hermon. The beauty of the town and its luxuriant setting have led it to be regarded as an earthly paradise, and for the Muslims and Christians especially it is a holy city, the site of the burial of Saladin and of the conversion of St. Paul.

Traditional manufactures include brocades (damask; *q.v.*), carpets, leatherwork, inlaid woodwork in the shape of boxes and furniture, metalwork, including gold and silver filigree and damascene blades (*see* DAMASK STEEL). Sugar refineries and factories for glass, furniture, matches, textiles, cement and preserves have been established. Rose-petal jam, confectionery and ice cream are long-established manufactures. An important market centre, Damascus exports wheat, tobacco, livestock, hides, dried and fresh fruits. The principal imports are machinery, automobiles, iron and steel, fuel oil and pharmaceutical products.

Antiquities.—The lines of the old medieval city can be traced from the position of the gates, and it appears to have been divided into several quarters. The most imposing building is the Great Mosque, Jami Al Umawi or Al Aqsa, built within the enclosure wall of the temple to Adad of 1st-century date and replacing the church dedicated to St. John the Baptist built by the emperor Theodosius I in 379. According to Christian tradition, after the Muslim conquest of the city the Christians and Muslims shared the church until 705, when the caliph al-Walid I destroyed the church and rebuilt the mosque. It appears more likely that a mosque and church were both situated within the temple temenos, but that in 705 the church was destroyed and the mosque enlarged

A SHELL PHOTOGRAPH

COURT OF THE GREAT MOSQUE, JAMI AL UMAWI, 8TH CENTURY, RESTORED 11TH, 15TH AND 19TH CENTURIES, WITH THE MINARET OF JESUS, DAMASCUS, SYRIA

and rebuilt by al-Walid with the aid of Greek architects. The restoration was a splendid building, the walls lined with marble overlaid with golden vines and the wooden roof inlaid with gold tracery, while from the ceiling hung 600 gold lamps. These were later replaced by the caliph Omar II. In 1069 the mosque was destroyed by fire and in 1401 the city was ravaged by Timur. In 1893 it was again damaged by fire, and the existing marble inlay dates from this period. In spite of all these disasters the mosque remains a structure of great beauty.

The citadel, a quadrangular building in the northwest of the old city, may be of Roman date, and was certainly in existence by medieval times as it was rebuilt in 1219. It was frequently restored, notably in 1262 by Sultan Baybars, who liberated Syria from the Latins. The *suks* (bazaars) are mostly recent, having been largely rebuilt after the revolt of 1925. Of the khans (inns for the exchange of goods) the best known is the Khan Asad, constructed of black and yellow stone with ornamental domes. Of interest is the Azam palace, built in 1749 for the governor of Damascus and converted after 1922 by the French into an institute for the study of Islamic art and architecture. Gutted in the 1925 revolt, it was rebuilt and shows a reconstruction of Arab town life in the 18th century. "The street called Straight" (Acts ix, 11) is usually identified with the Suk al Tawilah ("the long bazaar"), part of which is called Darb al Mustakim ("Straight street"). Investigations suggest that it is above the original street of that name. The Damascus museum, set in riverside gardens beside the beautiful Tagiah mosque in the west of the city, was founded by the French and contains fine collections from various excavations, including material from Mari (mod. Tall Hariri), Ugarit (Ras Shamra), Arpad (Tall Rif'at) and Palmyra. Its collection of Roman glass is one of the finest in the world.

History.—*The Pre-Islamic Era.*—According to Josephus, Damascus was founded by Uz, son of Aram; it was already a city by the time of Abraham. It is known to the Arabs as Al Fayha, "the fragrant," from its many gardens. The ancient name was Dimasqa, which is thought to be non-Semitic.

Traces of the Chalcolithic and Early Bronze Age have been found on the edge of the Ghutah oasis. In the escarpment overlooking the Barada are numerous rock-cut tombs of the 1st millennium B.C. and earlier. By the time of the Amarna letters (*see* TELL EL AMARNA) Dimasqa was the capital of the state of Ubi, a vassal of Egypt. Not until the area was overrun by the Aramaeans at the beginning of the 1st millennium B.C. did Damascus acquire political importance. Under Adad-Iri, it headed a league of Syrian states against Shalmaneser III and held out for at least four campaigns between 853 and 841 B.C. After Adad-Iri had been assassinated by Hazael, a usurper, Hazael was attacked by Assyria and defeated, but apparently Damascus was not captured. Hazael's son, Bar-Hadad, attacked Hamath (modern Hama) which belonged to the pro-Assyrian party. The sudden death of Bar-Hadad left his son Mari' unprepared for Assyrian retaliation; he allowed Adad-nirari III to enter Damascus unopposed and paid a tribute of 100 talents of gold and 1,000 talents of silver, an indication of the wealth of the city. Under Tiglath-pileser III Assyrian power in Syria was restored after a period of rebellion. Among the states which had revolted was Damascus, and after a siege the city fell in 732 B.C. The king, Rasun or Rezon, paid with his life; his subjects were transported to the borders of Elam and the famous orchards surrounding the city were destroyed. Thus ended Aramaean Damascus, the most powerful and prosperous of the Aramaean states in Syria.

Under the Persian empire Syria (with Palestine and Cyprus) formed the fifth satrapy, and Damascus became a Persian garrison city. On the collapse of the Persian empire after the battle of Issus, Alexander the Great's general Parmenio occupied Damascus without a struggle, but on the death of Alexander his Macedonian empire broke up, though Syria did not at first fall to the Seleucids. It was not until 312 B.C. that Ptolemy and Seleucus defeated Antigonus I Cyclops, and the final control of Syria was not established until after 301 B.C. Thereafter the city passed alternately from Egyptian to Seleucid hands, and by 112 B.C. it passed to Antiochus IX. Within the next decade the Nabataeans (*q.v.*) established themselves in Coele-Syria (mod. Beqa') and acquired Damascus. In 64 B.C. it was invested by the Romans, and it remained under their rule till A.D. 31, when Aretas, an Arabian ruler, took it on the death of Tiberius; it was under his control at the time of St. Paul's visit.

In 105–106 the Nabataeans were incorporated into the Roman empire as a province of Arabia. Under the Romans Syria recovered rapidly from the economic depression into which it had sunk. Fruit trees from Damascus, such as the damson plum, figs and pistachios, were introduced into Italy by the Romans. Under Roman rule Damascus was overshadowed by Antioch, although under Hadrian it achieved the status of a metropolis and Alexander Severus conferred upon it the rights of a *colonia*. Diocletian established armament factories at Damascus, which was noted for its manufacture of weapons.

The Damascenes worshiped Adad (*q.v.*), or Hadad-Rimmon, the storm-god, whose name was transformed to that of Jupiter-Damascenus. Christianity throve in Damascus, which became the seat of a bishop and sent delegates to the Council of Nicaea (*q.v.*) in 325. In Sept. 635 Damascus fell before the invading Arab forces. It was temporarily abandoned the following year before the battle of Yarmuk, which finally gave Syria to the Arabs.

(M. V. S.-W.)

Islamic and Modern.—The first Arab governor, Yazid, belonged to the Omayyad family of Mecca; his successor, Mu'awiya, became caliph of the Islamic empire after the murder in 661 of the fourth caliph, Ali. For almost a century Damascus was the capital of the caliphate (*q.v.*) and the political and cultural centre of Islam. The conversion of the population to Islam began; although Christians, who had been guaranteed possession of their property on payment of taxes, remained important as officials. In 750 the Abbasids destroyed the Omayyad power, Baghdad became the capital and Damascus a provincial centre. As the unity of the caliphate dissolved and local dynasties arose Damascus changed hands often, but for most of the 200 years from the middle of the 9th century it was held by those who ruled Egypt. In 1076 it was occupied by the Seljuk Turks, but in 1154 fell into the hands of Nureddin and then of his successor, Saladin (*q.v.;* Salah al-Din), founder of the Ayyubid dynasty. A period of prosperity, religious culture and fine building continued when, after a brief occupation by the Mongols, Damascus was included in 1260 in the Mameluke state of Egypt and Syria, and became the capital of one of its provinces. In 1401 it was briefly occupied and devastated by Timur.

In 1516 Damascus was captured by the Ottoman sultan Selim I and remained the capital of a Turkish province for 400 years. It was the point of departure of the pilgrim caravan for Mecca, and the governor's main duty was to organize and protect the caravan. Members or dependents of the Azam family ruled the province as Ottoman governors throughout most of the 18th century.

The 19th century saw a new expansion, beginning with the decade 1831–40 when Syria was incorporated in the empire of Mohammed Ali of Egypt. Foreign consuls and merchants settled in Damascus, trade increased, the population grew, schools and a public library were established and railways laid down to Beirut, Haifa and Medina. These changes did not take place without strain: political and economic factors together led to a massacre of Christians by a Muslim mob in 1860, although some Muslim notables tried to prevent it.

In World War I Damascus was the headquarters of the Turkish-German forces which tried to attack the Suez canal and later opposed the British advance in Palestine. In 1918 it was occupied by British and imperial troops and the Arab force which had operated on their eastern flank. The leader of this force, Amir Faisal, became military administrator of Damascus and the interior of Syria, while there was a French military administration on the coast. Two years of tension followed; Faisal's supporters wanted Syria to become an independent Arab state while the French wished it to be placed under their mandate. In March 1920 a Syrian congress meeting in Damascus offered the throne to Faisal, but in July French troops occupied the city after an ultimatum. For the next 25 years Syria and Lebanon were ruled by France

under mandate from the League of Nations. Beirut was the headquarters of the mandatory administration, but Damascus became capital of the Syrian republic, the largest of the regions into which the mandated territory was divided. Under the French there was material progress; new quarters of the city were built, ancient buildings preserved, the museum established and the university created. There was much political unrest, and a revolt in 1925 was not suppressed before the French had twice bombarded the city. In World War II British and Free French forces entered Damascus (June 1941) to oust the Vichy French. After four years of tension over the problem of independence, during which the French once more bombarded the city, agreement was reached on the withdrawal of British and French forces.

From 1946–58 Damascus was the capital of Syria, and prospered despite political unrest: the new quarters expanded, factories and an international airport were built and the university grew. During the union of Syria and Egypt in the United Arab Republic (1958–61), Damascus was administrative centre of the Syrian (Northern) region, but became once more the capital of Syria after the latter's withdrawal from the union.

See also SYRIA and references under "Damascus" in the Index volume. (A. H. H.)

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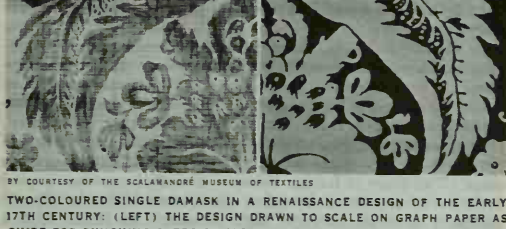
DAMASK, one of the most popular of patterned textiles. True damask was originally wholly of silk, deriving its name from the fine patterned fabrics produced in Damascus in the middle ages. Gradually the term came to be applied to a certain type of patterned fabric regardless of fibre. Single damask has one set each of warps and wefts and may be woven in one or two colours; compound or double damask has a greater number of wefts. Damask is woven on a Jacquard loom, the satin field being produced by floats of warp that pass over from two to seven and in some instances nine wefts. The design is a plain or taffeta weave, the warp and weft being at right angles that create less lustre than the satin areas.

Crusaders who had passed through Damascus introduced the fabric to Europe in the 11th century, and the weaving of linen damask became established in flax-growing countries—in France, for example, by the mid-13th century. The Flemish city of Courtrai was noted for its table linen in the 15th century, as was Haarlem, The Netherlands, in the 17th and 18th centuries. William III established damask weaving in Ireland in the late 17th century.

Antique damask was 18–25 in. wide, the distance a shuttle carrying the weft threads could be thrown by hand from selvage to selvage through the raised warps. Widths of 50 in. and more date from mechanized weaving, about 1835.



BY COURTESY OF THE SCALAMANDRÉ MUSEUM OF TEXTILES

TWO-COLOURED SINGLE DAMASK IN A RENAISSANCE DESIGN OF THE EARLY 17TH CENTURY: (LEFT) THE DESIGN DRAWN TO SCALE ON GRAPH PAPER AS GUIDE FOR PUNCHING CARDS OF JACQUARD LOOM; (RIGHT) DAMASK WOVEN FROM THE PATTERN. ON THIS SIDE THE DARK FIELD IS SATIN AND THE LIGHT PATTERN IS PLAIN WEAVE, WHILE ON THE REVERSE SIDE THE COLOURS AND THREADS ARE REVERSED

Damask is made in a wide price range and is used for upholstery and draperies, table cloths and napkins, bedspreads, face towels, evening wear and the like. For table damask *see* TEXTILES, HOUSEHOLD: *Table Linen.* (J. K. T.)

DAMASKINOS (1891–1949), archbishop of Athens and regent of Greece during the civil war of 1944–46, was born on March 3, 1891, at Dorbitsia in Aetolia. After attending the university of Athens he served in the army as a private during the Balkan Wars (1912) and was ordained priest in 1917. In 1922 he became bishop of Corinth and in 1938 was elected archbishop of Athens. His election, however, was voided by Premier John Metaxas because of his opposition to the regime, and Bishop Chrysanthos of Trebizond was appointed in his stead. Damaskinos was exiled, but recalled in July 1941 to replace Chrysanthos, who had refused to swear in the proaxis premier, George Tsolakoglu. After much misgiving Damaskinos became archbishop; he was always an opponent of the German occupation policy and urged the concealment of Jews to prevent their falling into Nazi hands.

Damaskinos was appointed regent with the absent king's permission on Dec. 31, 1944, during the civil war initiated by the Communist-controlled guerrilla forces (*see* GREECE: *History*). His integrity and impartiality made him the only person available for this position who was acceptable to all parties. During the next 16 months of political crisis Damaskinos appointed five premiers and in Oct. 1945 himself formed an interim cabinet. He resigned as regent on Sept. 5, 1946, four days after the plebiscite which voted for the restoration of the monarchy. Thereafter he devoted himself solely to his archiepiscopal duties. He suffered from a weak heart, and died in Athens on May 19, 1949.

DAMASK STEEL (DAMASCUS STEEL), a steel with a characteristic watered or streaked appearance, as seen in the blades of fine swords and other weapons of oriental manufacture. This appearance was the result of repeatedly twisting and forge welding together strips of steel of different qualities, the process used also to make Toledo and viking blades. A similar appearance but inferior result may be obtained by etching with acid the surface of a metal, parts of which are protected by some greasy substance in such a way as to give the watered pattern desired. The art of producing damask steel has been generally practised in oriental countries from a remote period, the most famous blades having come from Isfahan, Khurasan and Shiraz in Persia. A similar process in which strips or wires of iron and steel are twisted in a spiral to form a tube has been used to make Damascus barrels for sporting guns. *See* ISLAMIC ART: *Weapons;* IRONWORK: *India and Southeast Asia;* SWORD.

DAMASUS, the name of two popes.

ST. DAMASUS (*c.* 304–384), pope from 366 to 384, born at Rome of a Spanish family about 304, was a man of great virtue and of cultivated mind. Originally he supported Pope Liberius, whom Emperor Constantius exiled (355); Damasus then acknowledged the antipope, Felix, but finally again recognized Liberius. When the latter died, Damasus was elected pope in Oct. 366. Enemies made during this period vexed him for the rest of his life. In two synods (368 and 369) Apollinarianism and Macedonianism were condemned. Damasus later (381) sent legates to the Council of Constantinople, where these same teachings were again condemned. From a later synod (382) issued the famous "Tome of Damasus," a list of 24 anathemas against Trinitarian and Christological errors. In the east, the pope was unsympathetic in his dealings with St. Basil (*q.v.*), due to a lack of understanding of the Cappadocian's policies. St. Jerome served as private secretary to Damasus, who later gave him the important commission of revising the Latin translations of the Bible; the result was the Vulgate version. In 380 Theodosius declared that the religion preached by St. Peter, and then headed in Rome by Damasus, was the religion of the Roman state. Damasus enforced an imperial decree against worldliness among churchmen. He was outstanding in the work of discovering the tombs of martyrs, for which he personally composed epitaphs in verse. The church of S. Lorenzo in Damaso was restored by him. Damasus died on Dec. 11, 384, and is buried in a small church that he built on the Via Ardeatina. His feast day is Dec. 11. (W. M. K.)

DAMASUS II (Poppo) (d. 1048), pope from July to Aug. 1048, was bishop of Brixen (Bressanone, in Bolzano) when he was nominated in Dec. 1047 by the emperor Henry III to succeed Pope Clement II. It was not until July 17, 1048, however, that Damasus was enthroned, after Henry had peremptorily ordered Boniface of Tuscany to expel Benedict IX. Damasus died Aug. 9, 1048, at Palestrina. (C. P. L.)

DAME, properly a name of respect or a title equivalent to "lady," surviving in English as the legal designation of the wife or widow of a baronet or knight, or of a dame of the order of the British empire; it is prefixed to the Christian name and surname. It has also been used in modern times by certain societies or orders (*e.g.*, the Primrose league) as the name of a certain rank among the lady members, answering to the male rank of knight. The ordinary use of the word by itself is for an old woman. As meaning "mistress" (*i.e.*, teacher), "dame" was used of the female keepers of schools for young children which became obsolete after the advance of public elementary education. At Eton college, boardinghouses kept by persons other than members of the teaching staff of the school were known as "dames' houses," though the head might not necessarily be a lady. As a term of address to ladies of all ranks, from the sovereign down, "madam," shortened to "ma'am," represents the French *madame*, "my lady."

"Damsel," a young girl or maiden, now used only as a literary word, is taken from the Old French *dameisele*, formed from *dame*, and parallel with the popular *dansele* or *doncele* from the Middle Latin *domicella* or *dominicella*, diminutive of *domina*. The French *damoiselle* and *demoiselle* are later formations which developed merely to the title of a young unmarried lady, the *mademoiselle* of modern usage, the English "miss." At the court of France, after the 17th century, *mademoiselle*, without the name of the lady, was a courtesy title given to the eldest daughter of the eldest brother of the king, known as *monsieur*. Anne Marie Louise is known to history as La Grande Mademoiselle. The English literary form "damosel" was another importation from France in the 15th century. In the early middle ages *damoiseau*, Middle Latin *domicellus*, *dameicele*, *damoiselle*, *domicella*, were used as titles of honour for the unmarried sons and daughters of royal persons and lords (*seigneurs*). Later the *damoiseau* (in the south *donzel*, in Béarn *domengar*) was specifically a young man of gentle birth who aspired to knighthood, equivalent to *écuyer*, "esquire" (*q.v.*), or *valet*.

DAME'S VIOLET, the common name for *Hesperis matronalis*, a biennial herb belonging to the mustard family (Cruciferae) and closely allied to the wallflower and stock; called also dame's rocket and garden rocket. It has an erect, stout, leafy stem, two to three feet high, with irregularly toothed, short-stalked leaves and white or lilac flowers, three-fourths of an inch across, which give off a scent in the evening. The slender pods are constricted between the seeds. The plant is a native of Europe and temperate Asia, and is found in the eastern U.S. and Canada and in Great Britain as an escape from gardens.

DAMGHAN, chief town of a district in north Iran (in the general governorship of Semnan-Damghan), lies at 3,750 ft. at the southern foot of the Elburz range, on a large and mostly barren gravel plain which slopes down to the *kavir* (salt pan) of Damghan. It is 216 mi. E. of Teheran on the road and railway to Khurasan (Khorasan). Pop. (1956) 8,933; remainder of district 30,298. The oldest mosque in Iran, the Tarik Khaneh (*c.* 775), and four fine towers of the 11th and 12th centuries are still standing. Important archaeological excavations at nearby Tappeh Hesar disclosed cultures ranging from 3500 B.C. to A.D. 500. Damghan was an important town and the chief city of the province of Qumis in the middle ages, but was destroyed by the Afghans in 1723. The town has a trade in pistachios and thin-shelled almonds for which it is noted. (H. Bo.)

DAMIAN, SAINT: *see* COSMAS AND DAMIAN, SAINTS.

DAMIAN, SAINT PETER (PIETRO DAMIANI) (1007–1072), Italian hermit-monk, cardinal and doctor of the church, was one of the original leaders and most forceful figures of the 11th-century reform movement. A native of Ravenna, having attended schools there, at Faenza and Parma, he abandoned a brief but promising teaching career (1035) to enter the hermitage of Fonte Avellana on Monte Catria, where the Marches border on Umbria. Fully adopting its life of solitary prayer and extreme austerity, he was chosen prior in 1043. Peter's zeal for reform attracted attention beyond monastic circles, however, and he was soon actively engaged in promoting the religious revival that characterized his age. Created cardinal in 1057, with real reluctance, he served the church under three popes. Despite his fiery temperament, he fulfilled five difficult missions as papal legate with remarkable tact. Even in the semiretirement of his last years at his beloved Fonte Avellana (after 1067), he was still active in the cause of reform. He died on Feb. 22, 1072, at Faenza, where he is buried, after reconciling his native city with the Roman see. He was declared a doctor of the church in 1828, and his feast (Feb. 23) was extended to the universal church though he was never formally canonized.

An active author for 30 years, Peter was an enlightened spiritual writer, sound theologian, canonist and liturgist, and a fearless critic of the abuses of his coarse times, especially those of the clergy. A conservative in the political and theological controversies of the day, he often used strong language to present his position, reminding his contemporaries of the outspoken St. Jerome. As an apostle of voluntary poverty, he may be considered a forerunner of the gentler St. Francis of Assisi. His collected works are reprinted in J. P. Migne, *Patrologia Latina*, vol. 144–145 (1853). *Selected Writings on the Spiritual Life*, translated and with an introduction by P. McNulty, was published in 1959.

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DAMIEN, FATHER, the name in religion of JOSEPH DE VEUSTER (1840–1889), Belgian missionary, born at Tremeloo, near Louvain, on Jan. 3, 1840. In 1858 he joined the Society of the Sacred Heart of Jesus and Mary (also known as the Picpus Congregation), and while still in minor orders in 1863 went as a missionary to the Sandwich (Hawaiian) Islands, taking the place of his brother, who had been prevented by illness. On reaching Honolulu he was ordained priest in 1864. Struck with the sad condition of the lepers, whom the Hawaiian government deported to Molokai Island, in 1873 he volunteered to take spiritual charge of the settlement. Besides attending to the spiritual needs of the lepers, he managed, by the labour of his own hands and by appeals to the Hawaiian government, to improve the water and food supplies and the housing of the settlement, and after five years received assistance from other resident priests. He died of leprosy on April 15, 1889. Some ill-considered imputations upon Father Damien by a Presbyterian minister produced a memorable tract by Robert Louis Stevenson, *An Open Letter to the Rev. Dr. Hyde* (1890).

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DAMIENS, ROBERT FRANÇOIS (1715–1757), French fanatic, remembered for his assault on Louis XV and for its atrocious punishment, was born at Tieulloy in Artois on Jan. 4, 1715. Damiens, whose unbalanced mind may have been excited by the polemics between Jesuits and Jansenists and who may have felt that Louis XV's way of life was calling the wrath of God upon France, stabbed the king as he was entering his carriage at Versailles on Jan. 5, 1757, inflicting a slight wound. At first the government believed him to be involved in a widespread conspiracy. Condemned as a regicide, he was publicly tortured and then torn in pieces by horses in the Place de Grève, Paris, on March 28, 1757.

See A. L. Zévaès, *Damiens le régicide* (1933).

DAMIETTA (Coptic TAMIATI, Arabic DUMYAT), a town of lower Egypt, 8 mi. from the Mediterranean and 125 mi. N.N.E. of Cairo by rail, and capital of a governorate of the same name. The governorate, a union of adjacent portions of Al Gharbiyah and Al Daqahliyah governorates separated by the Damietta branch of

the Nile, was established in 1955. Area 233 sq.mi. Pop. (1960) 391,000. The town lies on the eastern distributary of the Nile called after it (anciently the Phatnitic branch), between the river and Lake Manzala. Pop. (1957) 66,525. Once the third town in Egypt, it declined after the development of Alexandria and Port Said but there is still some trade with Syria. The town has fine mosques and is an important market centre. Its manufactures include glassware, cotton, silk and rayon goods. It is not clear whether Damietta gave its name to a striped cloth known as dimity (*q.v.*) (Arabic *dumyati* derived through the Persian *dimyati*) for which it was once famous. It is one of the centres for the husking of rice, which is exported along with dates and salted fish from the lake.

Situated 4 mi. nearer the sea than the present town, ancient Damietta fell to the invading Arab forces in A.D. 638. An important medieval commercial centre, it suffered frequent attacks from crusader and other forces. In 1219 it fell to the Latins of the fifth crusade and was not freed until 1221 by al-Kamil after two years of almost continuous fighting. In June 1249 it was captured by King Louis IX of France and his troops of the sixth crusade, but was restored to Muslim hands on his capture the following year. It retained its Coptic character in spite of Muslim domination. Its exposed position led Sultan Baybars (A.D. 1260–77), of the Mameluke or Slave dynasty of Egypt, to block up the mouth of the Damietta branch of the Nile and to move the town to its present position. (A. B. M.; M. V. S.-W.)

DAMIRI, AL- (Kamal al-Din Mohammed ibn Musa al-Damiri) (1344–1405), Arab writer noted for his works on canon law and natural history, was born at Damira near Damietta in Egypt, in which country he spent his life. Of the Shafi'ite school of Muslim law, he became professor of tradition at al-Azhar mosque in Cairo. In the course of his work there he wrote a commentary on the Shafi'ite jurist Nawawi's *Minhaj al-Talibin* ("A Course for Students"). He is, however, better known in the history of literature for his *Hayat al-Hayawan* (Eng. trans. by A. S. G. Jayakar, *A Zoological Lexicon*, 1906–08), which treats in alphabetical order of 931 animals mentioned in the Koran and in the traditions and the poetical and proverbial literature of the Arabs. The use of the animals in medicine, their lawfulness or unlawfulness as food and their position in folklore are the main subjects treated, but occasionally long sections on political history are introduced. Several editions have been made of extracts of this work, among them the poetical edition by the 15th-century encyclopaedist Suyuti, which was translated into Latin in the 17th century. Samuel Bochart in his *Hierozoicon* (1663) made use of al-Damiri's work.

DAMMAM, AD, a town in Saudi Arabia, which in 1953 replaced Hufuf as capital of the Eastern Province (Al Hasa).. It lies on the western coast of the Persian gulf, 8 mi. N. of Dhahran. Pop. (1958 est.) 30,600. There are remains of a castle perched on a coral reef and Ad Dammam is a residential town for the Arab oil-field workers. Its development dates from the 1940s after rich oil deposits were discovered there and later exploration proved the presence of oil fields at Dhahran (*q.v.*). Ad Dammam is the principal port of Saudi Arabia on the Persian gulf and imports heavy machinery and other construction material. In the 1960s there was a major expansion of the port to increase its facilities. The town is the eastern terminus of the railway which extends from Riyadh *via* Hufuf and Dhahran and also operates on its 7 mi. long deep-water port.

DAMMAR (Dammer), a name often used for a great variety of hard, or varnish, resins obtained from various coniferous trees characteristic of southeastern Asia. In commerce, however, the term is usually applied to those resins obtained from several species of the family Dipterocarpaceae and a few species of the Burseraceae. Probably the most important sources of dammar are *Shorea* species, especially *S. wiesneri.*

The resin oozes in large quantities from the tree in a soft viscous state, being highly aromatic; however, it loses its odour as it hardens by exposure. The resin is much esteemed in oriental communities for incense burning. As found in many foreign markets it is a hard, transparent, brittle, straw-coloured resin, destitute of odour. It is readily soluble in alcohol, ether and chloroform, and with oil of turpentine it forms a fine varnish that dries clear, smooth and hard. The allied kauri gum, kauri copal or dammar of New Zealand (Australian dammar) is produced by the kauri pine (*q.v.*), *Agathis australis.*

Dammar is also a generic Indian name for various other resins that, however, are little known in western commerce. Of these the principal are black dammar, yielded by *Canarium strictum* (family Burseraceae), and white dammar, Indian copal or piney varnish, the product of *Vateria indica* (family Dipterocarpaceae). Sal dammar is obtained from *Shorea robusta.*

Dammar is exported to many western countries for use in plasters, varnishes and lacquers; a solution of dammar in chloroform or xylene is often used to preserve and mount thin sections of vegetable and animal matter for microscopic examination.

DAMMARTIN, the name of a countship famous in French medieval history. Its seat was at Dammartin-en-Goële, northwest of Meaux (in the modern *département* of Seine-et-Marne), where Hugh, the first recorded count, built a castle in the 10th century. In the 11th and 12th centuries its possessors were strong enough to oppose either the French kings or the counts of Flanders. Raynald (Renaud) I of Dammartin, who was also count of Boulogne, was a member of the great coalition crushed by Philip II Augustus of France at the battle of Bouvines (*q.v.*) in 1214; he killed himself in prison in 1227. Seized by the king, Dammartin then passed to his son Philip Hurepel (d. 1234), who was married in 1216 to Raynald's daughter and heiress Mahaut. On Mahaut's death (1258 or 1259), however, her cousin Mathieu de Trie, son of Raynald I's sister Alix, became count of Dammartin. Subsequently by a series of marriages Dammartin passed from the house of Trie through those of Châtillon, of Fayel and of Nanteuil to Antoine de Chabannes in 1439. This Antoine de Chabannes (d. 1488), who had already distinguished himself in campaigns with Joan of Arc, later became a leader of the Ecorcheurs and fought against Louis XI in the League of the Public Weal and then for Louis against the Burgundians; it was he who founded the collegiate church at Dammartin, in which his tomb and effigy remain. His great-granddaughter Françoise d'Anjou-Mézières, however, left heirs by both of her marriages, and one family sold Dammartin to the Montmorencys while the other sold it to the Guises. There followed a long lawsuit, which the Montmorencys won. Louis XIII confiscated the countship after the treason of Henry de Montmorency (1632), had the castle dismantled and finally gave the property to the house of Condé.

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DAMME, an agricultural polder village of Belgium, lies 5 km. (3 mi.) N.E. of Bruges on the Bruges-Sluis canal. Pop. (1955) 1,059. It was founded on the Hontsdam ("Dog's dike") at the extremity of the Zwijn, a navigable channel that ran from the North sea and that was the scene of the defeat of the French fleet by Edward III of England in 1340. Remarkable buildings are reminiscent of its bygone magnificence, particularly the church of Our Lady (1225–1485), partly destroyed by fire (1578); the choir alone is used for worship, although the tower also remains. Connected by canals with Bruges and Ghent, Damme served as an outer port for these major cities of Flanders and attracted many merchant guilds. There Jacob van Maerlant (*q.v.*), "father of Flemish poets," was born in 1235, and there too Charles the Bold married Margaret of York on July 2, 1468, in Count Wyt's mansion, now a museum. The flourishing era of Damme lasted only during the 13th and 14th centuries; then sand silted up the Zwijn and landlocked the port. In World War I Damme was in German hands from Aug. 1914 to Oct. 1918 and in World War II from May 1940 to Sept. 1944. (R. M. An.)

DAMOCLES, one of the courtiers of the elder Dionysius of Syracuse (tyrant 405–367 B.C.). When he spoke in extravagant terms of the happiness of his sovereign, Dionysius is said to have invited him to a sumptuous banquet, at which he found himself seated under a naked sword suspended by a single hair, symbolizing

the precariousness of the tyrant's fortune.

See Cicero, *Tusculanae Disputationes*, v, 61–62.

DAMODAR, a river of India which, with its many tributaries, rises in the Chota Nagpur plateau in the state of Bihar and flows eastward into West Bengal to empty into the Hooghly north of Calcutta after a course of about 368 mi. The valley of the Damodar on the Bihar-West Bengal border includes India's chief coal field and has long been an area of active industrial development, but the upper course of the river and its tributaries lies over the ancient rocks of the Indian plateau. The river derives its water from the summer monsoon and was liable to sudden floods and changes of course, whereas for half the year the broad sandy river beds were almost dry. Inspired by the success of the Tennessee Valley authority project in the United States, India formulated along somewhat similar lines the Damodar valley project. The Damodar Valley authority (D.V.A.) began work in 1948. On the river and its tributaries seven dams have been constructed to form a series of reservoirs (Tilaiya, Balpahari, Maithon, Bokaro, Aiyar, Konar and Panchet Hill) which supply water for irrigation and power—notably to the great Bokaro (Bokharo) power station —while lower down the river the Durgapur barrage affords a long stretch of navigable waterway through the coal field. Among the many new industrial developments associated with the project are the large fertilizer factory at Sindri (Sindhri) and the iron- and steelworks of Durgapur. (L. D. S.)

DAMOH, a town and district of Madhya Pradesh, India. The town (pop. [1961] 46,626), situated approximately 60 mi. N.W. of Jabalpur, is fast increasing in size. It has a municipality, a mission hospital, three oil mills and a college affiliated to Saugar university. It is situated on the Bina-Katni branch line and has road connections with Bhopal and Jabalpur.

DAMOH DISTRICT (area 2,827 sq.mi.; pop. [1961] 439,049) forms the easternmost spur of the Vindhyan plateau culminating in low country with a series of hills and valleys. About 40% of the area is under forest or grassland, and the principal crops are wheat, rice, pulses and oilseeds.

The British took over the Sagar-Damoh region from the Marathas in 1818. It was included in Sagar district from 1934 to 1956. The district abounds in medieval temples and forts, and there are two Vishnuite temples (6th century A.D.) 20 mi. N.E. of Damoh. Singargarh, a hill fort 28 mi. S.E. of Damoh, was the old Gond capital of the region. (S. M. A.)

DAMON AND PHINTIAS (erroneously PYTHIAS), two Pythagoreans, the subject of an anecdote about the elder Dionysius of Syracuse (tyrant 405–367 B.C.) related by Cicero to illustrate the tyrant's lack of true friends. Condemned to death, Phintias begged a respite to arrange his affairs and Damon pledged his life for the return of his friend. When Phintias did return, Dionysius released both and wished to be admitted to their friendship.

See Cicero, *Tusculanae Disputationes*, v, 63.

DAMOPHON (fl. 2d century B.C.), a Greek sculptor of Messene, who executed many statues at Messene, Megalopolis, Aegium and other cities of Peloponnesus. Soon after 183 B.C. he repaired the Zeus of Phidias at Olympia which was damaged by an earthquake. Considerable fragments, including three colossal heads from a group by him representing Despoina, Demeter, Artemis and the giant Anytus, were found on the site of Lycosura in Arcadia, where there was a temple of Despoina. The garment of Despoina is decorated with reliefs. A coin shows the statue with two figures standing, two seated.

See Margarete Bieber, *The Sculptures of the Hellenistic Age* (1955). (D. M. R.)

DAMP (MINING): *see* COAL AND COAL MINING: *Hazards of Mining.*

DAMPIER, WILLIAM (1652–1715), who spent most of his life as a buccaneer, is remembered chiefly for his visit to Australia in 1686, for the voyage devoted to exploration of parts of the coasts of Australia, New Guinea and New Britain which followed between 1699 and 1701, and for his account of his voyages. This shows him to have been a careful observer of everything affecting navigation and of the natural history of the lands he visited, with a gift for clear and easy description of what he saw. Dampier was born at East Coker, Somerset, in 1652, possibly in May. By the time he was 16 both parents had died and he joined a ship at Weymouth for a voyage to Newfoundland. Later he made a voyage to the East Indies and in 1674 became undermanager of a Jamaican estate. This post did not hold him long and he engaged first in local trade in the Gulf of Mexico, later in logwood cutting and buccaneering. Between 1678 and 1691 he took part in several piratical voyages, mostly along the west coast of South America and in the Pacific, returning eventually to England. During one of these voyages he visited Australia, probably near Melville Island. He spent just over two months on the coast, but found no water or animals and formed a dislike of the local people and their customs. Of his next few years little is known except that he published his *New Voyage round the World* in 1697, and two years later another volume including "A Discourse of the Winds."

He was appointed by the admiralty to command the "Roebuck" on a voyage of discovery to Australia and sailed from England on Jan. 14, 1699. He called at the Canary Islands, Cape Verde Islands and Bahia in Brazil, sailing thence round the Cape of Good Hope to Australia which he reached at Shark bay on the west coast on July 26. He examined the coast as far as Dampier archipelago but was unable to find a harbour or to obtain water or provisions and went to Timor for supplies and to clean the ship's bottom. Then he sailed for New Guinea which he reached on Dec. 3 and "passing to the northward I ranged along the coast to the easternmost part of New Guinea, which I found does not join to the mainland of New Guinea, but is an island, as I have described it in my map, and called it New Britain." He made a fairly good survey of the northern, eastern and southern coasts of this island, but did not discover that "St. George's bay" is really St. George's channel, nor did he visit the western side of the island or realize its small extent in that direction. By this time his ship was deteriorating rapidly and his crew were discontented, so he called at Batavia for provisions and to carry out repairs and sailed for England on Oct. 17, 1700. By the time he reached Ascension on Feb. 22 the ship had sprung a dangerous leak and had to be abandoned. The crew remained on the island until April 3 when they were picked up by a convoy of homeward-bound warships and East Indiamen. Dampier made two more voyages, as a privateer. The first was unsuccessful, but the second resulted in the capture of booty worth £200,000. He died in London early in March 1715.

See *Dampier's Voyages*, ed. by John Masefield, 2 vol. (1906); C. A. Wilkinson, *William Dampier* (1929). (A. M. F.)

DAMROSCH, WALTER JOHANNES (1862–1950), U.S. conductor and composer whose fruitful activities spanned more than half a century of American musical life, was born in Breslau, Germany, Jan. 30, 1862, the son of Leopold Damrosch (1832–85), German violinist and conductor, who settled in New York city in 1871. Walter Damrosch studied with his father, and upon the latter's death, he assumed the conductorship of the New York Symphony society and the New York Oratorio society founded by his father, and also conducted at the Metropolitan Opera company (1885–91). Later he organized the Damrosch Opera company (1895–1900), specializing in German operas. In 1903 Damrosch reorganized the New York Symphony society and conducted it until 1927, when it was combined with the Philharmonic society.

Like his father, Damrosch was an avowed propagandist of Wagner; as early as March 3, 1886, he gave a concert performance of *Parsifal* in New York. He also presented first American performances of symphonies by Brahms and Tchaikovsky. Although not in sympathy with new music he introduced several works by contemporary European and American composers. He was a pioneer of symphonic broadcasting, and also established a weekly series of radio lectures on music appreciation for schools (1928–42). A competent composer, Damrosch wrote several operas, which, however, lacked distinction: *The Scarlet Letter* (1896), *Cyrano de Bergerac* (1913), *The Man Without a Country* (1937), and *The Opera Cloak* (1942). He also composed incidental music to plays and published an autobiography, *My Musical Life* (1923; 2nd edition, 1930). He died in New York city on Dec. 22, 1950.

His brother Frank Damrosch (1859–1937) was also a conductor.

He led the New York Oratorio society (1898–1912); was the founder of the Institute of Musical Art, New York (1905–26), and published some teaching manuals. (N. Sy.)

DAN, one of the 12 tribes of Israel, descended from one of the two sons of Jacob and Bilhah, Rachel's maidservant (Gen. xxx, 4–6), the other being Naphtali. (*See* TWELVE TRIBES OF ISRAEL.)

The tribe originally settled in the region of Zorah and Eshtaol, just west of Jerusalem, but was unable to maintain itself there under the pressure of the ancient population and of the Philistines (Samson was a Danite from Zorah, Jud. xiii). Part at least of the tribe moved to the extreme northeast of the country, took the Sidonian city of Laish and called it Dan. In the local sanctuary they installed the image of Israel's God which they had stolen from Micah, and made Micah's Levite Jonathan, a descendant of Moses, the officiating priest (Jud. xvii–xviii). After the division of the all-Israelite state, which extended "from Beersheba to Dan" (I Chron. xxi, 2), Jeroboam I chose the old sanctuary of Dan as one of his two national shrines (I Kings xii, 29). The city was for some time dominated by the kings of Damascus (I Kings xv, 20). Its story ended most probably about 734 B.C., when the Assyrians invaded all the north of Israel (II Kings xv, 29). Its remains are at Tall al Qadi (*qadi* means judge, as *dan* does), in northeastern Israel, about 24 mi. N. of the Sea of Galilee.

(L. H. Gr.)

DANA, CHARLES ANDERSON (1819–1897), U.S. journalist who became a national figure as editor of the *New York Sun,* was born in Hinsdale, N.H., on Aug. 8, 1819. In 1839 he entered Harvard, but eye strain and financial stresses forced him to leave college in 1841. From Sept. 1841 until March 1846 he lived at Brook Farm (*q.v.*), where he was made one of the trustees. He had previously written for the *Harbinger,* the Brook Farm organ, and was employed by the *Boston Chronotype* in 1846. The next year he joined the staff of the *New York Tribune,* and in 1848 he wrote letters from Europe on the revolutionary movements of that year. Returning to the *Tribune* in 1849, he became its managing editor, and in this capacity actively promoted the antislavery cause. In 1862 his resignation was asked for, apparently because of wide temperamental differences between him and Horace Greeley, the editor-publisher. Secretary of War Edwin M. Stanton immediately made him a special investigating agent of the war department; in this capacity Dana spent much time at the front, and sent Stanton frequent reports. He went through the Vicksburg campaign and was at Chickamauga and Chattanooga, and urged the placing of Gen. U. S. Grant in supreme command of all the armies in the field. In 1864–65 Dana was second assistant secretary of war.

Dana became editor and part owner of the *New York Sun* in 1868, and remained in control of it until his death. Under his control the *Sun* opposed the impeachment of Pres. Andrew Johnson; supported Grant for the presidency in 1868; was a sharp critic of Grant as president; and in 1872 took part in the liberal Republican revolt and gave lukewarm support to Greeley's candidacy. In the presidential election of 1876 the *Sun* was a strong Tilden paper, and after Rutherford B. Hayes's inauguration often referred to him by such epithets as "His Fraudulency the President."

For two decades after Dana became editor, the *Sun* was a newspaperman's newspaper, much admired and imitated. It lived up to its claim that its news was "the freshest and sprightliest current," and it specialized in the "human interest story." For such writing Dana hired bright young men, many fresh from college. Editorially the paper was lively but notoriously inconsistent. Dana swung from an early liberalism, evidenced by his Brook Farm connection and his syndicated letters from Europe in 1848, to a later disillusioned conservatism. With George Ripley, Dana edited *The New American Cyclopaedia* (1857–63). He edited one of the most successful of American verse anthologies, *The Household Book of Poetry* (1857), and wrote *Recollections of the Civil War* (1898), *The Art of Newspaper Making* (1895), etc. He died at Glen Cove, N.Y., Oct. 17, 1897.

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DANA, FRANCIS (1743–1811), U.S. jurist, was born in Charlestown, Mass., on June 13, 1743, the son of Richard Dana (1700–72), a leader of the Massachusetts provincial bar. Francis Dana graduated at Harvard in 1762 and was admitted to the bar in 1767. He became a leader of the Sons of Liberty and in 1774 was elected to the first provincial congress of Massachusetts. He was a member of the Massachusetts Executive Council from 1776 to 1780 and a delegate to the Continental Congress from 1776 to 1778. In the autumn of 1779 Dana was appointed secretary to John Adams, who had been selected as minister plenipotentiary to negotiate treaties of peace and of commerce with Great Britain, and in December 1780 he was appointed diplomatic representative to the Russian government. In 1784 he was again chosen a delegate to Congress, and in 1785 he became a justice of the Massachusetts Supreme Court. He was chief justice from 1791 to 1806. Dana had been an advocate of the adoption of the federal constitution and was an influential adviser of the Federalist Party. He was a founder of the American Academy of Arts and Sciences. Dana died at Cambridge, Mass., on April 25, 1811. He was the father of the poet Richard Henry Dana (1787–1879) and grandfather of the author of *Two Years Before the Mast.*

DANA, JAMES DWIGHT (1813–1895), U.S. geologist, mineralogist and zoologist, the author of a number of standard works in his field, was born in Utica, N.Y., on Feb. 12, 1813. He early displayed a taste for science and in 1830 entered Yale college in order to study under the elder Benjamin Silliman (*q.v.*). After two years as teacher of mathematics to midshipmen in the navy, he was assistant to Silliman in the chemical laboratory at Yale in 1836–37 and then for four years acted as mineralogist and geologist for a United States exploring expedition, commanded by Capt. Charles Wilkes, in the Pacific ocean. In 1844 he again became a resident of New Haven, Conn., married the daughter of Silliman and, in 1849, on the resignation of the latter, was appointed Silliman professor of natural history and geology in Yale college, a position which he held till 1892. He died April 14, 1895.

A bibliographical list of Dana's writings shows 214 titles of books and papers, beginning in 1835 with a paper on the conditions of Vesuvius in 1834, and ending with the fourth revised edition (finished in Feb. 1895) of his *Manual of Geology.* His reports on *Zoophytes,* on the *Geology of the Pacific Area* and on *Crustacea,* summarizing his work on the Wilkes expedition, appeared in 1846, 1849 and 1852–54, in quarto volumes, with copiously illustrated atlases; but as these were issued in small numbers, his reputation more largely rests on his *System of Mineralogy* (1837; subsequent ed. rev. by his son, E. S. Dana; 7th ed. rewritten by C. Palache *et al.,* 1944–51); *Manual of Geology* (1862; 4th ed., 1895); *Manual of Mineralogy* (1848; subsequent ed. rev. by E. S. Dana; 17th ed. rev. by C. S. Hurlbut, 1959); and *Corals and Coral Islands* (1872; 2nd ed., 1890).

His son, EDWARD SALISBURY DANA, born at New Haven on Nov. 16, 1849, was also a distinguished mineralogist. In addition to his revisions of his father's works he wrote *A Textbook of Mineralogy* (1877; 4th ed., 1932) and *Minerals and How to Study Them* (1895; 3rd ed. rev. by C. S. Hurlbut, 1949). From 1879 to 1890 he was professor of natural philosophy at Yale and then was professor of physics until his retirement in 1917. He died June 16, 1935.

See D. C. Gilman, *Life of James Dwight Dana* (1899).

DANA, RICHARD HENRY (1815–1882), U.S. author and lawyer whose literary fame rests on a single book, *Two Years Before the Mast,* was born in Cambridge, Mass., Aug. 1, 1815, the son of a prominent poet, also Richard Henry Dana (1787–1879). He withdrew from Harvard when measles weakened his eyesight, and to regain health shipped to California as a sailor in Aug. 1834. After voyaging among California's ports and gathering hides ashore, he rounded Cape Horn, returned home in Sept. 1836, and re-entered Harvard. His experiences cured him physically and engendered sympathy for the oppressed and needy. In 1840, the year of his admission to the bar, he published *Two Years Before the Mast,* a personal narrative presenting "the life of a common sailor at sea as it really is," showing the abuses to which his fel-

lows were subject. Immediately popular, its realistic description made it an American classic. Later and lesser works were *The Seaman's Friend* (1841), a treatise on practical seamanship and the duties of masters and mariners, and *To Cuba and Back* (1859). In the 1840s Dana entered Free Soil politics. Although vigorously opposed by his own class of Bostonians, he gave free legal aid to Negroes captured under the Fugitive Slave law. As U.S. attorney for the district of Massachusetts (1861–66) he persuaded the U.S. supreme court to uphold the Federal blockade. His scholarly edition of Henry Wheaton's *Elements of International Law* (1866) precipitated an earlier editor's invidious suit. Charges of plagiarism helped defeat him in a congressional election (1868) and caused the senate to refuse confirmation when Pres. Ulysses S. Grant named him minister to England (1876). Hurt by these failures, he went to Rome in 1878 to rest and continue research on international law. There he died on Jan. 6, 1882. Posthumously collected works were *Speeches in Stirring Times* (1910) and *An Autobiographical Sketch* (1953).

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DANAË, in Greek legend, daughter of Acrisius, king of Argos. According to the myth, her father, having been warned by an oracle that she would bear a son by whom he would be slain, confined Danaë in a bronze tower. But Zeus descended to her in a shower of gold, and she gave birth to Perseus, whereupon Acrisius placed her and her infant in a wooden box and threw them into the sea. They were finally driven ashore on the island of Seriphus, where they were picked up and brought to Polydectes, king of the island. For her subsequent adventures *see* PERSEUS.

DANAÜS, in Greek legend, son of Belus, king of Egypt, and twin brother of Aegyptus. He was born at Chemmis (Panopolis) in Egypt, but having been driven out by his brother he fled with his 50 daughters to Argos, the home of his ancestress Io. The 50 sons of Aegyptus arrived in Argos, and Danaüs was obliged to consent to their marriage with his daughters. But to each of these he gave a knife with injunctions to slay her husband on the marriage night. They all obeyed except Hypermnestra, who spared Lynceus. She was brought to trial by her father, acquitted and afterward married to her lover. Being unable to find suitors for the other daughters, Danaüs offered them in marriage to the youths of the district who proved themselves victorious in racing contests. According to another story Lynceus slew Danaüs and his daughters and seized the throne of Argos. In the other world the Danaïdes were condemned to the endless task of filling with water a vessel which had no bottom. Crime and punishment alike have been variously explained by mythologists.

DANBURITE, a relatively rare mineral species consisting of calcium and boron orthosilicate, discovered in 1839 at Danbury, Conn., whence its name, where it occurs embedded in dolomite. Danburite crystallizes in the orthorhombic system and crystals are transparent to translucent, and colourless to pale yellow; they are prismatic in habit, and closely resemble topaz in form and interfacial angles. There is an imperfect cleavage parallel to the basal plane. The formula is $CaB_2(SiO_4)_2$. Hardness is 7 and specific gravity 3.0. Splendid crystals have been found in Japan.

DANBURY, the "Hat city," seat of Fairfield county, in southwestern Connecticut, U.S., lies about 65 mi. N.E. of New York city in rolling foothills of the Berkshires, about 20 mi. N.W. of Bridgeport. Settled permanently in 1685 by eight families, including seven from Norwalk, Danbury was named in 1687, incorporated in 1702 and became a city in 1889. It grew steadily until the American Revolution when it was made a depot for military stores. In April 1777 the town was raided by a British expedition under Gen. William Tryon and stores were seized and homes burned. At the approach of the Connecticut militia under Gen. David Wooster, the British retreated. A square, monument and cemetery in Danbury commemorate the bravery of Wooster, who was mortally wounded in the ensuing action at Ridgefield (9 mi. S.).

In 1780 Danbury's hat industry was launched by Zadoc Benedict with a factory making three beaver hats daily. Hatmaking expanded greatly in the 19th and early 20th centuries. Because of the industry's seasonal nature attempts began in 1917 to attract other industries. Although Danbury still has more than 30 hatmaking establishments, they constitute less than one-fourth of the total industrial concerns. Products include precision bearings, heat and power units, electronic testing equipment, magnetic tapes, specialty machinery, paintbrushes, boxes, screw-thread inserts, stainless steel flatware, furniture, aluminum foil, Christmas cards, pencils and surgical sutures. A state teachers college is located there. The Danbury fair, held annually since the early 19th century, is Connecticut's largest.

The Danbury Hatters' case, a suit for damages brought by a manufacturer against 186 hatters of Danbury in 1902, on the ground that their boycott was a violation of the Sherman Anti-Trust act, is important in the annals of organized labour in the United States. Damages were awarded to the plaintiff and his contention was upheld by the U.S. supreme court in 1908. For comparative population figures *see* table in CONNECTICUT: *Population.* (A. E. V. D.)

DANBY, THOMAS OSBORNE, EARL OF: *see* LEEDS, THOMAS OSBORNE, 1st Duke of.

DANCE, the name of two English architects of the Georgian period. GEORGE DANCE, the elder (1700–68), architect to the City of London, designed the Mansion house; the churches of St. Botolph, St. Luke's, St. Leonard; the old excise office, Broad street; and other public works of importance.

GEORGE DANCE, the younger (1741–1825), succeeded his father as City surveyor and architect in 1768. He had already distinguished himself by designs for Blackfriars bridge. His first important public work was the rebuilding of Newgate prison in 1770. He was a foundation member of the Royal Academy and the "revered master" of Sir John Sloane.

DANCE. Dance is regarded by some authorities as older than art and as providing the basis of all the arts: from it have sprung drama, décor and music, and it has given expression to religious motives and provided various forms of entertainment and recreation. The different kinds of dance will be considered in the following sections:

I. Introduction
II. Early Mediterranean Civilizations
  1. Ancient Egypt
    Sacred Dances
    Funeral Rites
    Secular Dances
  2. Ancient Greece
    Temple Dances
    Funeral Rites
    The Pyrrhic Dance
    The Gymnopedic Dances
    Dionysiac or Bacchic Dances
    Choric Dances
    Secular Dances
  3. Ancient Rome
III. The Orient
  1. India and Pakistan
  2. Indian Influence in Asia
    Southeast Asia
    Ceylon
    Burma and Malaya
    Laos, Cambodia and Thailand
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    The Philippines
    Tibet
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IV. Europe and America
  1. Folk Dancing
  2. Social Dancing
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    The 17th Century
    The 18th Century
    The 19th Century
    The 20th Century
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Musical Comedy
Films and Television
Ballet
Modern Dance
V. Technique of Modern Social Dancing
1. Six Basic Steps
Walking Steps
The Chassé
The Waltz
The Balance
The Pivot
The Running Steps
2. The Correct Position

I. INTRODUCTION

Dance has been defined as motion that arises from emotion. It is also used metaphorically to describe forms of motion other than human movement; *e.g.*, dancing particles, dancing moonbeams and boats dancing over the waves. Birds, animals and insects are said to dance when courting; many young animals dance from the joys of spring; young and growing creatures overflow with an energy that cannot be contained and is expressed in impulses, the repetitive pulsations having the appearance of flow or rhythm. The human body has a natural appetite for rhythm, reflecting the wave characteristics of pulse and propulsion. It is that undulatory response to pulse energy that comprises the act of dance: not only does the body of the dancer vibrate in the dance action but this action, by its rhythmic character, also spurs the watchers to vibrating response.

Such sympathetic vibrating permits the transmission of mood; *i.e.*, of a desire to respond and to mimic the action of the rhythmic mover. This infectious response is part of dance, the two-way process of motion and emotion. A primitive or a child, emotionally aroused, say by the pleasurable foreknowledge of some "good," will break into a dance of glee. The emotion can be recaptured by repeating that particular dance action and thus dance motion and emotion are interchangeable. The capacity for such interchange and build-up of feeling is at the root of hypnotic dances and explains the significance and power of tribal dancing. Since the early tribal chief could induce a mood (*e.g.*, the desire to hunt) in his followers by the rhythmic force of his dance-dramatic example, they hoped he might also induce some such mood in nature, procuring game, fruits, rain and even help from departed spirits. On cave walls artists of the Old Stone Age drew figures of shamans in dancing attitudes among the animals they magicked within range and then transfixed with painted arrows. This further concept of dance assumes a magical power as applied medicine to be dispensed as a healer or quickener. Thus the dance action of medicine men is in essence life-giving and in ritual and ceremony resurrects a dead or dying world.

The struggle of life to arise out of death in nature, that is, for fertility, is correspondingly expressed in primitive dance and is reflected in folk dance and folk custom. Australian aborigines practise magico-religious dances for food and rain, and North American Indians—especially in Arizona and New Mexico—perform elaborate cycles of dance in order to call down rain. In Europe peasant plowing customs have terminated symbolically with human coupling in the furrowed fields. Fertility is also represented when the Rumanian Calusari dancers, as "medicine men," after dispensing to the sick, draw in the unmarried girls and join with them in a chain dance. "Medicine" dancers, charged by the tribal chiefs with enactments of responsibility, invariably hide their identity behind masks or disguises. They link themselves with animals and vegetables by wearing skins and horns, flowers and greenery. They emphasize their otherworldliness with inside-out apparel and by upside-down behaviour and, in dance customs in many parts of the world, appear as a retinue of "fools."

Out of the *corps d'élite* of "fools" are projected master fools around whom further ritual has evolved. This central figure can be a king, a priest attending the god or even the god itself. A well-known pattern of such ritual takes the form of a dance drama, in which a god or a king is killed and is resurrected in human form or comes to life as green corn or in some other guise. The prehistoric dance dramas that led to classical Greek drama and had a part in Greek religion also led to other religions, fragments of which survive in folk custom in many parts of the world. Some religions, particularly in Asia, Africa and South America, have kept dancing as part of their ritual, although the ritual has through the centuries lost some of its significant content and become decorative and stylized, often barely distinguishable from secular ballet forms.

The orgiastic, frenzied nature of some religious dances such as the Greek Dionysiac rituals has been echoed in the dance crazes that have broken out throughout history, an extreme example being the quasi-religious dance hysterias of the middle ages. Since the living body needs to express organic energy in rhythm, and since civilization and culture tend to bridle such expression, periodically there are outbursts of "primitive" dancing, often touched off by contact with some new dance influence; *e.g.*, the effect on Europe of North American and South American and West Indian dance forms during and after both World Wars I and II. Rhythmic expression seems to be a necessary outlet for healthy organic life.

Dance serves to knit individuals into a unity, or society. It is a function adopted from time immemorial by religious sects like the dancing or whirling dervishes of the middle east, who have sought to induce a state of ecstasy through organized bodily movement in order to achieve union with the divine. Rhythm not only makes the individual whole but also links individual dancers by a common emotion. This linkage is further emphasized when the dancers join hands in a chain or ring: a chain of dancers or a chorus of dancing singers is one of the most ancient dance forms preserved in human record. Some of the earliest chain dances are drawn on rocks in the open near Luxor, Egy., *c.* 4000 B.C.; some are found in ancient Elam east of Babylonia *c.* 3000 B.C. In archaic Greece the chain dance was frequently depicted on vases and modeled in clay in closed ring form; these are claimed as the source of the Provençal farandole, but stylized examples are found on tomb vases of the Early Iron Age in Languedoc, France, and gaily dressed Iberians danced it *c.* 200 B.C. in Spain.

Pair dances are also ancient. On the same rocks near Luxor that immortalize the chain, couples are seen dancing face to face. In folk dance the pair dance is often of erotic intention, notably the saltarello of the Roman Campagna with its apron play. The communal dance by several pairs is designed chiefly for recreation, as in the court dances of the past and modern ballroom dances. As entertainment, dance is as old as the oldest civilizations and, in such circumstances, lends itself readily to commercial exploitation as well as evolution. (D. N. K.)

II. EARLY MEDITERRANEAN CIVILIZATIONS

1. Ancient Egypt.—Throughout the history of ancient Egypt the dance was an important part of religious ceremony, but there appears to have been little secular dancing. Since there is no written description of any dance, the type of step and quality of movement can only be conjectured through painting and sculpture.

Sacred Dances.—Many religious rituals originated in the superstitions of primitive peoples. Seeking kinship with their gods, they evolved dances of imitation, many of which were representations of the cosmic movements: the "dance to the morning star" took place at dawn around the sacrifice of a white camel; the "labyrinth" imitated the passage of the constellations. This led to dancing in circular formation, to rotatory movements and to symbolic gestures.

Dances of adoration and supplication were performed before the effigies of the gods, to the chanting of hymns and prayers. The movements were austere, and each gesture had its special significance. Every temple had its trained dancers and musicians, the instruments used being harps, pipes, castanets and sistra.

Religious festivals began with a procession of priests, dancers and musicians through the streets. Dramatic scenes were enacted, telling stories of the god to whom the festival was dedicated. At the festival of Isis, dancers represented the goddess as the dawn and as the wind of spring and mimed the story of her wanderings in search of Osiris. At the feast of Osiris at Abydos, priests and worshippers enacted the death and resurrection of the god.

Hathor, the goddess of dance and music, was specially honoured at her festivals with these two arts. A festival to Ptah took place at harvest in gratitude for the overflowing of the Nile river.

Funeral Rites.—Dances played a part in ceremonies connected with death and burial. These dances, expressing the grief of the mourners, were performed mainly by women. "The feast of Eternity" was a public ceremony in honour of the dead, at which many mourning dances were performed by both men and women.

Secular Dances.—The cultured upper classes of Egypt do not appear to have indulged in any form of social dancing. Some fresco paintings show women dancers performing at banquets as professional entertainers and a few figures suggest that there was some form of acrobatic dancing.

2. Ancient Greece.—Dancing, since it was universally practised, was a factor in the life and education of ancient Greece throughout its history, each period contributing some dance form of its own.

Temple Dances.—These originated in a primitive form during the Mycenaean era, in the 2nd millennium B.C., but in time developed into temple ceremonies. Great festivals were established in the Dorian age, the most notable being the Panathenaea, the Eleusinian mysteries, the Olympic, Pythian, Isthmian and Delian games. These festivals began with a procession through the city to the temple of the god concerned, where during the religious ceremonies the temple virgins, known as hierodules, performed dances of worship and adoration. Sacred dramas were enacted, the most famous being the one that took place in the temple at Eleusis and told the story of Demeter and Persephone; during the Eleusis festival, tragic dances, torch dances and symbolic dances were performed. At the Pythian games at Delphi a dramatic dance told the story of Apollo's fight with the serpent god Python (Pytho); the priestess of the Delphian oracle gave out her messages while under the influence of a hypnotic dance in which she imitated the movements of a serpent.

Funeral Rites.—During the Minoan and Mycenaean periods, frenzied dances of self-laceration took place around the dead. These orgies continued until the 6th century B.C., when Solon stopped them by law; the gestures then became symbolic and these tragic dances changed to movements of dignity and beauty that came to be accompanied by the music of flutes and harps. They were performed by professional dancers who, at funerals of importance, sometimes mimed an event or incident in the life of the deceased.

The Pyrrhic Dance, a war dance, was perfected by the Spartans about the 7th and 6th centuries B.C. It was danced with the weapons of war and was a mimic battle performed by one, two or more youths. It consisted of the actions of attack and defense and was also used to express victory. There were masters to teach it, for it was an essential part of military training; the dance was performed to the music of flutes and the singing of war songs.

The Gymnopedic Dances were the outcome of the training of athletes for the games. The actions of javelin and discus throwing were practised to the music of flutes, in order to gain rhythm and grace; these gave rise to dances mimetic of hunting and other sports.

Dionysiac or Bacchic Dances arose from the rustic festivals of the country people, who celebrated the vintage with dances in honour of Dionysus. They trampled the earth into a circular dancing ground and, to the chanting of dithyrambs, executed their dances around an emblem of the god. The death of the god was celebrated with tragic dances in the winter, and his return to life in the spring was welcomed with wild dances of ecstasy. These country festivals were the origin of the drama of Greece and of the Great Dionysia of Athens. The dancers were disguised as satyrs, maenads and bacchantes and danced with wine jars, thyrsi, cymbals, castanets and tambours, to the accompaniment of flutes, songs and shouting.

Choric Dances were an important part of the dramatic performances of the Dionysia. There were masters to train the chorus, who expressed in action the words of the poet; these dances were in tragic, ritual, lyric or other form suitable to the verse. In the satyric comedies the dancers were disguised as satyrs or animals and performed movements that were grotesque and frequently obscene. Although the choric dances were accompanied by flute or harp, it was the measure of the verse that set the rhythm of steps and gestures. This link with drama and poetry brought the dance of Greece to its highest intellectual form.

Secular Dances.—The dances of the peasantry were mimetic of their occupations and were mainly performed to singing. The "reapers," the "millers" and the "weavers" were danced by men; women danced the "spinners," the "woolworkers" and the "cooks." Games also were played to singing, especially games of ball. Wedding dances were performed to marriage songs; and country dances performed by youths and maidens, holding hands in lines or circles, were a social enjoyment. At banquets and parties professional dancers were hired as entertainers: they were expert in performing complicated steps and turns; used cymbals, tambourines, bones and castanets; and often performed acrobatics. Banquets often ended with the guests dancing the *komos*, an exaggerated version of the Dionysiac dances.

3. Ancient Rome.—Though the Romans developed the art of mime, their contribution to the art of the dance was negligible. In the early days of Rome some agricultural dances, mimetic of the sowing of the seed, were performed in the spring for the fertilizing of the fields, as were others representative of farm activities.

Such religious dances as existed were of an orgiastic type. The priests of Mars danced as warriors with weapons of war and, at the festival known as "the day of blood," the priests of Kybele and Attis performed frienzied dances in which they gashed their bodies with knives and potsherds.

About 200 B.C. a form of secular dancing came into fashion that was entirely drawn from the choreography of the Greeks and Etruscans; but in the hands of the Romans it deteriorated and soon died out. Dancing of all kinds was regarded with disfavour by the cultured and intellectual people of Rome. (R. Gi.)

III. THE ORIENT

1. India and Pakistan.—Dance in its several aspects has always been prominent in Indian culture. Until modern times important and impressive tribal dances were very much alive: the horned buffalo dance among the Gonds in central India, the war dances among the Nagas in Assam, the rousing sword dances round the fire among the Pathans, the courting dances of the Santals in Bengal and Bihar and of the Makrans along the Persian gulf. Also popular were the almost ubiquitous community (not tribal) stick and/or handkerchief dances and the hobbyhorses that were often connected with wedding festivities but in the state of Rajasthan (formerly Rajputana) were reminiscent of the wars between the Hindus and the invading Muslims. Strictly ceremonial dances, such as the trance dances of the "Bhuta" priests in south Kanara or the fire-mask dances at the Dharmapuja in Birbhum in west Bengal, were or are definitely magical in purpose.

Constantly influenced by these innumerable folk dances and in turn exercising influence on them are the official classical dancing styles. The principles each follow in their own way were formulated about the beginning of the Christian era in a treatise called *Natya Shastra.* Its mythical author, the sage Bharata, claims to have received his instruction from the supreme god Brahma himself. The *Natya Shastra* is a handbook of dramatic art and deals with all aspects of the theatre, of which dance is an important part; the word *natya*, the name of the highest form of drama, is derived from the root *nat*, which means "to dance." Dance in the stricter sense, however, is called *nrtta* when it is pure dance and *nrtya* when it is meant to convey a certain meaning, for instance illustrating the words of a song by means of stylized hand and foot movements. These movements form a kind of sign language, which, when properly executed, is transformed into a dance of entrancing beauty. The term *mudra*, used to designate these different hand movements, should, properly speaking, be confined to the closely related movements of the priests during Vedic sacrifices, where, however, they are not meant to be a dance at all but are thought to confirm the power of the chanted formulas.

The style as described in the *Natya Shastra* owes a great deal to Vedic ritual, as Bharata acknowledged, but also has a strong

element drawn from non-Vedic traditions. There are, as usual, no historical records but, under the cloak of mythological terminology, some historical development can be traced. The strictly Vedic elements are said to have sprung from Brahma, the rest from Siva. With the growing prominence of Siva—especially in his form of Nataraja, the lord of the dance—the importance of the Vedic elements was obscured and can only be traced occasionally in the surviving traditions. Parvati, Siva's spouse, who now is considered at least the equal of Siva as a creative force in dance, is entirely absent in the oldest text.

Four main schools survive in modern times and have found great appreciation in the new India. Perhaps closest to the art as described in the *Natya Shastra* is the style generally called Bharata Natyam (*q.v.*), derived from the dance as performed by the devadasis in the south Indian temples. It is, however, not *natya* ("drama") but *nrtya* ("descriptive dance") mixed with *nrtta* ("pure dance"), mostly to the accompaniment of very intricate drumming. The second school, Kathakali, found along the Malabar coast, is pure theatre. The pieces performed are taken from the rich Hindu mythology, especially from the fairly late *Puranas*, or from the much older epics, the *Mahabharata* and the *Ramayana*. The magnificently dressed and painted actors do not speak but mime the text as it is sung by men in ordinary dress at the back of the stage. The story is often interrupted by pure dance to instrumental accompaniment, mainly on drums. The third school, Kathak, found in north India, has also a sign language, mostly connected with the exploits of the god Krishna and his beloved Radha. Its many centuries of development as entertainment at the courts of Muslim (and also Hindu) princes have given it a special, sometimes decidedly erotic, character. As a marvel of technical perfection it is in no way inferior to either Bharata Natyam or Kathakali. The fourth school, found in the little kingdom of Manipur in Assam, also concerns itself mainly with Krishna legends and uses a sign language akin to that of the Kathak. It was —and perhaps still is—performed by the ladies of the court and thus escaped the stigma once attached to both Kathak and Bharata Natyam. This is why Rabindranath Tagore chose this form of dancing to be taught at the Santiniketan, Bolpur, when he wanted to reintroduce dancing as a form of expression among his pupils. Manipuri in its best form also has great technical refinement and is accompanied by superb drumming.

In the Indian classical theory, dance is considered as one component of a triad expressed by the word *Sangita* (vocal music, instrumental music and dance) and is said to be dependent on the other two components. (Ar. A. B.)

2. Indian Influence in Asia.—From India two great religions, Hinduism and Buddhism, spread throughout Asia. Both affected the philosophies of the areas they touched and determined the character of the dance. Each in its own way and in its particular area remained remarkably steadfast, despite the subsequent arrival of such conflicting influences as Christianity, Islam, colonialism and the psychological and physical encroachment of the west and modern times.

Hinduism is most notably entrenched in the dances of southeast Asia. The historian's designation of these countries (with the exception of the Philippine Islands and Vietnam) as "greater India" suggests the power of ancient India of the Hindus, as do the more colloquial terms "Isles of the Indies," "Indochina" and the like.

From a century before Christ, preachers of the Buddhist faith, local converts and even refugees from Hindu persecution of Buddhists in India brought tales of the Lord Buddha to Ceylon, Burma, central Asia, northeast to China and eventually, by the 8th century, to Japan. In these countries, while it may be said that dances are fewer than in Hindu areas, their playlets and dramas contain more social and even political significance; and an awareness of kings, queens, generals and nobles—rather than of gods, goddesses and mythological characters—pervades the national theatre arts. However, in both Buddhist and Hindu countries of Asia, the basic character of Sanskrit theatre is found: the fusion of dance, drama, poetry, music and song.

In general, the dances of Asia fall into one of several different pairs of categories: the simple and the complex; the group and the individual; the primitive and the sophisticated; and, on an economic level, the folk and the palace or, more simply, the amateur and the professional. Underlying each, but applying more specifically to the highly evolved dance forms, the guiding aesthetic principle is an emphasis on tradition or classicism. An Asian artist can spend a lifetime repeating a single set of gestures traditionally handed down from generation to generation, with the result that perfection of known and approved detail assumes greater importance than novel effects to surprise and titillate the spectator. A taste for departures from the familiar only developed in modern times.

Southeast Asia.—Both the dances and dance movements of southeast Asia are especially rich and variegated. The westerner first notices a fundamental difference in the use of the human body as an instrument of artistic expression. Postures are usually asymmetrical and off-centre, in contrast to western ideas of balance and alignment: the back arches sharply, knees splay, elbows break in hyperextension and the torso creates irregular angles of imbalance. Parts of the body are independently articulated: shoulders shudder, fingers tremble like butterfly wings, eyes fly up and down or from side to side in their sockets, the head clicks and swivels from side to side or forward and backward, and even the feet and toes curl and uncurl to beat time.

Using this technique, dance assumes its various forms: dramatized stories from the epics; abstract sequences of no meaning; fragments of moods or suggestions of vague ideas; virtuoso passages to display acrobatics; and individual dances that do little more than exhibit a chain of decorous motions with objects—pieces of cloth, sticks, flowers, fans, fire, water, swords or daggers. While many of the dances have profound religious associations that involve temple preparation, trance, initiations and ceremonies of an elaborate nature, some of them have purely temporal meaning and serve erotic purposes.

Some dances date back as far as the Stone Age, such as those on Nias Island in Indonesia, where, along with other remnants of protohistoric culture, stones are worshipped. Trance dances are also widely practised. These may be induced by autosuggestion or through hypnotic spells cast by priests; they always conclude with superhuman feats such as plunging into waist-high fires, balancing precariously from bamboo poles or on the shoulders of other dancers, or even stabbing daggers into the dancer's own flesh.

Where dance has erotic connections, it may be performed by eunuchs, like the *suwa-suwa* dancing boys of the Sulu islands in the Philippines; by virgins, as in Bali, who offer their purity to the gods; or by prostitutes who earn their living first by dancing to entice and stimulate. One feature of dance in Asia is the frequent performance of men dressed as women and, to a lesser degree, that of women dressed as men.

From an artistic point of view, the highest achievements in southeast Asian dancing are reached at the courts of kings by the palace dancers, or, where potentates have been supplanted by democratic institutions, by descendants of these noble performers.

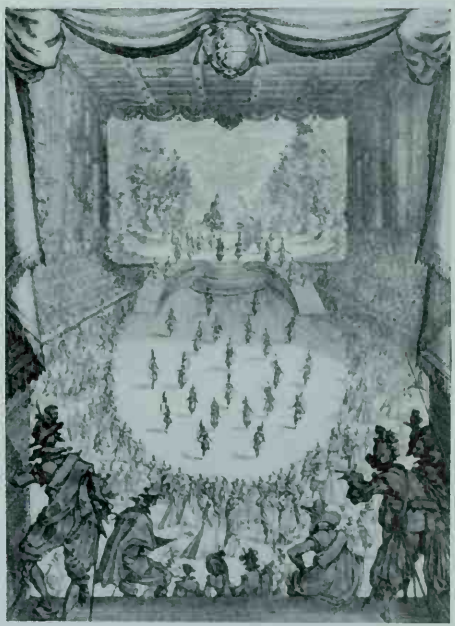
Ceylon.—Ceylon is famous for its devil dancing of pre-Buddhist origin and its Kandyan dances of Hindu inspiration. Less known, but of equal importance in dance history, is *kolam*, dance dramas of kings and queens with frequent intercessions of the Buddha and pointed morals regarding conjugal fidelity and the iniquity of greed.

Devil dancing is exorcistic, usually performed by specially trained troupes when sickness or insanity is discovered in a family. It involves dancing with fire, prophetic utterances, interspersions of contemporary playlets of excellent mimicry and realism (for the general entertainment of the crowds that gather as soon as the music commences) and a display of horrifying grotesque demons.

Kandyan dances require greater *expertise* in dance technique. While they are often performed in concert form, they constitute an integral part of the famous *perahera* or procession when a tooth of the Buddha is carried through the streets of Kandy, the old capital of kings of Ceylon, and the dancers are flanked by drummers, elephants and scores of monks.

Maenads, inspired by wine, dance at a feast of Bacchus, ancient Greece

Roman war dance enacting the legend of Jupiter (Zeus) and the Curetes



Scene from *La Liberazione di Terreno*, a 17th-century Florentine *veglia* (vigil), a dance form combining ballet and masked ball. From an etching by Jacques Callot

Ring dance. From an engraving by Israhel Van Meckenem (c. 1450–1503)

ANCIENT AND MEDIEVAL DANCING

BY COURTESY OF (BOTTOM LEFT, RIGHT) THE ART INSTITUTE OF CHICAGO

DANCE

Doris Humphrey and Humphrey-Weidman group in *Shakers*

José Limon in *Chaconne*, composed by Limon to music by J. S. Bach

MODERN DANCE

Trio from *American Document* with Frieda Flier, Sophie Maslow, Marjorie Mazia

Martha Graham and dance group in *Primitive Mysteries*

PHOTOGRAPHS, BARBARA MORGAN

Cyd Charisse and Fred Astaire dancing in the *Murder Mystery* ballet sequence of the motion picture *The Band Wagon*

Irene and Vernon Castle, c. 1913, dancing "The Half and Half"

BALLROOM, MOTION-PICTURE AND TELEVISION DANCING

Mata and Hari, U.S. nightclub and television satiric dance team

Russ Tamblyn and Gina Trikonis in a scene from the motion picture *West Side Story*

Leslie Caron and Gene Kelly in a scene from *An American in Paris*

BY COURTESY OF (TOP LEFT) METRO-GOLDWYN-MAYER INC. (BOTTOM RIGHT) © 1951 METRO-GOLDWYN-MAYER INC. (CENTRE LEFT) ANN BARZEL, (BOTTOM LEFT) © 1961 UNITED ARTISTS CORPORATION, PHOTOGRAPH, (TOP RIGHT) THE DANCE COLLECTION OF ARTHUR TODD

DANCE

Kabuki dancer in role of Benkei in a scene from the play "Kanjincho"

Uday Shan-Kar and his company, east Indian dancers

Two members of the Yugoslav ballet in the folkloric dance "Teškoto"

Spanish dancer José Greco (second from left) and company

FOLK AND ETHNIC DANCING

BY COURTESY OF (TOP LEFT) THE CONSULATE GENERAL OF JAPAN, NEW YORK CITY; PHOTOGRAPHS, (TOP RIGHT) ALFREDO VALENTE, (BOTTOM LEFT) PAUL WILSON, (BOTTOM RIGHT) MAURICE SEYMOUR, CHICAGO

Burma and Malaya.—In Burma, *pwe* means any theatrical show and, as in most Asian theatre, no performance is complete without a preponderance of dance. *Zat pwe*, the most traditional theatre form, deals with excerpts from the Jataka stories of Buddha's life (occasionally Rama is introduced as a "future" Buddha). Other *pwes* specialize in clowns, puppets and spirits. All are accompanied by orchestral music of extreme beauty and refinement.

Among the Shans, Chins, Kachins and Nagas of upper Burma, the dances are aboriginal in character and consist mostly of pantomimic imitations of various animals and stylized fights with swords or sticks of fire.

Malaya boasts no dances of note, apart from the scant folk dances of its aboriginals and a few social dances, performed in pairs or in groups by its urban populations.

Laos, Cambodia and Thailand.—These countries compose a single dance unit with folk and social dances common to all three and with their classical dances connected with the courts. The most formal of the classical dances are generically known as *khon* and are performed with masks by men exclusively. Their themes all derive from the *Ramayana* and are connected by long interludes of pure dancing that indicate obeisances, promenades, embraces, etc. A related dance form, generally known as *lakon*, is performed by women without masks. It is larger in scope in that it incorporates local mythology and can be adapted to represent any story, provided it is traditional. At the court of the king of Cambodia, the royal Khmer palace dancers exhibit on special occasions and at the invitation of the king the finest examples of this type of dancing. Garbed in costumes of brocade and crowned with tiaras of beaten gold studded with diamonds, the dancers execute their graceful movements describing the glories of Hindu gods with the studied perfection of a classical ensemble trained in a most resplendent tradition.

Indonesia.—The range of dance in Indonesia is bewildering. Each island, each area, each racial minority offers dances that vary in quality from the superb troupe at the palace of the sultan in Jogjakarta in Java and the extraordinary brilliance of the hundreds of professional dancers in Bali to pockets of aboriginal dancers enacting head-hunting dance rites.

The Philippines.—The Philippine Islands are an inseparable part of southeast Asia in geography, but not in the field of dance. This is partly due to their unique position as the only Christian country of Asia and the only one to be colonized by Spain and the United States. Apart from the Muslim islands in the south, where Indian-style dances prevail, most of the folk dances consist of simple movements on unsubtle themes, such as planting rice, gathering the harvest, trick movements with burning candles and glasses filled with water. The majority of the existing folk dances are comparatively modern and, having been introduced by the Spaniards, are closer to the west than to Asia. In modern times, ballets in western style based on Filipino texts gained popularity and competed with the rumbas and tangos, with which the Filipinos have more affinity.

Tibet.—The people of Buddhist Tibet and Ladakh in central Asia regard dance neither as folk nor professional art but as part of pageants and annual festivities, whose theme must be exclusively religious. The dancers, magnificently attired in huge masks and colourful robes, walk on stilts to gain height and to increase the supernatural qualities of the performance. They enact scenes to prove the triumph of Buddha and his followers over the evil and illusions of this world. The central Asia of Bhutan and Nepal is Hindu and the dances are on the level of village entertainment, being used as a means of courtship or to display movements of an acrobatic nature.

3. China.—Within China and areas influenced by Chinese culture (this includes in a broad sense Vietnam, Okinawa, Formosa, Korea and Japan itself) an enormous aesthetic shift in Asia takes place. Dance is in the main superseded by drama. In China itself there may be lotus dances, stilt dances, butterfly dances, lion dances (inspired by Buddhist stories from the parts of India where lions are known) or Yangko dances from the outer edges of China, but the chief theatrical activity is confined to "operas." From the 8th to the 20th centuries, China has had a flourishing operatic form of theatre that recounts tales of battles, warring kingdoms, domestic troubles and love stories. These transmit the country's history in visual form and perpetuate the moral values of Confucianism as revealed in situations based on filial piety, matrimonial devotion, loyalty, conflict between duty and feeling, and the place of the peasant side by side with the noble and scholar.

Artistically, the focus was originally on the beauty of arias and the delicacy of dramatic interpretation within roles. This increased over the centuries until dance became a negligible entity within the over-all theatrical framework. Mei Lan Fang (1894–1961), a performer of female roles and the greatest singer-actor-dancer in China's history, was responsible for the reinstatement of dance. He not only revived the dance repertoire but also enhanced passages of pantomime until they merged into pure dance.

Opera in China is stylized, exaggeratedly gesticulated and gorgeously costumed; use is made of masklike make-up of fantastic colour combinations and patterns that inform the spectator of the character and motivations of the role-type being portrayed. Acting includes not only singing and, within limits, dancing but also a good measure of acrobatics. As the dramas develop, the movements become vertiginously swift, the music deafening and the tragedies and comedies of the past, describing high and low life, rush to their climaxes.

4. Japan.—Japan has the most all-embracing theatre complex in the world. The country's long isolation from the west and other parts of Asia until the end of the 19th century preserved its arts meticulously and allowed them to evolve more particularly than those of any other country in Asia.

Bugaku dances of the imperial court imported from India and China in the 7th century are performed with traditional exactitude. They are foursquare, with movements stiffly repeated in prescribed patterns, and costumed in the fashions of the period. Patronage by the imperial family guarded them closely, and only after World War II were public performances allowed.

Nō drama (*q.v.*), long familiar in the west through translation, is in effect as much dance as drama or poetry. The concluding dance that ends all nō extends each play's theme through pure movement. Nō dates in its present form from the 15th century and presents a spectacle of excessive control and repose, aesthetic qualities that with their understatement contrast strikingly with the bombast and pyrotechnics of their counterparts elsewhere in Asia. A kimono lying on the floor of the stage represents an ailing princess, a lift of the mask a smile, a downward glance a frown, a raising of the hand a flood of tears; an entire vocabulary of gesture has been created that communicates to the initiate the deepest feelings.

With Kabuki, Japan's popular dramatic form coeval and in many respects similar to Elizabethan drama, dance reaches its most brilliant and cosmopolitan attainments. The themes cover many subjects, from those as simple as a lovelorn village maiden taking a walk, to a series of deceitful ruses employed by a warrior-priest to escape a trap. (*See* KABUKI THEATRE: *Kabuki Dances.*)

Japan's puppet theatre, in which the puppets reveal the most intimate aspects of human nature, also includes dances as essential parts of all programs.

Geishas perform, either in the private rooms of restaurants or at public performances in theatres, a vast number of dances peculiar to them. Their gestures illustrate the words of songs based on sentiments appropriate to love, natural beauty or heroes and heroines of history. Some folk dances are practised in the provinces and remoter areas of Japan and many of them have been enlarged into forms suitable for stage presentation.

Variety or vaudeville troupes, such as the pre-eminent Takarazuka, depend primarily on dance for their success. Some of these are western in style, others incorporate indigenous elements and appeal to an eclectic taste that demands the past and present, the native and imported. Several Russian ballet schools thrive in Tokyo and guest artists from other countries are invited to perform with the local dancers. Japan embraces the dance arts of the west with its own in a thoroughgoing manner. Alone among countries Japan seems best able not only to appreciate and import but to support and maintain the dance traditions and inventions of both

sides of the world simultaneously within the bounds of its own culture and without detriment to either. (F. Bs.)

IV. EUROPE AND AMERICA

1. Folk Dancing.—The concept of "folk" embodies two ideas: (1) that the form of dance was evolved over great stretches of time by communal practice; and (2) that the process of handing on through successive generations operates within a framework of unconscious choice. Many of the folk dances of Europe and America contain elements of ancient ritualistic and courtship practices, and some are distinctively national in character. For a full discussion *see* FOLK DANCE.

2. Social Dancing.—*Medieval.*—Dances of the early medieval period in Europe, as reflected in decorated and illuminated texts, included processions of couples and chains of singing dancers. The latter type, known as the carole, survived in folk custom in several European countries.

The figures and form of some of these dances undoubtedly influenced the trend of the 15th-century *danse basse*, which, from midway through the 14th century, endured in the courts of Europe for about 200 years. The *danse basse*, although not necessarily a solemn dance, consisted of ceremonial gliding movements. Only a limited number of steps were used, but they could be combined in many ways. Before the 15th century there were no professional teachers; the task of teaching was left to mimes and jugglers, but then the first of the dancing masters appeared in Italy and gradually a technique developed, so that court and folk dances were separated. The dances of the people remained intimate and largely spontaneous, whereas the increasingly voluminous clothes of both the men and women of the nobility restricted movement and frequently caused the dances to become little more than an excuse for the display of finery. Textbooks on the dance of the 16th century describe the *danse basse* as being slow and stately, with small gliding steps and a graceful rise on to the toes. After about 1550 this dance began to disappear and in his *Orchésographie* (1588) Thoinot Arbeau laments its passing.

The 16th Century, with the growth of a more varied and liberal outlook, found greater scope for self-expression in its festivities and entertainments. The development of the printing of music brought lutes, guitars and organs within earshot of everyone, so that social dancing flourished throughout Europe. Numerous books on the technique and steps of dancing appeared throughout the century. Various forms of galliard (*q.v.*) won high favour and Arbeau devoted 50 pages to descriptions of this dance in all its varieties. In 3/4 time, it was a dance of tremendous zest, consisting of a number of thrusting steps and leaps. At first it contained an element of pantomime: the man first traversed the hall with his partner, then released her and danced before her with a wooing and courtly manner. At this the lady retreated, only to be courted with greater intensity until she relented. Later this element of mime disappeared and the dance grew into a vehicle for the man to display his skill and agility. As the dance developed in complexity the dancer who wished to hold his own had to be able to jump high and perform double turns in the air.

In extreme contrast to the galliard was the slow and stately pavane (*q.v.*). In 4/4 time, it was known in some regions as the peacock dance, for it was danced "prettily" with a strutting motion. By the end of the century, however, this form had become less strict and little skipping movements gave it a lighter character.

The *volta* was favoured by the young people, for in it the dancers, in pairs facing each other, were required to rotate at high speed and at one point the lady was lifted off her feet. For a while the dance was considered impolite but any stigma was removed when Queen Elizabeth I danced it herself at court.

During the last half of the 16th century the courante (*q.v.*) grew in favour. But whereas the *volta* soon declined, the courante lasted for about 200 years. In its first stage the dance was of a light tripping nature in rapid 3/4 time; then at court it developed a more stately but still not ponderous style.

The *allemande* (*q.v.*) was yet another dance that flourished; processional in form and usually performed to music in common time, this too was at first of a stately nature, although it contained a peculiar step in which the dancers rose on the toes of one foot and threw the other foot forward, pointing the toe.

The 17th Century.—With the continued increase in skill needed for the execution of the court dances, in France particularly, the social dances gradually left the hall and found their way on to the stage, forming the basis of the technique of ballet. This led, in the 17th century, to a decline in social dancing at court, but as dress became simpler the styles in dance gradually were transformed. The gavotte (*q.v.*), a modified form of an earlier dance style, enjoyed tremendous popularity: it took the form of a square dance in which every couple had a turn to dance on its own.

English country dances were also very popular at this time and John Playford published *The English Dancing Master* in 1651 (*see* COUNTRY DANCE). Within 80 years this book ran into 18 editions, each one bringing in more dances. Country dances were divided into rounds and rings: in the former, one figure was danced in a circle and in the latter, while still retaining a circular pattern, the dancers also moved inward toward the centre and out again. The Maypole dance is an example of the ring form. The circular patterns were also varied by the formation of squares and lines.

The dance for which this period is chiefly remembered is the minuet; during the 100 years from halfway through the 17th century it was the dance most continuously in favour. In its fully developed form the minuet was executed with small, neat steps and a delicate air. Several great composers wrote music especially for it, and some of this music has become far more familiar than the dance itself.

The 18th Century.—In the 18th century the spacious houses of the nobility became centres of social activity, including dances, while at fashionable holiday and health resorts assembly rooms and other halls were the centres of frequent balls. Professional dancing masters were now abundant, particularly in England after the French Revolution, and they invented new dances and added to the complexities of the old.

The country dance was introduced into France toward the beginning of the 18th century and was accepted at the court balls. From it was developed the French *contredanse* (*q.v.*), which, with the cotillion, became popular in that country. About the beginning of the 19th century four favourite *contredanses* were combined to form the quadrille (*q.v.*) which was brought to England about 1815.

The 19th Century.—Although the waltz (*q.v.*) first made its appearance at the Austrian court in the second half of the 17th century, it did not begin to find widespread favour until well into the second half of the 18th century. The age of the minuet (that dance had by now deteriorated into mincing steps and highly artificial behaviour) gave way to the demand for naturalism, satisfied by the uninhibited turning motion and rhythmic lilt of the waltz. At first this dance was regarded as vulgar, but after the waltz had been danced at a ball given in 1816 by George IV when prince regent it was generally, but not completely, accepted. The waltz was probably the first dance in which the closed hold was fully employed.

During the same period set or square dances grew in popularity (*see* SQUARE DANCE). In 1815 the lancers became the first of a series in which groups of dancers, usually eight, formed into squares, performing a number of different turns, interweaving and linking and changing partners, each couple dancing a short solo in the centre of the square. The waltz turn was featured prominently in the actual dancing in these squares.

About 1840 a great revival of national feeling and culture arose in certain eastern European countries then under foreign dominance, and great sympathy was felt for these countries in western Europe. This may account for the popularity, at about this time, of the polka (*q.v.*), a new turning dance from Bohemia that gained phenomenal success in Vienna, Paris and London. In its train followed the mazurka from Poland, the polka mazurka and other dances that achieved brief marked favour in western Europe.

After this mid-century efflorescence of new dances, Britain and to a great extent France were sterile as regards new dances and the initiative for the first time passed to New York and the new world. From here in the early 1900s came the military schottische or

barn dance, the cakewalk (*q.v.*), the two-step (*q.v.*), the Boston and the turkey trot.

The 20th Century.—Between 1912 and 1914 Vernon and Irene Castle launched a campaign to refine these various dances. The Castle walk was perhaps the most important outcome of this campaign, for this heralded an entirely new style in which a more or less natural walking step was utilized as the basis of dance movement. Inventions by this same famous couple in the tango (*q.v.*) also aided that dance to become a craze. The early fox trot (*q.v.*), too, evolved through their experiments, and the chassé figure of three steps, one of them bringing the feet together, became an integral part of the figures of most dances of this time.

In the United States during the first part of the 1920s the *paso doble*, peabody and one-step (known as fast fox trot) became established. With the increase in popularity of Dixieland jazz in the mid-1920s, the Charleston (*q.v.*) suddenly engulfed society, reaching its peak about 1925 and petering out, along with the black bottom, in the late 1920s. By 1927 the lindy hop ushered in what was to become known as jitterbug (*q.v.*), a form of dancing that in its early stage consisted of gymnastic feats, breaks and wild footwork.

Good dancers in England adopted the Boston as the English waltz, the American turkey trot became the English one-step and, with the arrival in England of "Alexander's Ragtime Band" in 1912, ragtime became firmly established on both sides of the Atlantic. In that same year the Argentine tango, with its fascinating habanera rhythm, arrived via the French casino towns. Although attacked as an indelicate dance, it soon became exceedingly popular. In 1930 a Cuban dance, known as the rumba (*q.v.*), made its appearance; the rhythms of the Cuban music and the rumba movement electrified the public. While interest in the rumba continued to grow, several group dances appeared in the late 1930s. The conga, a "follow the leader" dance consisting of a line, lasted several seasons. Coincident with it came the Lambeth walk, a dance performed in a jaunty, strutting manner, to be followed by boomps-a-daisy. Both these dances, which originated in England, were adopted in the U.S., where they endured into the 1940s. The most popular dance in the U.S. in the late 1930s, however, was the big apple: in it the dancers formed a circle, a leader calling out the various figures, which bore such names as shag, Suzy Q and truckin'. By 1941 the samba became established and the Charleston was revived in 1949.

In England the first *palais de danse* appeared in 1919, to be followed in the 1920s by many similar halls throughout the country. This type of hall, with its cheap prices of admittance, good bands and spacious floors, enabled working people to take up dancing, and large numbers of them became skilled dancers. At the same time dancing in the more expensive resorts and exclusive clubs deteriorated until it became little more than a purposeless shuffle on floors that grew smaller and smaller and more crowded.

The teaching of dancing became a popular profession in England, and schools sprang up all over the country (*see* DANCE TEACHING). Then, just before the outbreak of World War II in 1939, jitterbug found its way across the Atlantic, having already won tremendous favour in the U.S.; about the same time in the U.S., jitterbug evolved into the quieter swing and jive. By this time, too, competition dancing was popular in England and a list of rules had been laid down by the Official Board of Ballroom Dancing (formed in 1929) to govern amateur status and other matters. Thousands of competitions are held every year, the most important being the British and the International championships. International events also developed rapidly, and in 1950 the International Council of Ballroom Dancing was founded. At that time the title "world championship" was not held in very high esteem, as various private promoters had organized so-called world events that attracted entries from only a few countries and in which leading couples from the most prominent of the "international style" countries did not compete. At first the International council therefore discouraged the organization of world championships, believing that an interval of time was desirable for the title itself to live down the reputation it had gained. Thus it was not until 1959 that the first world championships in both amateur and professional sections, held in accordance with rules and conditions laid down by the International council, were organized. They became yearly events and were contested in the four standard dances (waltz, fox trot, tango and quickstep), Viennese waltz and Latin-American dances such as rumba, samba (*q.v.*) and *paso doble*.

After World War II, the English waltz, the fox trot, the tango, the quickstep and the Viennese waltz remained the principal competitive dances. On the other hand, masses of young people found different, less skilled but more obviously rhythmical forms by which to respond to certain dance music trends of the period. Perhaps the most common of these forms were the mambo (introduced from Latin America about 1947), the calypso and rock 'n' roll, but this style soon shed its initial coarseness for more subtle rhythms and sophisticated movements. In the late 1950s and early 1960s the cha-cha also had a highly popular vogue. The twist, a grotesque dance consisting almost entirely of twisting movements of the body, with the knees bending and flexing, the partners well apart and without contact, attained international popularity after being introduced in the U.S. in 1961.

In the U.S. social dancing was not standardized so effectively as in England, nor was the technique so fully developed. Teachers differed not only from state to state and from city to city but even in the same city since various teachers used different styles and methods. The United States Ballroom council was working in the early 1960s on a certain amount of standardization, but teachers did not agree that the same kind or degree of standardization was desirable as in England, although the English style (known in the U.S. as the international style) was enthusiastically promoted by some U.S. teachers who had studied intensively in England.

3. Theatrical Dancing.—Theatrical dancing is a vague term. Ballet (*q.v.*) itself is of course theatrical dancing of a kind, but theatrical dancing is generally understood to refer only to the dancing employed in musical plays, variety and cabaret. Theatrical dancing varies in many ways, from classical ballet dancing performed by highly trained dancers and arranged by the world's leading choreographers to simple chorus numbers that can be accomplished with little training. The styles, in addition to classical ballet, include tap, acrobatic, sometimes even a highly stylized form of national dancing and yet another style, variously known as modern, contemporary, expressive and central European. (*See* CHOREOGRAPHY.)

Musical Comedy.—It is frequently stated that the standard of dancing in musical comedies and variety was extremely low until toward the end of the 1920s, but this is not entirely true. Some of the dancing in the Paris music halls of the 19th century achieved a reasonably high standard, although the skilled performer stood out against a chorus of mediocrity. In the music halls, many individual "acts" produced brilliant acrobatic work and, indeed, Russian ballet dancing of a high standard was introduced to London in such halls: both Tamara Karsavina and Anna Pavlova appeared in this way. Musical comedies of this time and for some years to come, however, usually relied upon a large chorus of girls who executed simple routines, the effect depending upon spectacular costumes together with the group patterns and uniformity of the ensemble rather than any strong originality or brilliance in the dancing itself. Very rarely were the dance routines an integral part of the action of the play; instead they formed an introduction or background for the stars. This kind of work was perhaps best exemplified by the famous totem chorus in *Rose Marie*.

Toward the end of the 1920s, large-scale groups and routines without any real choreographic merit began to give way to a kind of work rather more closely allied to the plot in musical comedies, and in cabaret and variety the dance element became more highly skilled. Perhaps the pioneer in this advance was Albertina Rasch, who trained troupes that became famous throughout the world for their work in films. All the members of these troupes were well trained in classical ballet and, through this training, were able without undue difficulty and in a short time to learn other forms. In the 1930s famous choreographers were engaged to create the dances in many musical plays and films.

By this time some of the pioneers of the modern dance move-

ment, notably Martha Graham, had worked for some time in the United States. Although there was only a small and specialized audience for these styles in their pure form, dancers and choreographers already began to adapt some of the angular, introspective movements into their own vocabulary. This influence reached Britain, and a dance composed on this style that accompanied Sonnie Hale's song "Dance, Little Lady" in C. B. Cochran's review *This Year of Grace* proved to be a tremendous success.

Ballet dancing itself, however, remained extremely popular in stage musicals and most members of dance troupes had by now to acquire a good all-round training in the main styles. The tap dance (*q.v.*) too had developed, and complex rhythms were necessary for all except the greatest of the nonchalant stylists such as Fred Astaire and Jack Buchanan.

Stage dance competitions became an important feature of the English dance scene, attracting large entries in all the various styles. At first the winners were usually offered splendid professional opportunities but, even with more competitions and more professional openings, the titles remain highly coveted. Several notable stage personalities gained their first success in these events.

After World War II theatrical dancing made further developments, becoming more and more firmly integrated into the action of the play until, in some productions, it became undoubtedly the most important element. Indeed, dance became so vital an element that in *West Side Story* members of the cast had to be able to dance, sing and act with equal skill. In this musical Jerome Robbins (*q.v.*) utilized a kind of modern dance that derived much from both classical ballet and other forms. *West Side Story* is undoubtedly the outstanding example of the way in which dance achieved equal partnership with the other elements, but earlier productions displayed a marked tendency in this direction. The dance scenes in *Kiss Me, Kate,* for example, were closely allied to the plot and were of an intense, dynamic nature, being devised by Hanya Holm, a choreographer of German origin and a naturalized U.S. citizen. In *Oklahoma* and, later, in *Paint Your Wagon,* Agnes de Mille, who had been trained as a classical ballet dancer and who subsequently studied modern dancing, brought the dance closely into the plot and characterization. It is significant that choreographers such as Robbins, De Mille and Michael Kidd (the choreographer of *Finian's Rainbow* and *Destry Rides Again,* among many productions) graduated from the role of choreographer to that of producer of the entire production: the dance element became so much a key to the whole work that in many cases it was essential for the choreographer to have complete charge in order to integrate this element with the others.

In British works dance also occupied a vital place, providing much of the humour in certain productions and possessing high standards both in arrangement and in the skill demanded from the performers. But in Britain modern dance did not exert quite the same influence as in the United States and choreographers were not able to make use of it with the same impact as their North American contemporaries. On the other hand they used period dance, such as the Charleston in *The Boy Friend,* in ways that added much to the over-all effect.

Films and Television.—Theatrical dancing in the early 1960s played a prominent part in both film and television productions. Even in mediocre films the music and dance element was often of a quality far beyond that of the rest of the production. In both media only dancers of a high all-round ability could find regular work, and choreographers became more and more inventive in their constant search for novelty. Indeed, the influence of the modern musical stage production was very strong in both film and television, for almost every kind of variety show possessed well-integrated dance arrangements. Although advanced experiments were being carried out in television with electronics and new types of lens, so that dancers could be apparently multiplied in number, distorted and seemingly robbed of all weight, for the most part the dance element was left to create its own impact without undue interference from producers or technicians. (A. H. F.)

Ballet is an art of the theatre made up of music, dancing, costumes and scenery. It can tell a story, suggest an atmosphere or illustrate the music, the emotions or dramatic situations being conveyed in movement alone. The dancers are taught the technique of ballet that has developed organically like a language; in classical ballet this language is used directly, in modern ballet it may be adapted in such a way that its basic form is no longer immediately recognizable. In whatever way it is used the technique of ballet is an essential discipline for the training of ballet dancers.

The choreographer's function is to orchestrate the movements of the dancers. Though systems of notation are being developed, in practice a particular ballet is handed down from generation to generation through memory and tradition. The changes that inevitably develop have helped to preserve the classical ballet, since, while the essentials remain, details that belong specifically to a period and would seem incongruous at a later date are eliminated.

Ideally music, dance and décor are equal partners in exploiting a theme. An outstanding example of the successful ballet is *Petrouchka,* in which composer Igor Stravinsky translated popular music in terms of a symphony orchestra; choreographer Michel Fokine translated folk movement for the use of trained ballet dancers; and artist Alexandre Benois adapted popular costume for the stage. These three collaborators co-operated in presenting a dance drama that is readily understandable without the need of program notes.

Ballet must stand on its own without the support of literary explanation. This illustrates both its strength and its weakness. It cannot tell a complex story—how does one convey sister-in-law in action?—nor can it paint subtle characters. On the other hand it can suggest an atmosphere in a way that no other theatre art can. In this same *Petrouchka,* for instance, audiences can either follow a straightforward fairy tale of the loves and jealousies of puppets or, if they are more imaginative, they can read into it the agonizing birth of a soul.

Tamara Karsavina in *Le Spectre de la Rose* and Galina Ulanova in the first act of *Romeo and Juliet* revealed the poetry of adolescence in an unforgettable "moment of truth." The role of the poet from Molière to Jean Cocteau has always been a major one in ballet; if the scenario is faulty the ballet is doomed to failure from the start.

The genius of Sergei Diaghilev lay in the skill with which he composed his team of artists, a skill never before matched in the history of ballet. In addition, therefore, to the choreographer, composer, painter and poet, ballet requires an artistic director whose knowledge of the arts must be authoritative and extensive and who must be creative in that his presence inspires creation in others whom he himself has carefully selected.

The role of the dancer varies considerably according to the demands of the choreographer. In some cases the dancer interprets a fully conceived work, while in others it is the personality and physique of the dancer that inspires the choreographer and, in such cases, the dancer collaborates to a greater or lesser degree in the creation.

Under ideal conditions the composer also collaborates closely with the choreographer; *e.g.,* Tchaikovsky and Marius Petipa, Stravinsky and Michel Fokine. Music for ballet is only part of a whole, and good ballet music is not necessarily good music considered in isolation (*e.g.,* A. C. Adam's *Giselle*), though it may be that the music is considered by many to be more successful as a concert suite than on the stage (*e.g.,* Maurice Ravel's *Daphnis and Chloé*). In the case of already composed music, timing is an all-important factor, since the eye takes in a situation with greater rapidity than the ear. Much music is unsuited to ballet not merely because it is absolute in the sense that it is complete in itself but also because it is too long in its development. Few people outside the ballet theatre realize the short duration of even the longest adagios and variations in classical ballet. Because of their brevity, the successful symphonic or concerto ballet is an exception.

Much the same applies to the role of the decorative artist. His shapes and colours are not to be seen in the flat and static form of a fresco composition but in a continually changing and developing picture. Not only must his costumes assist the dancers in

motion they must also reveal the choreographer's intentions at all times. (A. L. Hl.)

Modern Dance.—This form of theatrical dance came into existence in the early years of the 20th century largely through the revolt of certain pioneers against what was regarded as the rigid formality and outmoded conventions of classical ballet. In Germany Mary Wigman (*q.v.*) studied the relationships between music and movement first under Émile Jaques-Dalcroze and later under Rudolf von Laban. With this strong, scientifically inclined background, she began to compose her own works, her first publicly presented creation being *The Seven Dances of Life*, in 1918. Soon she gathered round her a number of enthusiasts and her influence on the development of modern dance was considerable.

This form of dance was fostered in Germany after Mary Wigman's early experiments, but elsewhere in Europe it did not, generally speaking, gain much response. In the United States, however, two pioneers emerged at the end of the 19th century and were followed by a continuous stream of creative artists. Isadora Duncan (*q.v.*) studied ballet as a child but broke away from what she considered its undue restrictions in order to express herself in her own way. Her vaguely formed idea was that dance is the expression of an inner urge or impulse and that the source of this impulse comes, physically, from the solar plexus. In working out her movements she was influenced strongly by the art of ancient Greece, her favourite style of costume being a flowing tunic. She is generally believed to have been the first western dancer to perform on the stage in bare feet. Soon her work became known in Europe, and she gave successful performances in many European cities. In 1904 she opened her own school in Berlin and, even in those circles that refused to accept her theories, her experiments exerted their influence on various forms of theatrical dance. But her definite avoidance of set movements and figures and her constant improvisations that were never crystallized into an established technique meant that, notwithstanding her personal influence, no systematized method was left after her death in 1927.

Ruth St. Denis (*q.v.*), who is often referred to as the "first lady of American dance," sought ideas and actual dance forms from the east, producing theatricalized versions of nautch (*q.v.*) and yogi dances. But, different though her style was from that of Duncan, she too sought the same end of releasing dance from what she vowed were the tight and frustrating restrictions of traditional ballet and the virtuosity of *pointe* dancing. Unlike Duncan, however, St. Denis, in collaboration with her husband, Ted Shawn, (*q.v.*), himself a pioneer, was able to develop a technique and training method. Many of her dances were based firmly in religious ideas and she reintroduced dance into certain religious services.

St. Denis' greatest, if most controversial, pupil was Martha Graham (*q.v.*), who studied and worked for seven years at Denishawn, a school and workshop set up by St. Denis and Shawn. Afterward she produced, both by herself and with a small company of votaries whom she trained complex works in which she sought to express deep states of mind and profound emotional relationships. Her images were frequently so personal that their meaning was elusive. Nevertheless, some of her movements had an intense and powerful impact, even when their literary significance could not be understood. While she herself resisted all temptations to give way to popular appeal, she influenced several U.S. choreographers and her work undoubtedly affected the trend of the U.S. musical, with its stress on a variety of dance forms integrated both with themselves and with the action of the play.

In the U.S. other leaders in modern dance included Doris Humphrey (*q.v.*), Hanya Holm, who created dances for several musicals; and Katherine Dunham, who added to the vocabulary of the modern dance form with innovations derived from her studies in ethnological dance.

Gradually more and more teachers and practitioners of modern dance realized that it could no longer remain in isolation from the supreme physical discipline of classical ballet. As a result, in many modern classes exercises derived from those of classical ballet were employed in the basic training.

There were also signs that in turn modern dance was insinuating itself into the vocabulary of classical ballet. (A. H. F.)

V. TECHNIQUE OF MODERN SOCIAL DANCING

1. Six Basic Steps.—All the modern social (ballroom) dances are composed of combinations of the six basic steps. Without a thorough knowledge of these basic steps, one cannot hope to do any of the modern dances really well. With a knowledge of them, there are practically no combinations, done ordinarily in the fox trot and the waltz, at least, that cannot be picked up readily. The six basic steps are: the walking steps, the chassé, the waltz, the balance, the pivot and the running steps.

Walking Steps.—Each of the walking steps takes up two beats of the music. On the first beat, the man places the whole foot forward on the floor, toe first, the heel barely touching. The woman reaches backward with the toe as far as possible. On the second beat, both rise slightly on the toes to give spring and pep to the step, and finish.

Step smartly and lightly, shifting the weight from one foot to the other. After taking a step with one foot, always lift the other off the floor. Never drag or slide the feet along.

Practise taking long, slow steps about the room. Women, in their practice, should give especial attention to walking backward. Keep the knees straight and firm and always make the toes lead. Dance as if you did not have a foot but only a great toe. Practise stretching the toes forward, or backward, as far as possible, and always keep them turned out to avoid a pigeon-toed appearance. Always step in a straight line, directly forward, directly back or directly to the side. This is fundamental to a good balance, good appearance and a sense of unity with your partner.

The Chassé.—The chassé is a short, quick step directly to the side—either to the right or to the left. For the left chassé, step directly sidewise to the left and draw the right foot up to the left. For the right chassé, step directly to the right with the right foot and draw the left foot up to the right. Complete the movement with smartness and precision by bringing the feet together so that they actually touch each time.

The Waltz.—The waltz is a combination of a walking step and a chassé (in 3/4 time). In the modern waltz, the accent falls upon the walking step, and all the steps are of the same length and value. Practise the waltz steps to modern waltz music, counting one, two, three with a definite accent each time on the "one." Or, better still, keep time with the words, "step, side, together," the accent falling upon "step."

The waltz may be done forward, backward or used as a turn to left or right. The waltz may also be danced to fox trot music by holding the first step for two beats and giving the second and third steps each one beat.

The Balance.—The balance is a hesitation. Step forward, back or to the side with the whole weight upon one foot, and rise, pointing the free foot forward, back or to the side with the toe just touching the floor. The balance is used in many combinations in both the fox trot and the waltz. When danced to fox trot music, it is given two counts. When danced to waltz music, it is given three. It is a very graceful step, interesting to do, and, moreover, a sure means of developing a good sense of balance.

The Pivot.—This is simply a particularly graceful and effective way of making a quick turn. Always see that one foot is directly in front of the other. Rock forward, on right foot, bringing the entire weight upon the ball of the forward foot, and spin round, making a quarter turn. Rock back on the left foot, and repeat the motion.

The Running Steps.—These are known as syncopated steps because three steps are taken to four beats of the music; take three quick running steps, then pause on the fourth beat. The syncopated steps are helpful to the woman in following because they teach her to step quickly. This is a decided asset to one who must change her step rapidly in order to follow various partners. Although the running steps are faster than walking steps, they are just as long. It is always best to take long steps, whether they be fast or slow. A short step betrays a lack of confidence.

A man must train his feet by constant practice to do the various steps and combinations automatically in order to inspire confi-

dence in his partner and to lead with that easy nonchalance that is the mark of an accomplished dancer. It is a mistaken idea that to be a strong leader a man must take a death grip upon his partner and push and pull her with force about the floor. Hold your partner firmly, yes—especially with your right hand—and then go through your steps with certainty and precision. If she knows the steps she will be able to follow. If she does not no amount of forceful guiding upon your part will be of any help to her.

The rumba, a graceful and exciting dance step, is based on the rumba rhythm: one, two, three, pause; one, two, three, pause. Because the knees are actively employed in this step, the dancers stand about eight inches apart. Stand erect, heels together, and relax your weight on the heel of the left foot and at the same time cross your right knee in front of the left. Then shift your weight to the heel of the right foot and cross the left knee in front of the right. Once again shift your weight to the heel of the left foot and cross the right knee in front of the left. Pause after the third count. This is the basic rumba motion, unique for this dance and employed in all rumba steps, whether forward or backward.

2. The Correct Position.—The best position is the easiest and most natural. Stand erect on the balls of your feet, making yourself as tall as possible. Rest the weight upon the foot that you are not going to use first, leaving the other one free for your initial step. Keep the back straight, the shoulders relaxed, the chest out, head up, chin in, eyes directed over your partner's right shoulder, arms high, at about shoulder height. It is very important to keep the arms well up in dancing. Women who unconsciously allow their arms to sag always seem heavy, even though they may be very light on their feet.

The man holds the woman straight in front of him—never to one side—and firmly, just close enough to enable him to guide her easily. His right hand rests in the middle of her back, just below the shoulder blades. His left arm is extended to the side and bent slightly at the elbow, the left hand holding her hand lightly.

The woman rests her left hand lightly upon the back of the man's shoulder. She should never curl her hand under his arm. Trick holds are out of date. Her right arm is extended to the side in an easy, graceful curve with the right hand resting lightly in the man's. Be careful to avoid a spasmodic clutch. It betrays a tension and a lack of confidence that are destructive to your partner's pleasure in dancing with you.

In starting, the man steps forward directly toward his partner, leading with his left foot. The woman steps directly backward, leading with her right foot. Don't be afraid of stepping on your partner's feet. If you start on the proper foot and step in a straight line, directly forward or directly back, you never will get in your partner's way.

There is no fixed sequence for the six basic steps or any of their variations. In modern dancing, the leader may swing into any step at any time, as his fancy may dictate or the music seems to suggest. This is why it is so extremely important that the woman should be thoroughly familiar with the steps her partner may decide to do. The only way to gain confidence and to overcome self-consciousness, awkwardness and stiffness in dancing is to learn the steps and by constant practice to master them so perfectly that you could almost do them in your sleep.

Self-assurance, ease, grace and relaxation come as a natural consequence of knowing how. Self-consciousness, stiffness, awkwardness will vanish, and you will find yourself dancing with ease and spontaneous enjoyment.

See also references under "Dance" in the Index.

(A. Mu.)

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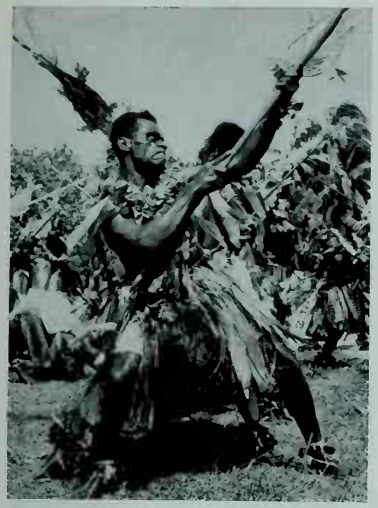
DANCE, PRIMITIVE. Primitive dance, in the sense of elementary or the earliest dance, does not exist today, though Australian and other aborigines trace their rites to an ancestral dream time. But many dances retain all or part of their original character and purpose. They are integrated with activities of daily life and religion and are impelled by a desire to communicate with supernaturals, to control the spirit world and nature by offering, sacrifice and thanksgiving. Such dances survive in all continents, though those in the neighbourhood of industrial centres have suffered more change than those in the wilderness. The term primitive dance will here refer to dance with recognizable retentions of pristine purpose.

Functions.—The earliest dance rituals probably celebrated the crises of life, such as puberty, illness, cure and death. Among dances for economic survival, hunt and animal rites generally preceded agricultural festivals. These types persist, while social, contest and display dances continue to gain in prominence. All contain themes of fertility and physical exuberance.

In Australia, pubescent boys are initiated in groups during the *waiung-arree*. A dream song accompanies the climactic *wallang-arree* dance by the neophyte and attendants. During puberty rites for girls, women of the Wargaitj tribe near Darwin approach the mother of the neophyte in a line dance and enact a symbolic rebirth. In South America the Ona and Yahgan Indians of Tierra del Fuego impersonated demons at a boy's initiation, with terrified women as spectators. The Maipure and Baniba Indians of Venezuela masked as the demon Mauari to initiate boys or girls. The Choroti and Ashluslay women of the Gran Chaco protected a girl in circle dances. Many California tribes celebrated a boy's initiation with masked spirit impersonations and a girl's coming-of-age with circle dances. In the second half of the 20th century, the *gahe* or crown dancers of the Apache Indians were still masking as mountain spirits for a pubescent girl's benefit.

Curative rites are universal. In central Asia they are particularly dramatic. The Siberian and Manchurian curer-seer or shaman possesses beneficial and nefarious powers from an animal spirit or ghost. He works himself into a trance by chanting, stamping, leaping and whirling to the beat of his drum, sometimes with the aid of narcotics. In Eskimo ceremonialism the focal *angakok* trembles and falls in a trance. Among North American Indians, medicine men still dance and juggle in the elaborate ceremonies of the Algonkin *mide* and the Iroquois *yeidos*. In South America, individual shamans can cure or lead harvest ceremonies, as does the female *machi* of Chile's Araucanians.

Trance dances take various forms throughout Asia, as in the firewalking of India and the whirling of Turkistan and Afghanistan.



Fijian warriors performing their traditional *meke*, or war dance; Matuku Island in the Lau group, Fiji Islands

Australian aborigines, Melville Island, carrying the totem pole into camp during part of the Pukumani ceremony, a funeral rite performed in three stages and lasting three months

Rom dance, a ceremonial exchange of goods, performed by the aborigines along the Liverpool river, Arnhem Land, Australia

Arunta aborigines of central Australia dancing a corroboree, a totemic ceremony of the sacred pole

Aborigine men of Millingimbi, Arnhem Land, enacting their tribal creation story during part of a circumcision and initiation ceremony

Aborigines of Melville Island during a dancing stage of their Pukumani totemic ceremony for the dead

PRIMITIVE DANCING IN AUSTRALIA AND THE FIJI ISLANDS

BY COURTESY OF (CENTRE RIGHT) PUBLICITY & TOURIST BUREAU, SOUTH AUSTRALIAN GOVERNMENT; PHOTOGRAPHS, (TOP LEFT) ROB WRIGHT, (TOP RIGHT) TED SHAWN, (CENTRE LEFT, BOTTOM LEFT AND RIGHT) AXEL POIGNANT

DANCE, PRIMITIVE

Tibetan ceremonial devil dancer, masked as the Spirit of Barren Mountain, performing at a religious festival

War dance being performed by Igorot tribesmen, mountain people of north Luzon, Philippines

Confucius temple dance, a ritual performed at the Temple of Confucius in Kufow, China, dating back to the Han dynasty, 202 B.C.–A.D. 221

Dancer, dressed in ceremonial robes and carrying sacred silver sword, ready to begin the firewalking trance dance of India

Men of Afghanistan, near Kabul, participating in war dance traditionally performed on New Year's day

PRIMITIVE DANCING IN ASIA

PHOTOGRAPHS, (TOP LEFT) © ENCYCLOPÆDIA BRITANNICA, (TOP RIGHT) FUJIHIRA FROM MONKMEYER, (CENTRE LEFT) EASTFOTO, (CENTRE RIGHT) T. S. SATYAN FROM BLACK STAR, (BOTTOM) VERA PENZL

Swazi tribesmen, draped in colourful ceremonial garb, performing a reed dance, Swaziland, South Africa

Tutsi (Watusi) boy dancing the lion dance with men of his tribe, Burundi. The headdress is symbolic of a lion's mane

Bushmen of Northern Rhodesia performing a primitive dance, probably an animal mime

Bridesmaids dancing during part of a wedding festival. Valley of a Thousand Hills, Natal, South Africa

War dance of the Zulus, members of the Nguni group of Bantu people, Johannesburg, South Africa

Masked dancers, members of a secret society of the Bekom tribe, former British Cameroons, in a funeral procession

PRIMITIVE DANCING IN AFRICA

BY COURTESY OF (TOP LEFT, CENTRE RIGHT) SOUTH AFRICAN TOURIST CORP., LONDON, (CENTRE LEFT) NORTHERN RHODESIA INFORMATION DEPT., PHOTO BY H. WATT, (BOTTOM RIGHT) MILWAUKEE PUBLIC MUSEUM; PHOTOGRAPHS, (TOP RIGHT) GATTI—PIX FROM PUBLIX, (BOTTOM LEFT) AUTHENTICATED NEWS

DANCE, PRIMITIVE

Apache *gahe*, or crown dancers, masked as mountain spirits during a celebration for girls' coming-of-age

Corn dancers performing during an agricultural festival of the San Ildefonso Pueblo Indians, New Mexico

Dancers masked as a dog and tiger for the *tlacololeros*, a dramatic combat dance of Mexico

Mexican sun dancers, *quetzales*, named after the quetzal bird

Kuikuru Indians, upper Xingú river basin, Brazil, performing *undufe* dance in celebration of a successful fishing expedition

Yaqui masked dancer representing the sacred clown, Pascola, in Sonora, Mexico

Teseque Pueblo Indians of Santa Fe, N.M., performing traditional buffalo dance

PRIMITIVE DANCING IN AMERICA

BY COURTESY OF (TOP LEFT, BOTTOM RIGHT) MUSEUM OF NEW MEXICO; PHOTOGRAPHS, (TOP RIGHT) JOHN CANDELARIO FROM WESTERN WAYS, (CENTRE RIGHT) GERTRUDE E. DOLE AND ROBERT L. CARNEIRO, (CENTRE LEFT, CENTRE, BOTTOM LEFT) BODIL CHRISTENSEN

The therapeutic possession dances of Africa have spread to the new world, as in the *candomblé* of Brazil, the *winti* of Surinam (Dutch Guiana) and the *vodun* of Trinidad and Haiti. In these dances an African deity enters a devotee and produces frenzied dancing in the character of the god. Visionary cults are also native to the new world, as the ecstatic peyote léaping of the Huichol and Tarahumara Indians of Mexico and the datura cult of southern California tribes.

Mortuary rites are also ubiquitous, but vary in their emphasis. The California Yuma focus on cremation processions. Women often officiate at wakes and memorial feasts, as among the Iroquois. In Africa, secret societies convene at funerals. The dead may attend in imagination or as masked figures, as on Australia's Melville Island and as in the British Cameroons of Africa.

Animal impersonations serve as cures if a bear, eagle or other spirit must be appeased. They also enter into totemic memorial rites, exemplified by the Kwakiutl raven or wolf-clan emblems, or the Australian emu and kangaroo. But they function primarily in the hunt for food. A hunter or entire tribe addresses the creature's spirit with a placating formula and perhaps a mimetic pre-hunt dance, then with a thanksgiving dance after a successful expedition. The animal varies with the environment; it may be a duck, whale, buffalo, deer, tiger or bear, the latter of which is worshiped from the Carolina Cherokee to the Ainu of Japan. The enactment can be realistic, as in the Plains buffalo dance; semi-stylized, as in the Yaqui (Cahita) and Pueblo deer dances; or stylized, as in the Pueblo buffalo dance.

Food gatherers celebrate the harvests of annual first fruits: maple sugar, berries, wild rice, acorns, algarroba. Agriculturalists address the tutelaries of corn, beans, squash, melons and of the much-needed rain and sun. The natives of the southern United States, the Mexican highlands and the Andes maintain their earlier animal dances along with the maize ceremonies: the rain-bringing *kachina*, the sun-splendid *quetzales*, and the *voladores* for sun and fertility.

Ceremonies developed composite contents as a result of cultural innovations and borrowings from other peoples. Cure, totem and animal dances blended. Sword and stick combats came to bring victory to seasonal new life; among the Oraons of India such combats accompany wedding processions. Ceremonial clowns, usually masked, fuse concepts of death, rebirth, cure, harvest; they enact ancestral or supernatural prototypes. They terrify, censure and chastise as well as amuse, and they can enact social parodies.

The Drama.—The dramatic concepts involved in dance are presented in manifold forms. Sometimes the impersonations enact a myth, such as the wanderings of Australian ancestors or the emergence of the *kachina*, the eponym of the Hopi. The actors vary from a virtuoso soloist to a small trained group or the entire community. War mime may engage a pair of men as in Borneo or a large group as among the Zulu and Afghans. A long list of dramatis personae may add dialogue to movement, as in the Mexican *tlacololeros* combat of farmers and their dog with a destructive tiger.

In their full splendour the dances enhance their potency with other dramatic elements: the setting of an underground shrine, a sacred grove or a plaza; symbolic designs on body, mask and costume; paraphernalia such as evergreens, flowers and rattles in the hand or on parts of the body; instruments such as bullroarers, (*q.v.*) drums and flutes; spirit cries and songs by the dancers or separate musicians.

The enactment may last an hour, as in the Iroquois false-face dance, with the entrance of maskers, curative procedure, paired dance by maskers and sponsoring matrons, and round dance for everyone. After secret preliminaries, the public drama may take several hours, as in the Hopi snake-antelope ceremony, where the priests circuit the plaza four times, stamping on the underworld entrance, then sway in parallel lines, circle four times in groups of threes with the snakes and finally release the reptiles to the four directions in search of rain. The whale cult of the Alaskan Eskimos extends over a week in anticipation of a catch, with a woman as whale, incantations and songs during the catch, dance of rejoicing by the shaman and people, a three-day "mourning" period of placation and a final feast with frenzied dancing. In British Columbia the Kusiut society's mythical dramas may last 27 days.

Patterns.—Not only the larger structure but each dance segment follows traditional patterns. Sometimes the sequence and steps are set, as in the Santa Clara rainbow dance. Sometimes, as in the Pueblo game-animal dances, the composers have considerable leeway within the frame of entrance, slow dance, fast dance and exit. Often the dancers improvise within an established style, as in Afghan and Plains war dances, African animal mime, and antics of sacred clowns.

Techniques vary greatly in different parts of the world, even between adjoining groups and between different dances of one tribe. Some people emphasize footwork; others torso motions; others hand gestures. African and Afro-American dances are often acrobatic and violent, while Mexico's native dances are dignified and measured. In Oklahoma the serpentine stomp dances of the Cherokee and Creek adjoin the lively Kiowa display dances and have been exchanged. From Australia to the North American plains, the women's shuffle serves as foil to the men's leaps and gyrations. Eskimo men jerk, while their women sway with curving arms. Yet the sexes may step in unison, as do the Hopi butterfly dancers.

Basic formations, such as circles and lines, are more universal than physical techniques. However, circles may proceed with or against the sun, among hunters or agriculturalists; they also may open into a meandering line. Two lines may run parallel or cross over, or interweave. Sometimes the four cardinal directions determine the dance orientation and ground plan, as among the Great Lakes tribes and Pueblos.

In functional dances all motions and formations are fraught with symbolism: the phallic stamp, the generative leap and kick, the ecstatic whirl, the vernal arch, the solar or sinister course for power from the sun and sky or from the moon and earth, the serpentine course for fertility. Two factions in opposing lines may compete as good and evil spirits, or the sexes may entice each other. The performers may interlace in circles or in pairs, but in aboriginal dances men and women never dance in a ballroom embrace.

Persistence and Change.—Many of the earliest rituals have persisted, even in the midst of modern civilization. The Rumanian Calushari, the Austrian Perchten and the Portuguese Bugios still enact fierce spirit impersonations. Serbian girls enact the rain-bringing dance of the Dodole supernaturals. In the midst of Catholic ceremonies, the Aymara of Bolivia retain their *choquela* mime of the vicuña hunt; the Quechua of Peru celebrate their *inti raimi* winter solstice; the Aztecs of Mexico perform their sun dances and animal dances. Pueblo and Iroquois conservatives even maintain their ritual organization, including the integration of dance rites with clan and moiety patterns.

Yet changes have been continuous and recently accelerating, due to creative inventions, adaptations to new environments and economic conditions, and borrowings from friends or impositions by conquerors. Often a dance changes meaning, from war to cure, from hunt to weather control, with obsolescence of the original function. Evolution from dance ritual to art theatre has been a frequent event, as in Greece, India, Japan and elsewhere. An equally frequent trend is secularization into folk and social dancing and into displays for tribesmen or tourists.

Aggressive European culture and religion have exerted a profound and usually destructive influence on native dance traditions in all continents. Not only did pagan dances of Europe change under the sway of medieval Christianity; they have been transported to the new world and have amalgamated with new-world rituals, under names like *moros y cristianos* (Moors and Christians), *Santiago*, *matachin* or *conquista*. European steps have blended with native styles and have produced new vocabularies for dance rites as well as secular round and couple dances. New forms have sprung up in Latin America and Oklahoma. Colonial or modern dress, instruments, paraphernalia and backgrounds have been replacing symbolic native costumes and settings. Often the native dances have disintegrated.

The new world has felt an almost equally strong influence from

Africa, through the slaves of European conquerors. African rituals have persisted with colourful variations, even in the urban Holiness churches of the United States. They have mingled with Spanish, French, British and Indian elements on southern plantations and have spread to northern cities as exuberant variants of jazz dance. Thus, while ancient, functional, primitive dances are disappearing, new forms continue to arise from time-honoured patterns.

See also DANCE; MUSIC, PRIMITIVE; SUN DANCE.

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DANCE FORMS IN MUSIC. The essence of dancing is rhythm, and as soon as it became possible to write down music in a reasonably accurate rhythmic form, dance forms appeared in music more and more frequently.

Medieval Forms.—There are two-part dances of the early 13th century in the same manuscript that contains *Sumer is icumen in*, and contemporary European sources include types of dances such as the *ductia*, *estampie* and *stantipes*. Some of the court dances (*danses royales*) already show a tendency toward pairing movements of contrasting mood and tempo, and although these are generally monophonic it is probable that the instrumentation was extremely varied, for miniatures of the time portray dancers and groups of musicians in various formations. The round-dance, or *carole*, consisting of alternating and repeating sections, influenced the medieval carol, which was frequently constructed in the same way. In Spain, a few pilgrims' dances have been preserved, which doubtless resounded along the route passing through Limoges on the way to Santiago da Compostela. Less joyous bands of religious travelers, the flagellants, are also said to have danced with instrumental accompaniment as they made their way from town to town.

An Italian manuscript of the 14th century has preserved a group of dances that are monophonic like the *danses royales* but considerably varied in mood and style. There are the *istampita*, derived from the *estampie* favoured by troubadours, trouvères and their jongleurs; the *saltarello*, the *trotto* and the *rotta*. The *rotta* was a quick after-dance that followed a slow and solemn initial dance. Repetition of sections is again noticeable in these compositions, a different ending being provided for the first and second statement of each section. Polyphonic dance music came into fashion in the late 14th century; it was usually performed by a trio of wind instruments such as two cornetti and a shawm, the music being for the most part memorized or extemporized. It was some time before attempts were made to write down dance music in accurate fashion, but the 15th century is rich in manuscripts containing the themes of various *basse-danses*, which were played in measured rhythm by the instrument lowest in pitch, while the other two descanted above. Occasionally the three parts are written out in full, as in the *Alta* of the Barbieri Cancionero and the three *basse-danses* (one by an Englishman called Tyling) in the Trent codices. About 1500 a book on dancing by Toulouze printed several *basse-danse* melodies for the first time.

Renaissance Forms.—Dance music flourished with especial vigour during the Renaissance, owing to the growing popularity of the lute (and, later on, of keyboard instruments) as well as the continued development of the small groups, now extended to include both bowed and plucked stringed instruments. Although much new dance music was specially composed, it was common to take songs and other compositions, arrange them slightly by the addition of ornaments and then perform them as dance pieces. Thus a French chanson for three voices, *Entre Peronne et St. Quentin*, appears in the Glogau Liederbuch as a four-part instrumental composition entitled *Der Pawir Schwantz* ("Peasant's Dance"). In the field of dance music proper, the popular paired dances such as *pavane-gaillarde*, *passamezzo-saltarello* and *hoftanz-hupfauf* hold the attention of composers until nearly the end of the 16th century, but alongside these pairs there begins to come into being an extension of the basic idea, with a third dance added to form a choreographic triptych. In France the *basse-danse-recoupe-tourdion* and in Italy the *pavana-saltarello-piva* gradually assisted the dance to gain a stylized detachment, from which eminence it soon gave rise to the suite (*q.v.*), which was to enjoy such a lengthy vogue in instrumental composition during the baroque era.

Understandably, dance compositions for lute or virginals could hardly be used for large groups of dancers, and louder ensembles sometimes up to 10 or 12 in number supplied the necessary background for court balls. This type of dance music was usually in four-part harmony, though five-part settings are not uncommon, as may be seen from the publications of Claude Gervaise and Étienne du Tertre in the mid-16th century. Dance forms became a favourite medium of expression for the English composers for consorts of viols, and though the pavane-galliard pair was by far the most popular, as indeed it was in the contemporary school of virginalists, there are numerous examples of the *alman*, *coranto* and *jig*. The slow, stately *sarabande*, mentioned for the first time in printed literature by a Dominican priest resident in Mexico in 1579, gained favour among keyboard players in particular, and it was not long before prototypes of the suite were found. By the middle of the 17th century the four dances, usually known in their French spellings of *allemande*, *courante*, *sarabande* and *gigue*, had crystallized into the suite, which was modified and extended throughout the continent without, however, getting rid of the prevailing influence of dance rhythms and tempi.

French and Italian Forms.—Newcomers to the ever-growing repertory of dances were the local peasant dances from various parts of France, refined and raised to a degree of courtly beauty by the composers who served under Louis XIII and Louis XIV. From the Auvergne came the sprightly *bourée*, from the Dauphiné the *gavotte* (often followed by a *musette* before the gavotte was repeated) and from Brittany the lively *passepied*. The *rigaudon* probably originated in Provence and the *minuet* in Poitou, while Normandy provided the *loure*, a dance in moderate tempo associated (like the *musette*) with the bagpipe family of instruments. All these dances were used by 18th-century French composers of suites, sonatas and *ordres*, and all were subjected to special refinements of rhythm and tempo that sometimes changed the character of the dance from its original form. It is doubtful whether a Parisian connoisseur of the music of Rameau and Couperin would recognize a dance type immediately if he were to witness a performance in a country village, though in some cases there was an obvious similarity.

Italian composers of the 18th century, whose instrumental music was imitated all over Europe, made extensive use of dances in their *sonate da camera* as well as publishing countless anthologies of dance music without any pretense to greatness. This was utilitarian music for the study or the small ballroom, yet some of the best composers of the age contributed music in this vein. Often there was no attempt to group the pieces into suites or sonatas, and dances of each genre were grouped together under such names as *balletto*, *giga*, *sarabanda*, *corrente* and *allemana*. In the sonatas, thematic links between one dance and another were not unusual, for this treatment had a venerable ancestry going back to the days when composers first discovered that it was possible to produce a group of dances of the utmost variety even though only one melodic idea prevailed.

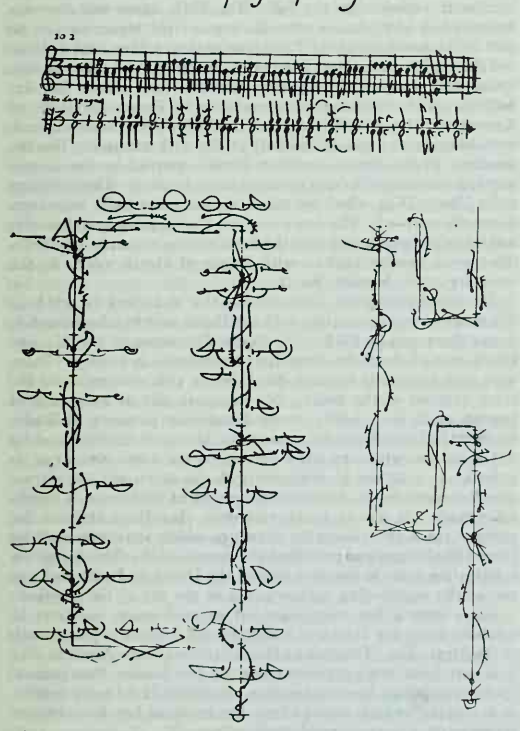
Later Forms.—The minuet was to the 18th century what the waltz was to the 19th, though the former penetrated the symphonic barrier in a way that no other dance ever has done. Haydn and Mozart wrote dozens of minuets for ballroom use and did not disdain even the humbler *contredanse* (a name very probably derived from the English country dance) and the graceful *ländler*. In sonata, symphony and string quartet the minuet traditionally oc-

cupied third place as a light interlude between slow movement and finale, but in the hands of Beethoven the dance-like character disappeared, giving way to the more rampageous scherzo, whose only link with the dance was its trio section. The waltz has made only very occasional contact with the symphonic repertory, though it frequently appears in operatic scores. Dances such as the Polish *mazurka* and Bohemian *polka* are found first and foremost in their national art-music, while the names of the *polonaise, écossaise* and *malagueña* refer unmistakably to their country of origin. Spanish dances in particular have attracted the attention of non-Spanish composers, mainly in France and Russia, so that the *habanera, jota* and *fandango* have become almost internationally known through orchestral settings. Modern dance forms have made only a very slight impression on the orchestral and chamber music repertory, though there are a few examples of dance suites in a national idiom comparable to the Hungarian and Slavonic dances of the 19th century. In works for the concert hall, composers of the early 1960s seemed to prefer to elaborate upon dances of earlier periods by decking them out with newly devised musical trappings.

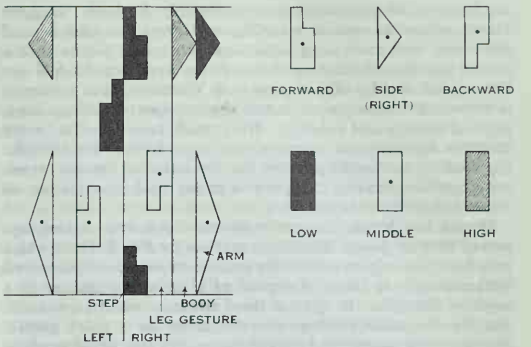
See also separate articles on the dance forms, such as ALLEMANDE; BOUREE; COURANTE; JIG, etc. (D. W. ST.)

DANCE NOTATION is the recording of dance movement on paper through the use of symbols. Man's effort to make a written record of body movement is not a recent development. It is believed that the ancient Egyptians used hieroglyphs to represent dance movements and that the Romans employed a method of notation for gestures of formal greeting. However, the earliest known manuscript setting forth a dance notation method dates from the late 15th century.

The history of dance notation follows closely the development



RAOUL FEUILLET'S SYSTEM OF DANCE NOTATION USED DURING THE 18TH CENTURY



LABANOTATION, THE MOST DIVERSIFIED AND UNIVERSALLY USED SYSTEM

Labanotation is read from the bottom up. The location of a symbol on the staff shows the part of the body to be used. The shape of a symbol indicates direction, its shading shows level and its length controls the time value of the dance movement

of dance. As dance became more complex, the first primitive notation devices gradually gave way to progressively more advanced methods until, in the 20th century, dance notation became, in some instances, thoroughly scientific. Many of the older devices continued to appear in modern times, however, particularly in the form of shorthand used for established movement patterns such as in ballet. Systems of movement notation fall into six categories: word abbreviations, track drawings, stick figures, music notes, mathematical forms and abstract symbols.

In the early Renaissance in France, the *basse* "low" dances were recorded through word abbreviations (*R* for *révérence, B* for *branle,* etc.) because the steps were simple and well known. The first books employing word abbreviations include *L'Art et instruction de bien danser* (1488) and Thoinot Arbeau's *Orchésographie* (1588). As the patterns of the dancer's path across the floor became more intricate, systems based on track drawings appeared. Indication of the actual steps used on these tracks reached its highest development in Raoul Feuillet's *Chorégraphie ou l'art de décrire la danse* (1700). Through this system, which was widely used in Europe, a record of the dances of that period exists, although many details of performance were not recorded.

During the reign of Louis XIV, professional ballet first became distinguished from social dance, and thereafter notators added to the Feuillet script in order to record the more complex use of the arms and body. This soon proved too cumbersome, and a new approach was tried in showing the various positions by tiny stick figures, usually placed under the music notation to indicate the timing. The first system of this kind, *La Sténochorégraphie,* was introduced in France in 1852 by Arthur Saint-Léon. Later a very similar device appeared in the *Grammatik der Tanzkunst* by Albert Zorn, the German balletmaster in Odessa. These systems received widespread acceptance and were subsequently modified and improved by others.

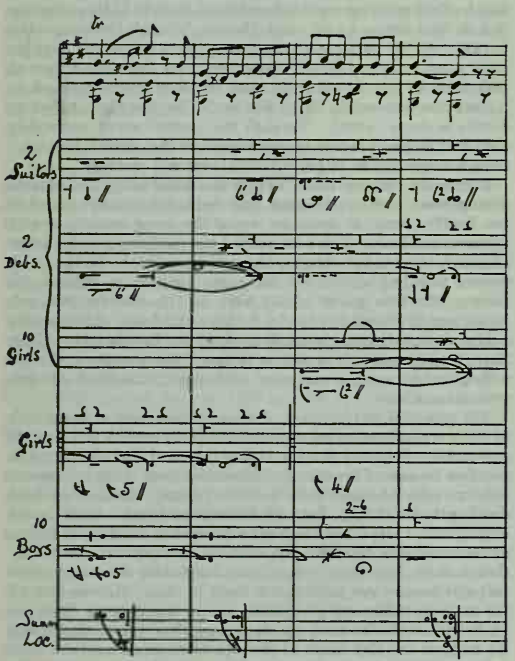
The principal disadvantage of a stick-figure system is the lack of accurate indication of continuity or relationship and flow of movement. Believing that the answer to this problem lay in music notation because of the common element of time, many subsequent notators adapted music notes to record dance. In his *Handbuch der Tanzkunst* (1855), Bernard Klemm used music notes in the description of steps, but the first to produce a full-fledged system of this kind was Vladimir Stepanoff of the Imperial Maryinsky theatre in St. Petersburg, whose book *L'Alphabet des mouvements du corps humain* was published in Paris in 1891. He aimed to fill the needs of ballet, and though the system was dropped from the St. Petersburg Ballet academy curriculum after a few years, it was the method in which much of the repertoire was recorded.

During the early part of the 20th century, dance developed far greater range of movement and also made use of the floor, as in falls. To record this variety, a system of notation fundamentally

applicable to all movement was needed. In England, Margaret Morris, whose interest in recording movement extended beyond dance into such fields as physical therapy, brought out in 1928 a system based on abstract symbols. In the same year Rudolf von Laban published his *Kinetographie* in Vienna. Laban's interest in movement encompassed dance, theatre, sports, anthropology, physical therapy and industry. His system, known in the United States as Labanotation, employs abstract symbols. Its scientific approach to movement provides for indication of quality, stress and expression, making it applicable to any field in which human movement needs to be recorded.

During the decade between 1946 and 1956, two systems appeared (one by Joseph Schillinger and one by Noa Eshkol) which were based entirely on a scientific analysis of movement, described mathematically in terms of degrees of a circle in a positive or a negative direction. In spite of these advances, notation was still used by comparatively few, and the desire for a quick general description of movement resulted in new systems based predominantly on pictorial stick-figure drawings. Outstanding among these was the system of Joan and Rudolf Benesh brought out in 1955 while Joan Benesh was a member of the Sadler's Wells Ballet in London and used by that company in shorthand form to record its ballets.

The extent to which a system of movement notation can be developed and the range of uses to which it can be put are best seen in the Laban system, which attracted people from many different fields who had a common interest in recording movement. Through diversified applications, the system became highly developed, its universality assured and its practicability tested. Because it stated the basic elements of movement used and indicated the dynamics, timing and sequence, it could record all forms of movement. All styles of dance techniques, ballet, modern, Spanish, Hindu, etc., have been recorded, as well as sports, diving, skating and other activities such as physical therapy and industrial observation of movement. Major works so recorded range from the classic ballets to Kurt Jooss's *The Green Table*, George Balanchine's *Agon*, Doris Humphrey's *The Shakers* and Broadway musicals such as *Kiss Me, Kate* and *My Fair Lady*. Its widespread use resulted in the establishment of several dance notation centres, notably in the United States, England and Germany.



BY COURTESY OF JOHN CRANKO

EXTRACT FROM "LADY AND THE FOOL" ILLUSTRATING THE BENESH SYSTEM OF NOTATION INTRODUCED IN 1955

In New York the Dance Notation Bureau, Inc., founded in 1940 for the advancement of the art of dance through the use of notation, adopted the Laban system as the best, after studying all other available methods. The work of this group produced an advancement in the knowledge and use of dance notation, and Labanotation became established as an aid in teaching dance and in the study and reconstruction of dance works, as well as a means of recording works for copyright registration. (AN. H.)

DANCE OF DEATH, a medieval concept, expressive of the all-conquering power of death, to which the arts of painting, sculpture and music all made their contribution. In painting and sculpture this phrase, often used loosely in the sense of *memento mori* ("effigy of death"), should be restricted to representations of a procession of the living and the dead.

The Dance of Death probably originated in a mimed dance or a morality play. Such a drama existed in France in the late 14th century and probably earlier. The oldest-known musical example is the dance song "Ad mortem festinamus," found in a 14th-century Spanish manuscript preserved at the monastery of Montserrat. The oldest pictorial example was that in the cemetery of Les Innocents in Paris (1424–25), in which the whole hierarchy of church and state, from the pope and the emperor down to the child, the clerk and the hermit, formed a stately dance, the living characters alternating with skeletons or corpses and the dead escorting the living to the grave.

The work was a stern reminder of the inevitability of death and a summons to repentance and amendment of life. The theme of the ultimate equality of all had great satirical potentialities that later were exploited to the full. The Paris *danse macabre* was destroyed in 1669, but a reproduction or free rendering can be seen in the woodcuts of the Paris printer Guyot Marchant (1485), and the explanatory verses have been preserved. All other picture cycles were derived directly or indirectly from that of Les Innocents. The oldest surviving examples in France are those of Kermaria-an-Isquit in Brittany and La Chaise-Dieu (Haute-Loire), both belonging to the second half of the 15th century. The dependence of the Breton series on Paris is proved by the accompanying verses, apart from pictorial resemblances. The paintings at La Chaise-Dieu, which are more original and artistic, have been discreetly restored. The *danse macabre* lost its grotesque character and its awe-inspiring power at the Renaissance, as can be seen from the carved wooden capitals with Dance of Death motifs in the cemetery of St. Maclou, Rouen.

The oldest example in Germany was that at Lübeck (*c.* 1463), a fine series of mural paintings with the Hansa port as a background; it was destroyed in 1942. The Berlin *Totentanz*, in the Marienkirche, was of about the same date, but inferior in quality. There were also numerous German block books and woodcuts and literary versions of the dance. No European picture cycle was so famous as that (*c.* 1480) in the Dominican cemetery at Basel, fragments of which can be seen in the historical museum and by which the overwhelming effect created by the whole series can be judged. It must not be confused with the older and less attractive *Totentanz* in the Augustinian convent of Kleinbasel, a northern suburb. It was in Basel, moreover, that Hans Holbein the younger made the celebrated drawings which were engraved by Hans Lützelburger and published at Lyons in 1538. This forms the culminating point in the evolution of the Dance of Death and was one of the outstanding achievements in the art of the woodcut.

Apart from a few interesting but isolated mural paintings in northern Italy, the Dance of Death did not become popular south of the Alps. The "Triumph of Death" in the Campo Santo at Pisa is an art form truly representative of the Italian Renaissance. Spain contributed one masterpiece, the poem "La Danza general de la muerte," which, derived from the verses at Les Innocents, is nevertheless a very original performance.

The Paris Dance of Death was also the inspiration of a cycle of

pictures in Pardon churchyard, near Old St. Paul's, London. The poet John Lydgate translated the French verses into English and they were inscribed below the pictures. Of the other English examples only mutilated fragments remain: four painted groups at Hexham, Northumberland; one at Newark, Nottinghamshire; three scenes on a carved misericord at St. George's chapel, Windsor; and a stained glass window with one group at St. Andrew's church, Norwich. Scotland has a curious set of eight sculptured figures (*c.* 1450) on the vaulting ribs of the choir of Rosslyn chapel, near Edinburgh. (J. M. CL.)

In music, the Dance of Death frequently has been depicted in compositions associated with death. The theme usually has been stated by quoting the opening notes of the *Dies Irae* (*q.v.*). Compositions portraying the death dance include Saint-Saens' symphonic poem *Danse Macabre*, Liszt's *Totentanz* for piano and orchestra, Mussorgsky's *Songs and Dances of Death* and the "Dance of Death" scherzo movement of Glazunov's *The Middle Ages* suite. (X.)

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DANCE TEACHING. In many countries, particularly the United States, Great Britain, the Commonwealth of Nations and Europe, instruction given by well-qualified teachers is readily available in almost every kind of dancing, from social dance to classical ballet, folk dance to acrobatic. Instruction in all forms is mostly obtained from privately operated schools, but a number of general educational establishments on all levels also feature various kinds of dance education either in their normal curriculum or as an extramural subject.

UNITED STATES

Social Dancing.—During America's colonial period, the dancing master taught his charges not only the steps of the popular social dances of the times but also the social graces. To the colonists and, later, to the citizens of the young republic, such instruction was deemed to be of great value in convincing Europeans that Americans were not untutored and uncouth barbarians. The churches, especially during the colonial days and even into the 19th century, occasionally frowned on social dancing (dancing masters were sometimes driven out of town) but social and business leaders, educators and politicians were generally convinced of the importance of dance training for girls and for boys and young men with ambition to advance.

In the 20th century, the social graces are infrequently taught along with the actual dances themselves. In girls' finishing schools and even in certain military academies, etiquette and dance figurations are taught and, of course, even the professional dance studios instruct the student in the proper way to ask someone to dance or to accept the invitation, how to hold a partner and other aspects of ballroom behaviour but, in the main, the professional ballroom dance studios are primarily concerned with teaching individuals how to dance or introducing them to new steps.

In the thousands upon thousands of independent, privately run dance schools that specialize in social dance instruction, millions of pupils learn the patterns of the enduring waltz, the basic fox trot (which came into popularity early in the 20th century), the tango (also a continuously popular Latin form) and those several Latin-American dances, such as the rumba, samba, conga and mambo, which characterized the social dance of the early 1960s.

Pupils, ranging in age from little children to elderly individuals, may take one lesson in a special dance they wish to learn or take a series of lessons or continue studies over the years. Ballroom dance schools range in size from a single studio, with a single teacher and a handful of pupils, to such vast enterprises as the Arthur Murray or Fred Astaire schools with branches throughout the land and even overseas and employing large staffs of instructors.

The calibre of instruction also varies. An ill-equipped or overworked or improperly trained teacher may simply teach steps, often inaccurately. The well-schooled teachers instruct the pupils not only in foot patterns but also in balances, body placements, rhythmic responses, posture, improvisational possibilities and the like. Indeed, the topflight social dance teacher, while not necessarily contending that ballroom dancing is an art form, nevertheless is concerned with communicating to the pupils the joy of movement and presenting the movement disciplines that govern social dancing as methods whereby that joy may be shared with others on the ballroom floor.

Ballet.—The teaching of ballet dancing is a far more complex process than the teaching of social dance, for this form of theatrical dance demands great physical virtuosity. Further, the really skilled teacher of professional and potentially professional dancers must be able to endow them with personal ideas on the interpretation, with adequate and proper feeling, of the many different figures that form the vocabulary of classical ballet.

Since colonial times, ballet has been taught in America, first by visiting ballet artists and ballet masters from France, England or Italy and later by Americans and experts of other nationalities. In the 20th century, the main influence has stemmed from Russia and many of the foremost teachers in the United States during the century have been retired Russian ballerinas (or soloists), leading male dancers, choreographers, *régisseurs* and the like. Their technical and artistic approaches are generally those of the elegant and refined Leningrad school rather than the more spectacular, physically driving and less polished methods associated with the Moscow ballet centres.

Teaching styles vary, of course, with individuals, and such systems as the Cecchetti method (based upon the teaching of the Russian-Italian ballet master long associated with the Diaghilev company) are taught by many instructors. The physical structure of the American and his temperament and his background have also affected the teaching of teachers coming from abroad and have caused them to adapt their styles, if not their fundamental techniques, to the needs of their new charges.

The usual ballet class runs from one hour to one hour and a half and is divided into three sections. It commences with exercise at the *barre*, a rod placed horizontally at varying heights from the floor (depending on the age of the pupil) upon which the dance student may rest his hand and assure balance while he performs exercises in the traditional five positions of the feet, including knee-bends, stretches, extensions, beats, kicks and the like. Following *barre*, the students move to "centre," away from the support of the *barre*, where the problems of balance are mastered as the students work with movements that are more elaborate extensions of exercises learned at *barre*. Some actions are of the sustained or "adagio" type motion while others are "allegro" leaps, jumps, turns and running steps. Combinations or series of movements are next given and the class customarily terminates with the teachers giving special instruction to the girls in "*pointe*" work (they do not wear toe slippers throughout the class) and to the boys in multiple air turns, leg beats and other movements mainly associated with the male dancer.

The majority of expert teachers believe that students should start ballet instruction at the age of eight, although simplified dance movements may be given at an earlier age, and that girls should not wear toe slippers until the age of eleven (variable, depending on the strength and development of the child) and then not until after a minimum of two years' ballet training in soft slippers. Because of ballet's complex technique and the great physical demands it places on the human body, it is essential that the instructor be thoroughly trained himself in the technique of ballet and equally aware of the potentialities and limitations of the body. Because few states have licensing laws, anyone can teach ballet whether he knows anything about ballet or not. Thus, it must be confessed, there are in the United States many teachers of dance ill-equipped to teach ballet. They can and do harm the child student, not only artistically but also physically, through ignorance. Incorrect placement of the body, carelessness in the turnout of the limbs and, especially, too early, too much and improper use of toe slippers can cause harm.

Because of the absence of state licensing or inspection during the major part of the 20th century (and most teachers have objected to politically controlled licensing), organizations of teachers

and dancers were established for the express purpose of attempting to elevate the standards of dance instruction, especially in ballet. Controls, even voluntary, have been difficult to achieve because of the tremendous interest in ballet that developed during and after the 1930s, particularly after television began to feature ballet artists and, most important, ballet "spectaculars" on its programs, for student demand tended to outstrip the availability of trained teachers.

Schools of More Than One Type of Dancing.—Not all of the professional dance studios of the land have been exclusively devoted to ballet instruction. In many communities, including large cities as well as small towns, schools that offer classes in ballet, tap, acrobatics, ballroom and other techniques are common. Indeed, the sign "toe-tap-acrobatic" has been a familiar sign of a dance curriculum over the door of many a studio. The combination of courses has not necessarily meant low standards (although low standards have prevailed in certain of these schools), for some of the large establishments have hired experts in various dance fields to teach, under a single management, ballet, modern dance, tap, jazz dance (in the second half of the 20th century almost a necessity for dancers hoping to work in musical comedy and television), corrective movement and, perhaps, certain ethnic forms, such as Spanish or oriental dance.

Modern Dance.—In modern dance, training methods have been based mainly upon the techniques developed by Martha Graham, Doris Humphrey, Charles Weidman, Hanya Holm (derived from the style evolved in Germany by Mary Wigman), Helen Tamiris and other dance innovators and independents. While ballet training is based upon the teaching of traditional steps and movements of what is generally called the *danse d'ecole* and of character and folk dance steps incorporated into ballet, modern dance training is designed to foster personal creativity. Naturally, basic disciplines have been evolved and these form the exercise base of classroom work. However, improvisation, dance composition and choreography are also fostered, subjects almost entirely (although there are exceptions) removed from the ballet curriculum.

Other aspects of modern dance training that differ from ballet include the following: the use of the floor, rather than the *barre*, for preliminary exercises; instruction in dynamics; studies in the use of space patterns; in the Graham technique, the principle of contraction and release of the muscles; in the Humphrey technique, the principle of fall and recovery as the basic pattern of physically exciting and potentially dramatic action; in the Wigman technique, the principle of tension and relaxation and the degrees of energy that lie between the two extremes. Furthermore, students normally work barefooted, although soft slippers or half sandals (supporting the arches) may be used.

Schools devoted solely to modern dance instruction are to be found in New York and most other large cities, though outside New York modern dance may represent one aspect of a large dance curriculum. The vast majority of modern dance teachers include the following: the innovators themselves, their students, company members and newer modern dance performers or individuals trained in colleges and having collegiate dance majors, usually obtained in association with their over-all physical education studies. As in the case of ballet, there are poorly trained or unimaginative instructors.

Tap Dancing.—Tap dance, derived from both the Irish clog and the shuffle dances of the American Negro, has been popular in the U.S. theatre since the minstrel shows of the late 1800s, through vaudeville and into the period of musical comedies and revues. With the years, certain refinements were added and by the second half of the 20th century, many tap dancers incorporated both balletic and modern dance qualities into their basic tapping designs. Because of its lightness of spirit and basic simplicity (although elaborate tap techniques and artistries were evolved by professionals), tap became a popular course of instruction for children across the country. It has been deemed suitable for both boys and girls, it lent itself to community entertainments and it was long considered essential to a career in any phase of show business.

Jazz Dancing.—Jazz dancing emerged in the mid-1950s as one of the most sought after courses of instruction for young professionals wishing to centre their activities in show business as distinct from careers in the ballet or modern dance fields. In many schools, only experienced dancers with previous training in other techniques were eligible (although elementary classes were available), for the materials of the jazz dance form itself called for the precision of ballet, the muscular control and torso fluidity of modern (or primitive) dance and the speed of tap combined with special jazz rhythms and steps extracted from popular dance forms of the day. In terms of movement, jazz dancing's nearest link to a historical dance form would be with some form of primitive dance, generally African, Afro-American or Caribbean (which also possesses African as well as Latin roots).

Folk Dancing.—Folk dance instruction has almost always been combined with the actual folk dance session itself. In a sense, square dance callers are instructors since their calls guide the participants into various formations. Folk dance societies, including square dance groups, American country dance organizations and innumerable national dance associations (which carry on old-world dance traditions in America), customarily divide their sessions into periods of instruction, demonstration and participation. The work of callers is augmented by folk dance specialists who give students detailed instruction in steps, patterns, rhythms, styles and etiquette as they vary from region to region or nation to nation.

Ethnic Dance.—Ethnic (or ethnologic) dance, which is the art apex of folk dance, is a subject of comparatively limited interest. Ethnologists, students of anthropology and, of course, certain students planning to become professional dancers find this area of study stimulating, informative and enormously valuable in understanding and exploiting art differences. Instruction is frequently supplied by professional dancers who are natives of the lands where the dances originated or by Americans who have conducted lengthy studies of various ethnic forms, either with masters in the U.S. or through study and research overseas. Among the ethnic techniques of growing interest to Americans in the second half of the 20th century were the Spanish (an enduring favourite), Hindu (or East Indian), Indonesian, Japanese, Hawaiian and advanced forms of African and West Indian dance.

Public and Private Schools.—In addition to dance training in private dance schools, by societies or by itinerant instructors, the teaching of dance is to be found in both public and private educational institutions. By the early 1950s, the commissioners of education for every state in the union had recommended the inclusion of dance in the curriculums for both elementary and secondary schools. The recommendations were not universally implemented because local decisions are always the determining factor in elective classes. Nevertheless, game dances, certain forms of rhythmic gymnastics (often resembling modern dance), folk dances and some social dances have been introduced into many public schools. Instructors may be general subject teachers who have had some dance materials provided to them in their own normal school or college training. In larger schools, the instructors may be specialists in dancing.

On the college level, surveys have shown that in the 20th century, more and more institutions have offered courses in dance to students. Sometimes these classes are extracurricular; again they may be credit courses; often they are limited to elementary studies in modern dance techniques; with increasing frequency, however, courses have been extended to include scaled classes in modern dance, composition, dance history, music for dance, dance notation and related subjects. In some institutions, it is possible for the student to major in dance. After the 1920s, the prevalent technique was modern dance. Courses in tap, social dance and folk dance have also been included in the dance curricula of many colleges. By the 1950s, with the tremendous upswing in ballet interest, classes in ballet were made available to college students in a limited number of institutions. College dance instruction usually has been offered under the direction of departments of physical education, although independent dance departments exist and sometimes dance is supervised by music or fine arts departments.

College dance instructors generally have been college graduates

trained in the field of education and the students themselves have been given courses that would prepare them for teaching careers either in colleges or in public schools. Some, of course, have gone from college to professional dance studios to prepare themselves for theatrical careers. A unique school, combining the requirements of educational dance with professional theatrical dance training and experience, was established in New York city in the mid-20th century. Here, at the High School of Performing Arts (a metropolitan vocational high school), students in dance, drama and music are selected by audition and placed under the tutelage not of college-trained instructors but of professional performers and choreographers. The goal has been to make them performers, not teachers. The success of the dance wing of the school has been attested by the fact that a tremendous percentage of the graduates moved directly into ballet companies, modern dance troupes, Broadway shows, movies or television.

Dance instruction in the U.S. has also been employed for therapeutic purposes. Expert teachers, with the guidance of doctors, have used dance to correct body flaws, to aid patients to recover from injuries and to assist in the treatment of the mentally ill. Records of achievement in these areas have proved the success of dance as a method of therapy.

Although nothing can adequately replace the "live" teacher, aids in the teaching of dance include books on dance instruction and dance backgrounds, combinations of phonograph records and related manuals, motion pictures and dance notation.

GREAT BRITAIN, EUROPE AND OTHER COUNTRIES

Great Britain.—Dance teaching in Great Britain, as in the United States, includes instruction in ballet, social dancing, folk dancing, free-style dance (forms of modern and revived Greek classical) and popular theatrical techniques (tap, precision, acrobatics, etc.). Independent professional schools may range in size from modest classrooms to large institutions. Unlike the United States, the teaching of dance in higher institutions of learning (universities) is not generally treated as a subject for academic credit or major study. Dance, however, is taught (and increasingly) in many schools (primary, secondary, college) devoted to general education.

Ballet teachers, as in America, may employ any of a number of methods of instruction, for in the independent studios teachers may be of Russian, French, Italian (and other) origin and training. There are also many English teachers of ballet, and through them what has become instantly recognizable as the English ballet style was born. The most celebrated centre of ballet instruction in Great Britain is the Royal Ballet school, the training centre of the Royal ballet (formerly the Sadler's Wells ballet). There, under the direction of a large and distinguished faculty, children are trained and the exceptionally talented ones groomed to take their places in the Royal ballet itself. Students at the Royal Ballet school receive instruction in classical ballet technique, character dancing, mime, dance notation (the Benesh method is employed here) and many related subjects. Several other schools of several years' standing are fully accepted by the educational authorities as boarding establishments with vocational training. There are also countless establishments, specializing only in dance, where excellent teachers provide a grounding before the most promising of their students are taken over by the "professional" schools.

Presiding over the quality of dance teaching in Great Britain (and, indeed, over that in much of the commonwealth) are certain powerful teachers' organizations. These organizations, whose chief functions are the planning, administration and setting of examinations and the development of ever-higher standards of performance and knowledge, constantly prepare and bring up to date syllabuses for the instruction of dance of all kinds, including classical ballet, national, Greek, stage, historical and social. These same organizations provide scholarships ranging from the payment of fees and subsistence at the Royal Ballet school to small awards for dance lessons. They also run special courses of study, including annual congresses, which invariably are attended by members from many countries. Although unfortunately no statute has been passed to make some qualification a legal necessity for anyone who wishes to teach dancing, there are but very few teachers who have failed to take advantage of the wonderful facilities offered by these organizations.

A form of modern dance, deriving mainly from the principles and methods established by Rudolf Laban, has been introduced into many of the schools in Great Britain. Both boys and girls receive graded classes in technique and also are led to explore their creative gifts in improvisations and choreography. Folk dancing is also taught, sometimes with emphasis on folk dances common to Great Britain.

Teaching systems that endeavour to combine modern dance with folk dance materials are also to be found. The group of best known leaders included Margaret Morris, founder-director of the Celtic Ballet of Scotland, who evolved her own technique of modern dance, invented a method of notation and exploited, both for theatrical and teaching purposes, Scottish folk dance forms.

The teaching of social dancing flourishes in Great Britain. Every small town possesses a number of dance schools, many of them concentrating solely on the social forms. Every year tens of thousands of pupils take medal tests, organized and administered by the teachers' examining bodies, in bronze, silver and gold standards; a number also take higher awards, such as the gold and diamond star. In addition a few teachers specialize in coaching competitors, the standard of competitive dancing being very high indeed.

Folk dance societies in Great Britain and in other parts of the commonwealth not only foster the continued performing of national and historic dances but also provide instruction.

Of supplemental assistance to the teaching of dancing in all its forms and to the furthering of interest in dance are the books, periodicals, manuals and other printed matter published in Great Britain in quantity and admirable range of subject matter.

Other Countries.—In many other countries, the patterns (if not always the techniques) of dance teaching resemble those familiar to British and Americans. In those countries that support national theatres—Denmark, Sweden, France, the Soviet Union, etc.—the centre of ballet instruction customarily resides within the government-supported institution itself, although in Denmark or France, for example, independent ballet studios exist and function successfully. Some of the most celebrated ballet instructors in the world live and teach in Paris. Folk dance societies, organizations and state-directed schools (such as in the Soviet Union and Yugoslavia) work for the preservation, popularization and even theatrical exploitation of folk dance forms.

In the orient, very young children are often selected for a dance career (many come from dancing families generations old) in a court ballet, national company or independent institution of great age. Thus, the dancers of the Royal Cambodian or Siamese ballets, dancers-actors of Japan's Kabuki theatre or the temple dancers of Bali are invariably trained from childhood for a lifetime of dancing.

Everywhere, however, the popularity of ballroom dancing as produced in Latin America, the United States, Great Britain and in other western cultures has spread to the degree that even those with living folk dance programs and ceremonies study, learn and enjoy the alien steps. (W. Ty.)

DANCOURT, FLORENT CARTON (1661–1725), French actor and playwright, who created the comedy of manners in the French theatre, was born at Fontainebleau on Nov. 1, 1661. He wrote upward of 30 plays, of which more than 20 are in one act. He became expert in the exhibition of current social types, and his plays are a record of many forms of social change, in addition to being amusing and well written.

Dancourt was one of the most popular French dramatists before the Revolution, and the following works were played more than 300 times in Paris: *Le Chevalier à la mode* (1687); *Les Vendanges de Suresnes* (1695); *Les Vacances* (1696); *Le Mari retrouvé* (1698); *La Fête de village* and *Les Trois Cousines* (1698); and *Le Galant Jardinier* (1704). His plays were imitated by Vanbrugh. He died at Courcelles-le-Roi (Loiret), Dec. 7, 1725.

See H. Carrington Lancaster, *A History of French Dramatic Litera-*

ture in the Seventeenth Century, part iv (1940) and *Sunset: a History of Parisian Drama in the Last Years of Louis XIV* (1945).
(W. G. Me.)

DANDARAH (Dendera), a village of upper Egypt on the west bank of the Nile, 417 mi. from Cairo by river. The nearest railway station is Qina, on the opposite bank. The modern village has little of interest, but is built on the site of Ta-ynt-netert ("She of the goddess pillar") or Tentyra. It was the capital of the sixth upper Egyptian nome and was sacred to the cow-goddess Hathor (*q.v.*), a sky and fertility goddess. The temple is one of the best preserved in Egypt. The present building dates to the Ptolemaic period and was completed by Augustus, but rests on the site of a far earlier foundation. References to early structures include one built by Khufu (Cheops) of the 4th dynasty on the site of an even older building probably dating to predynastic times and containing rebuilding and alterations of all the periods between the Old Kingdom and the Ptolemaic.

The temple is of sandstone, built within a large enclosure wall of dried mud brick surrounding an area 900 by 1,000 ft. The temple is approximately 260 ft. long and has an impressive north façade consisting of six gigantic Hathor-headed sistrum columns 50 ft. high and an entablature with a winged disk as chief decoration. These columns have screen walls between them, and between the centre ones project the jambs of the great door which once closed the entrance. All the columns are defaced. The great hypostyle hall is supported by a further 18 Hathor columns, giving a forestlike appearance; the whole hall is elaborately decorated, producing a rich effect, although the details are often crowded and ill-arranged. Few traces remain of the paintings which once covered the interior. The ceiling was adorned with astronomical scenes and the walls with the details of a royal visit. This hall opens into a smaller one with six columns of granite and a series of offering rooms and magazines; here the roof is intact, light and air being admitted through eight openings, and the sculptures represent the foundation of the temple. The small hall opens into two vestibules, the hall of the altars, where sacrifices (mainly vegetable) were made, and the hall of the divine Ennead, where some of the mysteries were celebrated. Opening off was the darkened sanctuary, the dwelling place of the golden one, where the sacred boat was kept containing the most holy image of the goddess. The sanctuary doors were opened only at the main yearly festival. Eleven small sacred chambers opened off the corridor surrounding the shrine, such as the flame room, the birth room, and the throne of Ra; the purpose of many of these is lost, but the flame room is probably that referred to in the 25th chapter of the Book of the Dead.

The staircases of the temple are decorated with representations of the processions of Hathor. The roof is flat and on two levels, on the lower of which are several chapels dedicated to Osiris. In one of these was the celebrated Zodiac, now in the Bibliothèque Nationale in Paris; it has been replaced by a cast. The sacred lake was situated to the southwest of the temple and was still in use *c.* A.D. 1200. Among other structures within the enclosure were two "birth houses" with scenes representing the birth and childhood of Horus, the smaller begun by Nekhtnebf (Nectanebo) I and completed under the Ptolemies, and the larger wholly of Roman date. (M. V. S.-W.)

DANDELION (*Taraxacum officinale*) and related species, perennial herbs belonging to the family Compositae (*q.v.*). The plant has a wide range, being found in Europe and central Asia. Elsewhere it has become a cosmopolitan and pestiferous weed, especially in North America. The leaves form a spreading rosette on the very short stem; they are smooth, of a bright shining green, sessile and tapering downward. The name dandelion is derived from the French *dent-de-lion* (lion's tooth), an appellation given on account of the toothlike lobes of the leaves. The long taproot makes it somewhat difficult to eradicate. The flower stalks (scapes) are smooth, leafless, hollow and numerous. The flowers bloom nearly throughout the year. The flower heads are golden yellow, and reach one and one-half to two inches in width; the florets are all strap-shaped. The fruits are olive or dull yellow in colour, and are each surmounted by a long beak, on which rests a pappus of delicate white hairs, which occasions the ready dispersal of the fruit by the wind; each fruit contains one seed. The globes formed by the plumed fruits are nearly two inches in diameter. The involucre consists of an outer spreading (or reflexed) and an inner erect row of bracts. In all parts of the plant a milky juice is present. The root externally is brown and wrinkled, internally white, with a yellow centre and concentric paler rings. It is two inches to one foot long, and about one-fourth inch to one-half inch in diameter. The leaves are bitter, but are sometimes eaten as a salad or are cooked for potherbs; they serve as food for silkworms when mulberry leaves are not to be had.

The root is roasted as a substitute for coffee. Several species and varieties of the dandelion are recognized by botanists; they differ in the degree and mode of cutting of the leaf margin and the erect or spreading character of the outer series of bracts.

The red-seeded dandelion (*T. laevigatum*), a native of Europe, very similar to the common species but smaller, with red, shorter beaked fruits and more deeply and finely cut leaves, is somewhat naturalized in the United States and Canada.

Russian dandelion, Kok-saghyz (*T. kok-saghyz*), was found in 1931 around Tien Shan, Kazakstan, near the China border. It is a perennial with roots about one-half inch in diameter. After 1931 it became a commercial source of rubber in the U.S.S.R. It was introduced into the U.S. in 1942 and experimental plantings were made in several states to determine its possibility as a source of rubber. The results were inconclusive.

The eradication of dandelions is easy if few plants are involved. Digging the roots is the most effective. If infestation is severe a spray of 2,4-D applied in warm sunlight is fatal, but it must cover the foliage.

See also Weed. (W. C. M.; N. Tr.)

DANDOLO, an ancient family distinguished in the history of Venice (*q.v.*). Though not listed among the *anteriores* and *nobiliores* who ruled Venice in the 7th–9th centuries, it rose quickly to prominence when expansion from the lagoons to the mainland began. By the 11th century it was rich, and by the 12th (when the branches of San Luca, San Severo and San Moisè can already be distinguished) it was competing for the highest posts in church and state. In the middle decades of the 12th century, when Enrico di Domenico Dandolo, as patriarch of Grado from 1146 to 1154, strove to defend his prerogatives against Pietro Polani (doge from 1130 to 1148) and the Michiel family, the whole Dandolo family was exiled until, after about ten years, peace was made on the basis of political concessions and matrimonial alliances.

As the power of the Michiel family declined, trouble arose between the restless Dandolo family and the Ziany family headed by the doge Sebastiano, who wanted to impose a policy of peace and internal reform instead of his predecessors' war program. In 1192 the septuagenarian Enrico Dandolo (d. 1205), of the branch of San Luca, himself became doge. His rule saw a rapid development of Venetian institutions and the setting of the customary law on a firm juridical basis, but he was chiefly important for his preponderant role in promoting the 4th crusade, which led to the overthrow of the Greek Byzantine empire and the establishment of the Latin empire in its place (*see* Byzantine Empire; Crusades; Greece: *History*). Refusing the imperial title, Dandolo claimed for Venice dominion over the maritime territories of the empire and styled himself "lord of the fourth part and a half of the empire of Romania." He also reserved a wide field of activity in the east for his own family: Marco Dandolo became lord of Andros; and Giovanni founded a powerful company that long exploited the colony of Tyre. The Dandolo policy, however, proved an embarrassment to Venice when the colonists tended to secede. In reaction against it, the Ziani and Tiepolo families came to power in Venice for much of the 13th century, so that the Dandolo family had to confine its energies to Crete, to the Negropont (Euboea), to the Aegean islands and to Dalmatia.

Reaction in turn against the Tiepolo family brought Giovanni Dandolo (d. 1289), of the San Severo branch, to the dogeship in 1280, in a period of internal crisis in Venice. At the same time the conflict between Venice and Genoa was on the point of developing

into a general Mediterranean crisis. When this came to a head, involving not only the Italian *signorie* but also Hungary, the king of Bohemia, the patriarchate of Aquileia and the kingdoms of Aragon and Naples, two more Dandolo doges had to bear the brunt of it: Francesco from 1329 to 1339 and Andrea from 1343 to 1354. During 20 years of vicissitudes the Venetians required Treviso in their hinterland but faced rebellion, fomented by Genoa and Hungary, in Istria and Dalmatia. Seeking allies near and far, the Dandolo doges resolutely refused compromise and also surmounted the further disasters of earthquake, plague (1348) and financial crisis; but the Venetian victory over the Genoese at Alghero in Sardinia (Aug. 1353) was finally offset by the crushing defeat at Portolongo in the island of Sapienza (Nov. 1354), two months after Andrea's death. The legacy of Dandolo rule was thus an unhappy one for Venice. Andrea in particular, who became doge in his youth, incurred much adverse criticism despite the fact that the conduct of affairs was not in his hands alone but under the concurrent control of the Venetian organs of state.

Whatever his rank as a statesman, Andrea was neither a good jurist nor a great writer. There is little originality in the book that he added to the statutes or in his *Summula* (a collection of administrative regulations); and his two chronicles of Venetian history merely work through earlier sources uncritically, sometimes even distorting the meaning by personal insertions. The collection of documents (*Liber albus, Liber blancus*), which he sponsored but did not himself know how to use, is of more value. Later historians up to the time of Marino Sanudo and G. I. Caroldo drew upon the chronicles, but they were excluded from the series of official history and were resurrected only by L. A. Muratori in vol. xii of his *Rerum italicarum scriptores* (1728). The best text of Andrea's works is that in the new edition of the *Rerum italicarum scriptores,* vol. xii, part i, with introduction and notes by E. Pastorello (1938–42). After Andrea no Dandolo was ever doge again, but members of the family still held high offices in the Venetian service till the fall of the republic. (R. Ce.)

DANEGELD, a word describing the taxes levied in Anglo-Saxon England to buy off Danish invaders in the reign of Aethelred II (978–1016), and also the recurrent gelds or taxes collected by the Anglo-Norman kings. The word is not recorded before the Norman Conquest, the usual earlier term being *gafol* (gavel), "tribute." Though the Danes were sometimes bought off in the 9th century, the word danegeld is usually applied to the payments which began in 991. They continued at intervals until 1016. Danegeld is distinct from heregeld, an annual tax levied after 1012, first to pay the Danish crews which had entered Aethelred's service and later to maintain a standing force; this was abolished by Edward the Confessor in 1051. William I is known to have imposed four gelds. Danegeld was last imposed in 1162. The commonest rate was 2*s.* per hide (*q.v.*), though 4*s.* and 6*s.* occur in some years. One purpose served by Domesday Book was to show the liability of estates to the geld. (D. Wk.)

DANELAW, the Anglo-Saxon name of the northern, central and eastern parts of England colonized by Danish armies during the Scandinavian invasions of King Alfred's time (late 9th century). In the 11th and 12th centuries, England south of the river Tees was divided into three great regions within each of which a distinctive form of customary law prevailed in the local courts of justice. England south of the Thames, from Kent to Devon inclusive, was the sphere of West Saxon law. Mercian law was in operation in Cheshire, Staffordshire, Warwickshire, Oxfordshire and the country between these shires and the Welsh border. The term *Dena lagu,* generally anglicized as Danelaw, was applied to the rest of England from Yorkshire to Essex. The term meant that the law administered in this region was marked by distinctive features felt to be of Danish origin, and the detailed analysis to which it has been subjected by modern scholars has shown that this derivation was correct. The usage does not imply that the whole of this wide country was ever settled intensively by Danish colonists. A Danish aristocracy dominant for a sufficient period in a shire would naturally impress its own ideas on the practice of the local courts, however small the number of its followers might be. But the currency of the term in official circles far into the 12th century illustrates the strength of the Danish influence to which this region had once been subjected.

The conditions under which the term arose were created by the 9th-century Danish settlements in northern, midland and eastern England. A Danish army which had been ranging widely over England divided Yorkshire among its members in 876. Another army divided the eastern half of the Mercian kingdom in 877 and in 880 a third army divided East Anglia. The Danes settled most thickly in Yorkshire and in the country around the Five Boroughs of Lincoln, Nottingham, Derby, Leicester and Stamford. To the south of the river Welland the signs of Danish settlement thin out rapidly, and in East Anglia they are much more evident in Norfolk than in Suffolk. But elsewhere a large number of Danish place names, a strong Danish colouring in dialect and agricultural vocabulary, local divisions of Danish origin such as the three "ridings" of Yorkshire and Lindsey and the survival of many Danish personal names among a medieval peasantry distinguished by a strong tradition of independence prove that a new element had been introduced into the English racial complex.

The annexation of East Anglia and the Danish midlands by the West Saxon monarchy was carried out by King Edward the Elder (899–924). Aethelstan, his successor, was recognized as king beyond the Humber in 926. The situation in Northumbria had recently been complicated by an invasion of Norwegian Vikings from Ireland. Until the mid-10th century English rule in the north was continually threatened from this quarter, and from time to time individual Norse leaders were able to seat themselves precariously as kings in York. But none of these adventurers was supported by the Danish settlers of Northumbria, and on the fall of the Norwegian king Eric Bloodaxe in 954 they came permanently and, it appears, willingly under West Saxon lordship.

The West Saxon kings had no desire to carry out any general assimilation of Danish to English laws and customs. The extent of their kingdom had been vastly increased in the last two generations, and they were anxious to limit rather than increase their responsibilities in government. King Edgar (959–975), the strongest of them, expressly granted autonomy to the men of Danish England in return for the fidelity which they had always shown him.

See F. Liebermann, *Die Gesetze der Angelsachsen* (1903–16), under *Denalagu;* F. M. Stenton, *The Danes in England* (1927), *Anglo-Saxon England,* 2nd ed. (1947). (F. M. S.)

DANGERFIELD, THOMAS (*c.* 1650–1685), English informer, was one of many rogues who exploited the panic of the "popish" plot. Born at Waltham, Essex, the son of a farmer, he began his career by robbing his father and, after a wandering life on the continent, took to coining false money, for which offense and others he was many times imprisoned. He was employed in 1679 to assist Roman Catholic suspects by blackening the characters of their accusers. He eventually betrayed his employers, Mrs. Elizabeth Cellier and the countess of Powis, and then claimed that Catholic peers had paid him to assassinate the earl of Shaftesbury and discredit the duke of Monmouth. Although incriminating papers were found at Mrs. Cellier's house in the meal tub where he had planted them, his evidence was so suspect that both she and Lady Powis were acquitted. When examined at the bar of the house of commons Dangerfield made other charges against the duke of York and the earl of Peterborough, but he and Titus Oates failed in an attempt to indict the earl of Castlemaine of treason. He continued to defame the Roman Catholics in a long series of pamphlets, among them *Dangerfield's Narrative* (1679), which led to his trial for libel. On June 29, 1685, he received sentence to stand in the pillory on two consecutive days, be whipped from Aldgate to Newgate and two days later from Newgate to Tyburn. On his way back from Tyburn he was struck in the eye with a cane by a barrister, Robert Frances, and died shortly afterward from the blow. The barrister was tried on July 16, and executed for the murder. (H. G. Ro.)

DANGEROUS OCCUPATIONS are those that present hazards to the health or life of workers. The dangers arising from likelihood of accidents are discussed chiefly in the article Industrial Medicine. This article deals primarily with illnesses

induced in workers by contact with chemicals, dusts and certain physical agents.

There are potential hazards in nearly every enterprise man undertakes. The housewife may suffer skin irritation from detergents or harsh soaps. The college professor doing research work may suffer a fatal anemia from inhalation of certain toxic chemicals. Industries, using a wide variety of toxic chemicals and harmful dusts, have through the years both caused and subsequently prevented a number of man-made diseases. The term "mad as a hatter" reflects general knowledge of a dangerous trade, for this expression arises from Lewis Carroll's knowledge that workers in the felt hat industry absorbed enough mercury to cause great nervousness and marked trembling.

The distribution of occupational hazards in the world varies greatly. Heavily industrialized countries with densely populated urban communities present one extreme, and small agricultural nations the other.

Knowledge of the effects of dangerous occupations is very old. In Roman times, slaves and political prisoners were used to work in deep underground mines with the certain knowledge that the fumes in the mines were lethal. The Italian physician, Bernardino Ramazzini (*q.v.;* 1633–1714), referred to as the father of industrial medicine, wrote, "Medicine should make a contribution to the well-being of workers and see to it that . . . they exercise their callings without harm." (B. Ramazzini [1713], *Du Morbis Artificum Diatriba;* Geneva, trans. by W. C. Wright, 1940, The University of Chicago Press.)

In the 18th and 19th centuries, the English writers Blake, Lamb and Dickens protested the cruel abuse of little children used as chimney sweeps. The "climbing boys," as these poor children were called, developed malignant diseases of the skin as a result of contact with the chemicals in the chimneys. Alice Hamilton roused interest in occupational disease in the United States early in the 20th century by correlating illness with exposure to toxic materials in industry. On the apathy of physicians in the United States on the subject of dangerous occupations she wrote, "When I talked to my medical friends about the strange silence on the subject in American medical magazines and text books, I gained the impression that here was a subject tainted with socialism or with feminine sentimentality for the poor." (Alice Hamilton, *Exploring the Dangerous Trades,* Little, Brown & Co., 1943.)

There is inadequate knowledge and reporting of man-made disease throughout the world. In the United States each of the states has a different method of tabulating industrial hazards. Swedish, British and pre-World War II German figures on occupational illness are the best available because of well-established systems of government inspection of factories. It is estimated from British records that dangerous occupations cause only 10% of sickness. The National Insurance act in the United Kingdom reported 7,000,000 episodes of sickness in one year (1951), and in the same year there were 720,000 new awards for injuries by accident and only 50,000 for occupational diseases. The much smaller figure for occupational illness has several explanations. Occurrence of job-related illness is less spectacular than, for example, an explosion in a mine causing a number of deaths. It may take a number of years of observation and research to discover that some particular dust, chemical or kind of physical energy is harmful.

In addition, physicians may have difficulty in deciding that an illness is attributable to the job. Many industrial diseases mimic sickness from other causes, and little is known of the ill effects and signs of continued small exposures to toxic chemicals. Another difficulty arises from the fact that although job-related disease may be suspected, doctors often lack tests to identify such disease as specific. As a result, against every diagnosed case of occupational disease there may be many incipient or unrecognized cases from the same causes. Introduction of materials of unknown toxicity, and changes in industrial operations, may create unrecognized problems in preventing harmful effects until after workers have been affected.

With experience and knowledge, dangerous occupations may be made safe. The substitution of a harmless material for a toxic one is the ideal method. If this is not possible, enclosure of the dangerous operation or use of appropriate ventilating devices may ensure a safe working environment. The least desirable method of control, and one to be used only for short periods, is protection of the worker with mask, clothing or glasses. Safe practice through substitution is illustrated in the manufacture of matches. White phosphorus caused destruction of the jawbones, a condition called phossy jaw, in many exposed workers; harmless phosphorus sesquisulfide was substituted for white phosphorus.

Toxic Chemicals.—Certain lead compounds (the oxides, carbonates and tetraethyl lead especially) are directly harmful to the body, producing anemia through red blood cell destruction, and causing paralysis by damage to nerves supplying muscles. Workers engaged in lead smelting, paint manufacture, paint removal, lead soldering, storage battery manufacture, spray painting, ship dismantling and manufacture of antiknock gasoline are exposed to toxic lead compounds. In contrast to the illness produced in children who swallow lead-containing paint, lead poisoning in workers almost always is a result of inhalation of lead fumes. For most jobs proper ventilation can control dangerous amounts of lead in the worker's breathing zone. Because lead exposure may be difficult to control, however, workers are given routine medical examinations, including blood counts and determination of the quantity of lead in body fluids. Many plans of treatment for lead poisoning have been suggested, none completely successful. A drug which complexes the lead and forces it into a harmless compound while it is passing through the body is in use. (*See* also LEAD POISONING.) This discussion of lead toxicity illustrates the knowledge accumulated by experience. Similar knowledge is available for operations using arsenic, mercury, antimony, phosphorus and chromium.

Examples of more recently discovered materials of importance in causing illness are certain beryllium (*q.v.*) compounds. During 1933 to 1942 Russian, Italian and German authors wrote of respiratory disease apparently following beryllium exposure during manufacture of beryllium alloys. U.S. experience accumulated after 1938, when beryllium began to be used in manufacture of fluorescent lamps and neon signs. Because beryllium makes very light alloys which are heat and stress resistant, it is used in manufacture of many items, including airplane structure, fishing rods, furnace bricks and laboratory crucibles. Inhalation of large quantities of toxic beryllium compounds results in acute disease which mimics a pneumonia. After inhalation of smaller amounts, a chronic disease occurs which is very like pulmonary tuberculosis. This relatively new hazard made a number of occupations potentially dangerous. A safe substitute made possible the continued world expansion of fluorescent lamp manufacture without the use of beryllium compounds.

Pesticides have caused illness among workers manufacturing these materials, and in a few cases among agricultural workers. Many of these are organic compounds of phosphorus; others are complex chemical compounds which act as the organic phosphates do on the nervous system, upsetting essential biological processes. In part, the danger from exposure to these materials arises because they are readily absorbed through the mucous membranes of the nose and through the skin, in addition to the usual hazard from entry into the body by inhalation.

Harmful Dusts.—Pneumonoconiosis (shortened in usage to pneumoconiosis; *q.v.*), from the Greek words meaning "dust" and "lung," refers to respiratory disease following long exposure to certain dusts. In order to cause disease, harmful dusts must be inhaled in a finely divided state. Evidence suggests that particles between one-half and five microns in diameter are retained in the lung, and some investigators believe that even smaller-sized particles are potentially hazardous. Larger particles are sifted out by nasal hairs or caught in the mucus secreted in the bronchial tree. The disease silicosis (*q.v.*) is a pneumonoconiosis of worldwide distribution caused by the inhalation of quartz or sand as free silica (SiO_2). For example, it may occur in men long-exposed in such different jobs as underground mining, sandblasting, some foundry operations, granite cutting and certain pottery operations. Silicosis is caused by deposition of harmful amounts of fine silica in the lung, producing an inflammatory reaction that

results in pathologic changes described as silicotic nodules. Complete control of dust can prevent silicosis, but in some operations, such as deep underground mining, this is nearly impossible.

Certain inert dusts on reaching the lung are simply deposited there, and if the quantity is great they may produce shadows visible in chest X-rays; iron, kaolin, tin and pure carbon are examples of such so-called benign dusts. In cases of extremely intense prolonged exposure to some inert materials, damaging changes in lung structure take place with consequent disability.

Other occupationally hazardous dusts are silicates—that is, naturally occurring materials such as magnesium and aluminum combined with silica. Asbestos is an example of a silicate (a combination of silicates of magnesium and iron) long used in industry and known to produce pneumonoconiosis. Evidence strongly indicates that there is a significant increase in lung malignancy in men with asbestosis.

Physical Agents.—Many modern occupations involve the risk of exposure to radioactivity, especially because of the development of atomic energy and use of radioactive isotopes by industrial, agricultural and medical research workers.

X-rays are used industrially for radiography and especially fluoroscopy. Necessary strength of fluoroscopic rays varies according to the thickness of the material to be penetrated; soft rays will show the position of metal plates in rubber heels; hard rays must be used to reveal flaws in castings. Undoubtedly, however, the chief source of X-ray injury is still medical practice, although now that proper measures for protection are known, instances of serious injury are rare. Surgeons are not always alert to the danger of prolonged manipulation of fractures under the fluoroscope, a practice which is dangerous to the patient and the helping attendant as well as to the manipulator. Radiologists doing medical diagnostic work, if adequate protection has not been provided, are engaged in potentially harmful work as shown by reports of high incidence of leukemia in radiologists. An introduced X-ray hazard to the public and to salesmen is the machine sold to shoe stores to demonstrate that a shoe does or does not fit. These provide risk of X-ray burns to the tissues of the foot and interference with normal bone growth in children. Several states of the U.S. have legislation prohibiting the use of X-ray shoe-fitting equipment.

Several hundred persons were killed by radium exposure prior to 1930. In 1931 cases of necrosis of bone, fatal anemia and bone malignancy were reported among young women workers in the United States engaged in painting self-luminous paint on dials. Such paint contained mesothorium and radium salts. The practice of moistening the tip of the paint-laden brush in the mouth is believed to have been responsible for the fatal cases of radium poisoning; European workers, among whom deaths from radium poisoning were rare, were prevented from such practice. Since that period the number of persons engaged in the industrial handling and application of radium has increased enormously. A modern industrial use of radium is found in the static eliminator; the ionization effect of the alpha particles from decaying radium acts to dissipate static electricity in textile and paper mills.

More serious industrial exposure to radioactive substances occurs in mining radioactive ores, handling and testing the products of the ores and making up radon seeds. Carcinoma of the lungs is reported in a significant number of miners of Schneeberg, Ger., where the cobalt arsenide ores are radioactive. Since the 19th century it has been known that a large proportion of the miners died prematurely of lung disease with wasting. The discovery that the disease was pulmonary carcinoma was made in 1878, confirmed in 1913 and again in 1926. The same ore is found on the Bohemian side of the mountain, where pitchblende also is mined, and the Bohemian miners also suffer from pulmonary carcinoma. The hazards of mining radioactive ores are difficult to assess and control.

Equipment that measures various types of radioactivity (dosimeters, film badges, Geiger-Müller counters) is used to record doses of radiation received by workers. It is possible to learn how much radium is in a man's body by measuring the radon gas (a radioactive decay product of radium) in his expired air. Permissible levels of radiation, at which a worker should receive no damage although he worked a lifetime, have been established. Medical examinations—including, *e.g.*, complete blood counts and eye examinations—are given regularly to exposed workers in all well-managed research laboratories, hospitals and industrial establishments where radiation exposure occurs. Shielding, protective clothing, enclosure and ventilation make it possible to carry out potentially dangerous jobs involving exposure to radioactivity.

Radar equipment takes advantage of ultrahigh-frequency waves for detection of solid objects at a distance, and workers and military men are exposed to such energy. High-voltage equipment, called klystrons, necessary for radar detection, generates X-rays. These must be measured to be certain they are at levels considered safe. Present studies suggest that heating is the only result of exposure to waves from radar equipment. Because the energies being used are continually changing, however, experimental work to discover presently unknown harmful biological effects continues.

In exploration of the space above the earth, the effects of gravity are lost and problems of friction to the body and wide temperature changes arise. Knowledge acquired by satellite exploration showed also that there is more radioactivity in the atmosphere surrounding the earth than previously had been realized. (*See* SPACE EXPLORATION: *Space Science: Life Sciences;* RADIATION: BIOLOGICAL EFFECTS; AVIATION MEDICINE.)

The condition called decompression sickness, or caisson disease, which occurs in workers—divers, "sand hogs," etc.—subjected to very high atmospheric pressures, is discussed in the article CAISSON DISEASE.

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DANGS, a district in India, was formed after the merger of the Dangs states of the former Gujarat states agency with the province of Bombay. Pop. (1961) 71,567. Area 689 sq.mi. From May 1, 1960, the district was included in the new state of Gujarat. The tract is extremely hilly and broken by deep ravines. Timber, bamboo and minor forest produce are the most important products. *Nagli* or raggee (*Eleusine coracana*), a variety of millet, and inferior rice are the chief crops but other food grains were being introduced in the early 1960s. The principal places are connected by roads suitable for bullock carts. Ahwa, on a plateau about 1,600 ft. above the sea, is the headquarters of the district.

(M. R. P.)

DANIEL (DANILO ROMANOVICH; also called DANIEL OF GALICIA) (1202–1264), prince of Halich and Volhynia (in modern Poland and Ukraine), was the son of Prince Roman Mstislavich, who fell in battle against the Poles in 1205, leaving the infant Daniel in his widow's charge. Instantly many pretenders appeared for the vacant throne: the Poles, the king of Hungary, the princes of Chernigov and later Prince Mstislav the Daring of Novgorod. After the latter's death (1228), Daniel finally asserted himself as prince of Halich and Volhynia. He founded new cities—Lviv and Chelm among them—invited foreign traders and craftsmen and moved his capital from Halich to Chelm, which became a strong fortress and a flourishing trading centre.

When the Mongol-Tatar Golden Horde conquered and devastated Kievan Rus in 1237–41, Daniel saw himself compelled to recognize the khan's sovereign power. In 1245, however, he defeated Hungarian and Polish troops at Yaroslav and thus reassured his independence from the west. To find help against Tatar domination, he negotiated with Pope Innocent IV, who planned to rally the Catholic powers of Europe for a crusade against the Golden Horde. The pope sent Daniel regalia of the king's dignity in 1253, and Daniel was crowned king, but no further help came. Daniel died an outwardly obedient but inwardly disillusioned and embittered vassal of the Golden Horde. He is buried at the Chelm Orthodox cathedral.

See N. P. Dashkevich, *Knyazhenie Daniila Galitskago* (1873); M. Hrushevsky, *A History of Ukraine* (1941). (S. G. PU.)

DANIEL (Daniil) of Kiev, the earliest Russian travel writer, who left one of the most important medieval narratives of pilgrimage to the Holy Land, which is of interest also for the study of ritual and of the Russian language. He was the abbot of a Russian monastery, and visited Palestine in the reign of Baldwin I, probably during 1106–07. Daniel's account is fuller and more accurate than that of his predecessor Saewulf and is a valuable record of the condition of the country before the changes effected by the crusaders. Despite his credulity and his errors of topography and measurement, Daniel's work is generally reliable and he has clearly been at pains to check his information wherever possible by his own experience. His narrative begins at Constantinople, whence he traveled along the western and southern coasts of Asia Minor to Cyprus and the Holy Land. He lived over a year in Jerusalem, of which he gives a minute and accurate description, and made three excursions, to the Dead sea, to Hebron and to Damascus. Palestine in this period appears to have been loosely governed and the Saracens much given to lawlessness, but the Latin and Greek Churches were on harmonious terms. The work includes a detailed description of the Easter services in Jerusalem.

Bibliography.—There are 76 manuscripts of Daniel's Narrative, of which only five are anterior to A.D. 1500; I. P. Sakharov's ed. (1838–39) is perhaps the best known (in *Narratives of the Russian People*, vol. ii, bk. viii, pp. 1–45). *See* also the French version in *Itinéraires russes en Orient*, ed. by Maitre B. de Khitrovo (1889) (*Société de l'Orient latin*); Eng. trans., annotated by C. W. Wilson, in the Library of the Palestine Pilgrims' Text Society, vol. iv (1895); the account of Daniel in C. R. Beazley, *Dawn of Modern Geography*, vol. ii (1901). (Wm. C. B.)

DANIEL, ARNAUT: *see* Troubadours.

DANIEL, GABRIEL (1649–1728), French Jesuit historian, known for his pioneer *Histoire de France depuis l'établissement de la monarchie française* (first complete edition, 1713; ed. by P. Griffet, 1755–60). Born at Rouen, Feb. 8, 1649, he entered the Jesuit order in 1667, later becoming librarian of the professed house at Paris, and was appointed historiographer of France by Louis XIV. He died in Paris, June 23, 1728. His writings include *Histoire de la milice française* (1721), *Dissertation sur l'origine du jeu de picquet* (1720), and replies to Pascal in *Entretiens de Cléandre et d'Eudoxe sur les lettres provinciales* (1694) and to Descartes in *Voiage du monde de Descartes* (1691).

See C. Sommervogel, *Bibliotheca Mariana de la compagnie de Jésus*, vol. ii (1885).

DANIEL, SAMUEL (1562?–1619), English poet, was a thoughtful, contemplative writer, praised by later poets for both substance and style. Born about 1562 near Taunton, Somerset, he entered Magdalen hall, Oxford, in 1581. After publishing a translation of Paulus Jovius' book on devices in 1585 for his first patron, Sir Edward Dymoke, he secured a post with the English ambassador at Paris; later he traveled in Italy, visiting the poet Battista Guarini in Padua. After his return, by 1592, he lived at Lincoln in the service of Sir Edward Dymoke, at Wilton as tutor to William Herbert, later earl of Pembroke, and at Skipton castle, Yorkshire, as tutor to Lady Anne Clifford. Soon after the accession of James I, Queen Anne chose him to write a masque in which she danced at Hampton court. She rewarded him with the right to license plays for the boy actors at the Blackfriars theatre and with a well-paid position as a groom, and later gentleman, of her privy chamber. Besides writing "under her roof," he had a garden house in Old street, London, and The Ridge, a farm near Beckington, Somerset, where he died in Oct. 1619 a few months after his wife, Justina. His brother John set two of his sonnets to music in *Songs for the Lute, Viol and Voice* (1606) and edited *The Whole Works of Samuel Daniel Esquire in Poetry* (1623).

Edmund Spenser praised Daniel for his first book of poems, *Delia*, with *The Complaint of Rosamond* (1592). Many of his sonnets had been printed in 1591 without his consent, but in this book Daniel published 50 sonnets with a dedication to Mary, countess of Pembroke, whom he celebrated as Delia. More were added in later editions. Less original than Shakespeare or Sir Philip Sidney, Daniel was strongly influenced by French and Italian sonnets and varied their themes with a quiet music of his own, as in "Care-charmer Sleep" and "When men shall find thy flower, thy glory pass." The passing of youth and beauty into sudden eclipse is the theme of the *Complaint*, a tragic monologue spoken by Fair Rosamond, the mistress of Henry II. In *The Tragedie of Cleopatra* (1594) Daniel wrote a Senecan drama to accompany Lady Pembroke's translation of *Marc Antoine* by Robert Garnier. *The Civile Warres* (1595–1609), a verse history of the Wars of the Roses, had some influence on Shakespeare in *Richard II* and *Henry IV*.

Daniel's finest poem is "Musophilus: Containing a Generall Defence of Learning," dedicated to Fulke Greville. In this dialogue the lover of the world, Philocosmus, argues that poetry is useless, fame an "inheritance of air" and action more important than knowledge. Musophilus, replying that "true knowledge can both speak and do," defends knowledge, "soul of the world"; virtue, "that all-knowing power"; and "blessed letters that combine in one All ages past, and make one live with all." Here the poet rose to the height of his argument. His *Poeticall Essayes* (1599) also include "A Letter from Octavia to Marcus Antonius." His *Defence of Ryme*, answering Thomas Campion's *Observations in the Art of English Poesie*, is a critical essay in prose second only to Sidney's *Apology for Poetry*. Composed as a private letter in 1602, the *Defence* was published in 1603 with "A Panegyrike Congratulatory" to James I and "Epistles" in verse to three lords and three ladies. To Lucy, countess of Bedford, he praised knowledge as the way to true happiness, and to Margaret, countess of Cumberland, he addressed a majestic expression of Christian stoicism. Fame and honour are the subjects of "Ulisses and the Syren" (1605) and of *A Funerall Poeme uppon the Earle of Devonshyre* (1606). Like Ben Jonson with his *Sejanus*, he had had to defend himself against a charge of sympathizing with the earl of Essex, in *The Tragedie of Philotas*, acted in 1604 (publ. 1605), but he explained that the play was purely historical drama. Earlier in 1604, he had pleased Queen Anne with his masque, *The Vision of the Twelve Goddesses*, and in 1610 he wrote another masque for her, *Tethys' Festival*, staged with scenery by Inigo Jones. *The Queenes Arcadia* (publ. 1606), a pastoral tragi-comedy in the Italian fashion, entertained the queen at Oxford in 1605, and a second pastoral, *Hymens Triumph*, celebrated a wedding in 1614. He spent much time in revising his poems and in writing in prose *The Collection of the Historie of England* (1612–18) as far as the reign of Edward III. Wordsworth admired his "Epistles," and Coleridge wrote to Lamb: "Thousands even of educated men would become more sensible, fitter to be members of Parliament or Ministers, by reading Daniel."

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DANIEL, BOOK OF, a book of the Old Testament. In the Hebrew Bible the Book of Daniel stands between Esther and Ezra-Nehemiah among the Writings, or Hagiographa, the third and latest division of the Palestinian canon; nearly half of it is written in Aramaic.

In the English Bible (following the Alexandrian canon) it is placed among the prophets. Three "additions" which became associated with the canonical text at an early date are found in the Septuagint and Vulgate.

Contents.—The 12 chapters of the canonical book present a collection of popular stories about Daniel, a loyal Jew, and the record of visions granted to him, with the Babylonian exile of the 6th century B.C. as their setting. After an introduction, which explains how Daniel and his three companions came to be living at the Babylonian court and how they remained faithful to the laws of their religion (Dan. i), there are five dramatic episodes calculated to demonstrate the wisdom and might of Israel's God and the unconquerable steadfastness of his loyal people. Thus, through God's gift of wisdom, Daniel outclasses the professional sages of the pagan court by revealing and interpreting Nebuchadrezzar's dream of a great image, made of four metals, which was shattered by a stone cut without human hand (Dan. ii), and then the king's further dream of the tree reduced to a stump, which presaged the punishment of his arrogance by madness (Dan. iv), and, finally, the writing on the wall, which spelt Belshazzar's doom at his sacrilegious feast (Dan. v). By trust in God, Daniel's three

companions, who refused to worship Nebuchadrezzar's golden idol, are miraculously delivered from a fiery furnace (Dan. iii), and Daniel himself, thrown into a den of lions for holding fast to his tradition of prayer, is divinely protected (Dan. vi).

The last six chapters of the book are cast in the form of "visions." In ch. vii, Daniel is granted a vision of four beasts from the abyss, which are brought under divine judgment, and of "one like a son of man" (Dan. vii, 13), who is brought before God to be invested with his universal and everlasting sovereignty. The mythological beasts are interpreted as four empires (Dan. vii, 17) and the manlike figure as Israel, "the people of the saints of the Most High" (vii, 27; *cf.* 18, 22). The vision of the battle between the ram (Medes and Persians) and the goat (the Greek empire) in Dan. viii portrays the iniquities of Antiochus IV Epiphanes, who desecrated the Temple in 167 B.C. (Dan. viii, 9–12), and assures the stricken Jews that the end of their tribulation is near (Dan. viii, 13 ff., 26). The writer's purpose in ch. ix is also to affirm that the time of Israel's suffering is short, and his method is to reinterpret a prophecy of Jeremiah that Jerusalem's desolation would end after 70 years. By making these 70 years mean 70 "weeks of years" (that is, 490 years), the writer is again able to focus attention on the period of Antiochus' persecution in the 2nd century B.C. and the imminence of his determined doom. The remaining chapters (x–xii) provide the third and final commentary on the crisis provoked by the Seleucid tyrant. The greater part of this "vision" is a sketch of such events as affected the Jews from the Persian period to the time of Antiochus Epiphanes (xi, 2–xii, 4), for whose reign of terror (xi, 21–45) all that precedes is mere preparation. After xi, 39, the account of Antiochus' life ceases to correspond with historical fact; the inaccurate prediction of his end in xi, 40–45 is the prelude to the announcement of the end of Israel's tribulation and the inauguration of God's kingdom (xii, 1–4).

The purpose of the whole book, stories and visions alike, is to encourage Israel to endure under the threat of annihilation and to strengthen her faith that "the Most High rules the kingdom of men" (iv, 17, 25) and will in the end give victory to his people and establish his kingdom (ii, 44; vii, 25–27).

Literary History.—The overwhelming majority of scholars have abandoned the belief (already challenged by the Neoplatonist philosopher Porphyry in the 3rd century A.D.) that the book was written, as it purports to be, in the 6th century B.C., and find the occasion for its production in the period upon which the visions are focused; that is, between 167 and 164 B.C. Among the considerations which point to this date in the 2nd century are the following:

1. The book is included among the Writings with the latest books of the Hebrew canon.

2. Daniel is not mentioned in Ben Sira's list of the great men of Israel (Ecclus. xliv–1, *c.* 180 B.C.).

3. The prophecy of Jeremiah cited in Dan. ix is regarded as authoritative scripture and interpreted in a manner similar to that found in the literature from Qumran.

4. The four metals of the image in Dan. ii and the four beasts of Dan. vii are generally interpreted as four kingdoms—the Babylonian, "Median," Persian and Greek. The writer's historical knowledge is sketchy and inaccurate for the first three of these kingdoms. Thus, the dating of i, 1 (*cf.* ii, 1) is wrong (*cf.* II Kings xxiv, 1 ff. and II Chron. xxxvi, 5 ff.). In Dan. v, 11 Belshazzar is represented as the son of Nebuchadrezzar and the last king of Babylon. In fact, Belshazzar was the son of Nabonidus, the last king of Babylon, and although he was invested with certain royal prerogatives he was never actually king. The immediate successor of Nabonidus was Cyrus and not Darius the Mede (v, 31), who is an entirely fictitious character suggested by prophecies of Babylon's overthrow by the Medes (Isa. xiii, 17; Jer. l, 9, etc.) and named after Darius I. By contrast, Dan. xi is a not inconsiderable historical source for the Greek period and more easily accounted for as prophecy after the event than as prediction made four centuries earlier. The date of this narrative is indicated precisely by the transition from accurate history to inaccurate prediction at xi, 40.

5. The type of Hebrew is late, though the Aramaic is inconclusive for a 2nd-century date.

6. The religious thought and piety of the book belong rather to the 2nd than to the 6th century. Thus, the resurrection of both wicked and righteous individuals is affirmed here for the first time in the Old Testament (Dan. xii, 2); a developed angelology is taken for granted (Dan. viii, 16; x, 13, 21; etc.); vegetarian diet is used to avoid infringing Jewish food laws (i, 8–16); thrice-daily prayer (vi, 10) and fasting with sackcloth and ashes (ix, 3) characterize late Jewish piety; and the "voice from heaven" (iv, 31 [28]; *cf.* Matt. iii, 17) was recognized as a medium of revelation after the decline of prophecy.

Literary Affiliations.—The literary affiliations of the book confirm its 2nd-century dating.

1. The stories of Dan. i–vi are similar in type to the didactic fiction in Tobit, Judith and Esther. Although these three books are products of the 2nd century B.C., their setting in each case is the distant and dimly remembered period of Israel's exile and dispersion and their theme is the success which attends the loyal Jew who resists the temptation to fall in with the way of the gentiles. The history of Susanna and Bel and the Dragon (*see* below) are completely congruous with this aspect of the tradition to which the book belongs (*cf.* the tale of the three youths in I Esd. iii–iv and the Aramaic story of Ahikar).

2. The close relationship between the Book of Daniel and the wisdom literature illuminates the didactic use of popular stories (*cf.* Job, Tobit and *see* above), the emphatic contrast between human and divine wisdom in Dan. i–vi (especially ii, 20–23; *cf.* Job xii, 13–25), and the connection with cosmological myths in the vision of the beasts from the abyss (Dan. vii; *cf.* Job iii, 8; Isa. li, 9–10; etc.) and in Nebuchadrezzar's dream of the tree (Dan. iv, 10–17; *cf.* Ezek. xxxi, 1–9). Moreover, if in Dan. xi, 33 and xii, 3 the writer is associating himself with "the wise," that is, the scribes and teachers of the Law, it is reasonable to suppose that he was not far removed from the learned circles in which Ecclesiasticus was written (*c.* 180 B.C.). The description of the ideal scribe given in Ecclus. xxxix, 1 ff. admirably fits what may be learned of the writer of Daniel from the contents of the book.

3. The writer was clearly a student of the prophetic writings; Dan. ix is a reinterpretation of Jer. xxv, 12 and the book contains many echoes of Ezekiel. It is, however, a curious and significant fact that many of the features which characterize prophetic eschatology and which were elaborated in such later apocalyptic writings as I Enoch, the Sibylline Oracles, the Assumption of Moses and II Esdras are absent from Daniel. Thus the writer neglects the prophets' cosmic imagery, their great eschatological battle scenes, their lurid descriptions of the fate of the gentiles, their highly coloured pictures of the final age and their usual (but not invariable) interest in the messianic leader of the eschatological community. The "anointed one" of Dan. ix, 26 is probably the high priest Onias III (*cf.* Dan. xi, 22; II Macc. iv, 33–38). The book of Daniel, therefore, cannot easily be placed on any clear line of development between prophecy and apocalyptic and its reputation as the greatest pre-Christian apocalypse rests largely on the fact that it inspired so many apocalyptic writers to imitate certain of its characteristic features. In particular, they adopted the author's method of presentation, whereby divine revelations concerning the future were ascribed to an ancient seer, written down by him and sealed in a book until the time to which they referred (Dan. viii, 26; xii, 4, 9; *cf.* Rev. xxii, 10).

Conclusions.—There is a prima facie case for more than one author in that the book is written in two languages, Hebrew (i, 1–ii, 4a and viii–xii) and Aramaic (ii, 4b–vii, 28), and is composed of two diverse elements, anonymous stories (Dan. i–vi) and largely pseudonymous "visions" (Dan. vii–xii). Fragments marking the change in language both at ii, 4b and at viii, 1 have been discovered at Qumran. The hard core of the problem arises from the lack of coincidence between the division of the book suggested by language and that suggested by literary form and, therefore, it is most critical in Dan. vii, which by language belongs to ch. ii–vi but by form to ch. viii–xii. In consequence, some

scholars have divided the book at the end of ch. vi, others at the end of ch. vii. Among the latter group, many take the view that ch. vii though closely related to ch. i–vi was independent in origin and later in date. Chapters viii–xii differ in the following ways from ch. i–vii: they contain references to the desecration of the Temple (*e.g.*, Dan. viii, 11); they are written in Hebrew; the style is tortuous and the symbolism naïve; the eschatological perspective is narrowed from God's inauguration of his kingdom (*e.g.*, Dan. ii, 44–45) to the time of Israel's vindication (*e.g.*, Dan. viii, 13–14); they show interest in developed angelology, theological determinism and individual resurrection.

A possible solution of the problem is the following: the book in its present form was produced between 167 B.C., when Antiochus Epiphanes desecrated the Temple, and 164 B.C., when the Temple was rededicated. Chapters i–vii were written after Antiochus Epiphanes plundered the Temple in 169 B.C. but before he desecrated it in 167 B.C. This author incorporated traditional stories into his first six chapters and wrote chapter vii. The remainder of the book was written between 167 and 164 B.C. by a scribe who translated Dan. i–ii, 4a into Hebrew, presumably to improve the book's reception among the *Hasidim* ("Hasidaeans") who resisted the Hellenizing Jews during the Maccabaean persecution.

The date of the traditional stories (Dan. i–vi) and the background of their hero, Daniel, are difficult to determine. A character named Dan'el (another form of Daniel) is mentioned as one of Israel's legendary saints together with Noah and Job in Ezek. xiv, 14, 20, as the wise man *par excellence* from whom "no secret is hidden" in the mythological content of Ezek. xxviii, 3, and as a righteous man in the tale of Aqhat among the Ras Shamra texts. It is not certain whether Daniel should be identified with this Dan'el or not. The stories in which he figured were found useful by the author of Dan. i–vi because they exposed the ludicrous pretensions of gentile kings and depicted the victories of true religion. The 2nd-century writer made his own contribution by unifying the stories about Daniel and integrating with them the independent tale about Shadrach, Meshach and Abednego (*cf.* Dan. i, 7) in the furnace (Dan. iii), by developing the theological reference of the stories and, above all, by crowning the book with a profound eschatological interpretation (Dan. vii).

Interpretation.—To recognize that the antedating of the visions is a literary device is to be delivered from the traditional assumption that the book contains predictions of the remote future and, in consequence, from all the sterile and fantastic speculations about their fulfillment. The stories are addressed to the immediate crisis and the visions refer to the immediate future. Their dominant theme is the sovereignty of the living God, now opposed by pagan arrogance but upheld by the fidelity of his people and shortly to be manifested fully and finally in the judgment of the kingdoms of the world and the inauguration of the Kingdom of God. The eschatological pattern and imagery of the book profoundly influenced the writers of the New Testament no less than Jewish apocalyptic writers. In particular, the corporate term "Son of Man" (Dan. vii, 13; *cf.* Mark xiii, 26) became on the lips of Jesus and in martyr contexts of the New Testament the perfect symbol for expressing the conviction that God is sovereign in human history and will assuredly vindicate his humiliated and suffering servants. (ER. W. H.)

Additions to Daniel.—Three short pieces not in the Hebrew Bible, Susanna and the Elders, Bel and the Dragon and The Song of the Three Holy Children, are appended to the Book of Daniel in the Septuagint and Theodotion's version, from the latter of which they passed to the Vulgate. They are rejected from Protestant Bibles and form part of the Apocrypha (*q.v.*). It is uncertain whether Hebrew, Aramaic or Greek was their original language, and they cannot be dated more precisely than to the 2nd century B.C. after the Book of Daniel or to the 1st century B.C.

Susanna and the Elders.—This further story illustrating the wisdom of Daniel forms the 13th chapter of the book of Daniel in the Vulgate. The Greek version by Theodotion is fuller than that of the Septuagint. It relates how during the captivity of the Jews in Babylon a devout and beautiful woman named Susanna was spied on by two elders as she prepared to bathe in her husband's garden. Her virtue, however, was impervious to their adulterous advances, though they threatened to accuse her publicly of an adultery of which they would claim to be witnesses. In the event, their word was believed rather than hers, but as she was led out to die Daniel appeared in her defense. His cross-examination of the two elders separately showed that they were lying, and Susanna was thus proved innocent.

Bel and the Dragon.—Two stories about Daniel as an attacker of pagan gods are told under this heading. In the Vulgate they form the 14th chapter of Daniel. Daniel proved to Cyrus, king of Persia, that the Babylonian god Bel (Marduk) was a lifeless idol by scattering dust around it so that those who came secretly by night to consume the quantities of food offered to it left clear traces of their activities. The living serpent or dragon, another object of worship, was also proved ineffectual as a deity by Daniel, who caused its death by feeding it with a mixture of pitch, fat and hair. Infuriated by their loss the people threw Daniel into the lions' den, where he remained unharmed and was fed by the prophet Habakkuk brought miraculously to Babylon by an angel for the purpose. On the seventh day Cyrus released Daniel and acknowledged the greatness of God.

The Song of the Three Holy Children.—The three holy children Shadrach, Meshach and Abednego, also known as Hananiah, Mishael and Azariah, were thrown by Nebuchadrezzar into a fiery furnace for refusing to worship a golden image (Dan. iii). This addition (inserted in the Septuagint and Theodotion's version, followed by the Vulgate, between Dan. iii, 23 and 24) consists of a prayer by Azariah (1–22), a narrative account of how an angel kept the fire from harming them (23–28) and a series of blessings of God uttered by all three "as with one mouth" (28–68). At the end there is a reference to the furnace (66), but apart from this the prayer and the blessings have no particular connection with their supposed occasion. Both are included among the canticles (*q.v.*) of the Orthodox Church, and the *Benedicite*, which is the greater part of the blessings, is said at lauds in the Roman Catholic Church and included in the Book of Common Prayer.

See also APOCALYPTIC LITERATURE. (X.)

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DANIELL, the name of a number of English late 18th- and early 19th-century topographical painters and engravers. THOMAS DANIELL (1749–1840) was best known for his work with his nephew William on *Oriental Scenery,* drawn in India in 1784–93 and published in six aquatinted volumes in 1808. WILLIAM DANIELL (1769–1837) was also noted for his Madras panoramas, for his aquatinted *Picturesque Voyage to India* (1810) and for *A Voyage Round Great Britain* (4 vol., 1814–25). He made soft-ground etchings (1808–14) of G. Dance's portraits of John Flaxman, Benjamin West, etc. Thomas and William were under the general influence of P. Sandby. William's brother SAMUEL DANIELL (1775–1811) traveled into Bechuanaland in 1801, one result being his aquatinted *African Scenery and Animals* (2 parts, 1804–05). Settling in Ceylon in 1806 he published in 1808 *Picturesque Illustrations . . . of Ceylon.*

Of Daniells unrelated to the above the most notable was EDWARD THOMAS DANIELL (1804–43), a Norwich clergyman, amateur landscape etcher, dry point engraver and water colourist.

Others included ABRAHAM (d. 1803), miniaturist of Bath; JAMES (fl. *c.* 1800), etcher; and JOSEPH (fl. *c.* 1810), etcher.

See Thomas Sutton, *The Daniells: Artists and Travellers* (1954).

DANIELL, JOHN FREDERIC (1790–1845), English chemist and meteorologist, best known for his invention of the Daniell cell (*see* BATTERY). He was born in London on March 12, 1790, and in 1831 became the first professor of chemistry at the newly founded King's college, London. He also invented the dew-point hygrometer known by his name (*Quar. Journ. Sci.*, 1820), and a register pyrometer (*Phil. Trans.*, 1830); in 1830 he erected in the hall of the Royal society a water barometer with which he carried out a large number of observations (*Phil. Trans.*, 1832). A process devised by him for the manufacture of illuminating gas from turpentine and resin was in use in New York for a time. His publications include *Meteorological Essays* (1823), an *Essay on Artificial Climate Considered in Its Applications to Horticulture* (1824), which showed the necessity of a humid atmosphere in hothouses devoted to tropical plants, and an *Introduction to the Study of Chemical Philosophy* (1839). He died on March 13, 1845, in London.

DANIELS, JOSEPHUS (1862–1948), U.S. editor, secretary of the Navy during World War I and diplomat, was born at Washington, N.C., on May 18, 1862. Educated briefly at the University of North Carolina, he was publisher, and intermittently editor, of the Raleigh, N.C., newspapers, the *State Chronicle* from 1885 to 1904 and the *News and Observer* from 1904 to 1948. He was a leader in movements for railroad and utility regulation, prohibition, labour legislation and women's suffrage. A lifelong Democrat, he became one of the original supporters of William Jennings Bryan (*q.v.*) in 1896 and was close to Bryan in his three campaigns for the presidency. In 1911 Daniels turned to Woodrow Wilson for leadership of the Democratic party and helped nominate him for the presidency in 1912. Appointed secretary of the navy in 1913 by Wilson, Daniels helped bring the navy to high efficiency during World War I. He named Franklin D. Roosevelt as assistant secretary of the navy. In 1933 when Roosevelt became president he appointed Daniels ambassador to Mexico. In that country Daniels won Mexican friendship and helped prevent expropriation of U.S. oil properties from disrupting Mexican-U.S. relations. His five-volume autobiography (1939–47) was an important contribution to American historical literature. He died on Jan. 15, 1948, at Raleigh, N.C. (A. S. Lk.; Jo. D.)

DANIELSSON, OLOF AUGUST (1852–1933), Swedish classical scholar and comparative philologist, especially noted for his work on Etruscan epigraphic remains, was professor of Greek at Uppsala university from 1890 to 1917. Danielsson's formative period, comprising years of study in Germany, coincided with the emergence of the "neogrammarian" school of Indo-European comparative philology, which emphasized the stringent regularity of sound laws governing linguistic change. Danielsson was one of the young scholars who introduced the new doctrines in Sweden. His own contributions to scholarship comprise numerous monographs and articles on the historical and comparative grammar of Greek and Italic languages and dialects, more strictly philological contributions on the exegesis of ancient authors, on Venetic, Lepontic and Lydian inscriptions, and above all the great enterprise of the *Corpus Inscriptionum Etruscarum*, begun by C. Pauli with Danielsson's collaboration in the 1880s. The first volume was published shortly after Pauli's death in 1901; Danielsson carried on the work, assisted by B. Nogara, G. Herbig and E. Sittig. Different fascicles of the second volume appeared during the ensuing decennia, but the gigantic undertaking remained unfinished at Danielsson's death; posthumous materials and remaining installments were published by the surviving collaborators.

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DANILEVSKI, NIKOLAI YAKOVLEVICH (1822–1885), Russian naturalist and historical philosopher, the author of *Rossiya i Evropa* (1869; Ger. trans. *Russland und Europa*, 1920), was born in Oberets (Orel), Dec. 10 (new style; old style, Nov. 28), 1822. He was the first to propound the philosophy of history as a series of distinct civilizations. According to him, Russia and the Slavs should remain indifferent to the west and concentrate on the development of political absolutism, their own special cultural heritage—not necessarily better than but different from that of the west. Danilevski was said to have "given Russian nationalism a biological foundation." His ideas influenced Konstantin Leontiev among Russian thinkers and, among western philosophers, Oswald Spengler (*q.v.*). He died in Tiflis, Nov. 19 (N.S.; 7, O.S.), 1885.

See his *Darvinizm*, 2 vol. (1885–89); also K. Pfalzgraf, *Die Politisierung und Radikalisierung des Problems Russland und Europa bei N. J. Danilevskij* (1954). (R. F. Hi.)

DANILOVA, ALEXANDRA (1904–), Russian-American ballerina, was born in Petergof, Russia. She attended the Russian Imperial and (later) the Soviet State Ballet schools in Leningrad, where she studied under Agrippina Vaganova, and became soloist at the Maryinsky theatre. In 1924 she visited western Europe with a small ballet ensemble headed by George Balanchine. The entire group joined the Diaghilev Ballet and never returned to Russia. Danilova soon rose to prominence in the Diaghilev company, creating leading roles in *Apollo*, *La Pastorale* and *The Triumph of Neptune*. After Diaghilev's death in 1929, she joined the Ballet Russe de Monte Carlo, making her American debut as its prima ballerina in 1933. While touring extensively throughout the United States, she achieved tremendous personal popularity through the warmth and individuality of her characterizations. Especially memorable were her brilliant performances as the street dancer in *Le Beau Danube*, the glove seller in *Gaîté Parisienne*, Odette in *Swan Lake* and Swanilda in *Coppélia*.

Danilova appeared as guest artist with Sadler's Wells Ballet, London, and with her own company danced in Japan and South Africa. She also appeared in musical comedy and in 1959 made a lecture tour.

See A. E. Twysden, *Alexandra Danilova* (1945). (Ln. Me.)

DANISH LANGUAGE, one of the Scandinavian group of the Germanic languages, has about 5,000,000 speakers. It is closely related to Swedish, Norwegian and Icelandic, which are all derived from a common Scandinavian language; the separation of the four languages began at about A.D. 1000. The primeval Nordic language (*c.* A.D. 250–800) is known from relatively few runic inscriptions, among which is the famous Danish *Gold Horn Inscription* (*c.* 400). In the period of so-called runic Danish (800–1100) remarkable changes took place, mainly through fracture, *i*-mutation, *u*-mutation and assimilation, and through the disappearance of unstressed short vowels. While these and other phenomena apply to all the Scandinavian languages, other changes, such as the monophthongization of *ei* into *e*, *au* into *ø* and *ey* into *ø*, and the disappearance of *h* in front of *l*, *n* and *r*, are characteristic only of the east-Scandinavian languages (Swedish and Danish). The period of Middle Danish (1100–1500) is characterized by a weakening of the vowels *a* and *i* into *e*, in an unstressed position, and by a change of the plosives *p*, *t* and *k* into *b*, *d* and *g*, after a vowel sound. Other characteristic changes are from *ja* into *jæ*, from *ju* into *jy*, from a long *a* into the *å*-sound, and from the unvoiced *th*-sound (written *þ*) into *t*. A general simplification of declension and grammar took place at the same time, more slowly in the eastern Danish provinces of Scania, Halland and Blekinge, most radically in the western dialects of Jutland.

Already in the viking period a number of loan words of Latin and Greek origin penetrated into the Danish language; this tendency was continued in the middle ages, when there was also a great influx of Low German words, prefixes and suffixes, because of the influence of Hanseatic merchants.

Modern Danish may be divided into two periods, before and after 1700. While the general simplification of the language continued steadily, many new words came into the language, mainly from High German and French but also from a variety of other languages. Several of these loan words disappeared again, to some extent the result of the deliberate efforts of language purists; but many came to stay. An influx of English loan words is noticeable from about 1870.

A characteristic phenomenon of the modern spoken language is the glottal stop (*Stød*), derived from an original tonal accent.

The grammatical structure of modern Danish is nearly as simplified as that of modern English; there are only two cases (nominative and genitive) and two genders (common gender and neuter). In addition to the letters of the English alphabet, Danish has the three letters *æ ø* and *å*. A spelling reform of 1948 abolished the previous general use of capital letters for nouns and replaced the letter *aa* by *å*.

See also SCANDINAVIAN LANGUAGES; RUNE; GERMANIC LANGUAGES.

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(E. L. BF.)

DANISH LITERATURE. Denmark's first literature is found in the runic inscriptions scratched on stone or carved on metal, mainly epitaphs of warriors, kings and priests, occasionally with short, unrhymed alliterative verses reflecting the viking spirit. Runic inscriptions were used in Denmark from about A.D. 250, but most of those preserved date from 800–1100.

Middle Ages.—With the introduction of Christianity Latin became the predominant language. Anders Sunesøn (*c.* 1167–1228) wrote *Hexaëmeron*, a long Latin poem describing the creation and the ecclesiastical dogmas. This poem, the poetry of Morten Børup (*c.* 1446–1526) and two poems of mourning and despair of unknown origin are Denmark's most important contributions to medieval Latin poetry. A number of legends and biographies of saints date from the early middle ages, notably one about Canute the Holy, by Aelnoth, an English monk; various annals of monasteries, as well as historical chronicles, have also survived. Sven Aggesøn's brief outline of Danish history before 1185, *Historia regum Daniae compendiosa*, was shortly followed by the *Gesta Danorum* by Saxo Grammaticus (*q.v.*), Denmark's first important contribution to world literature. Of its 16 books, written between 1185 and 1222, the first 9 cover prehistoric Danish antiquity, based on pagan legends and heroic poems passed down by word of mouth from generation to generation.

Danish medieval literature also includes a number of edifying books, hymns and various provincial laws for Scania, Zealand and Jutland; the Jutland laws were accepted by the rulers of the kingdom in 1241. Other important treasures are Peder Laale's *Ordsprog* ("Proverbs"; 14th century), some medical books by Henrik Harpestraeng (13th century), *Lucidarius* ("The Enlightener," a medieval "encyclopaedia") and *Rimkrøniken*, a versified Danish history, incidentally the first Danish book to be printed (1495). In a class by themselves are the medieval ballads, of which no country possesses a finer treasure; 539 are known in more than 3,000 versions, but nearly all were written down after the end of the middle ages. The first printed edition appeared in 1591. (*See* BALLAD.)

The Reformation and the Renaissance.—In 1536 the Reformation came to Denmark and this marked the end of the middle ages. The beginning of the 16th century was characterized by its many religious polemic pamphlets for or against the Roman Catholic Church. This inaugurated a new literature in the mother tongue. European humanism and the Renaissance made their influence felt also in Denmark, where Christiern Pedersen (*q.v.*; d. 1554) ranks as the most prominent of the humanists who supported the Reformation. He edited the first printed edition of Saxo's *Gesta Danorum* (Paris, 1514) and Laale's *Ordsprog*, translated the New Testament and adapted Martin Luther's pamphlets into Danish. Of supreme importance is his participation in the translation of the Bible (1550). Poul Helgesen (*c.* 1485–*c.* 1535) was the most gifted opponent of the Lutheran reformation (also the author of the *Skibykrønike*) and Hans Tausen (*q.v.*; 1494–1561) its most talented spokesman. The *Visitatsbog* of the Lutheran bishop Peder Palladius (1503–60) is a charming literary document.

The bulk of 16th-century Danish poetry was either religious or polemical, the main lyrical contributions being some fine love poetry and some hymns. Hans Thomissøn made the first important collection of hymns (1569) and Hans Christensen Sthen (1544–1610) was the first notable hymnist.

The earliest plays—mysteries, miracles, moralities, farces and school plays—date from the beginning of the 16th century, but many of them have been lost. *Ludus de Sancto Canuto* ("Saint Canute's Play"), a miracle play, dates from about 1530. The most important playwright of the period was Hieronymus Justesen Ranch (1539–1607) and the farce *Karrig Nidding* ("The Miserly Rascal") his best play.

Anders Sørensen Vedel (1542–1616) translated Saxo's work into Danish and edited the first collection of ballads; Peder Claussøn Friis (1545–1614), a Norwegian, translated Snorri's *Heimskringla*; and Arild Huitfeldt (1546–1609) wrote *Danmarckis Rigis Krønnicke* ("Chronicle of the Danish Realm") in ten volumes.

In the 17th century the literary renaissance reached Denmark, and led to a strict adherence to classical patterns. It was in Denmark an age of orthodoxy and blind belief in authority in political, religious and literary matters. Niels Hemmingsen (1513–1600), a theologian of European reputation, had fallen a victim to the heresy hunt in the previous century; and in religious literature Latin dogmatics, edifying leaflets and a host of pamphlets reflecting the superstitions of the century were dominant.

It was, however, a great era of science and scholarship. Ole Worm (1588–1654), a physician and antiquarian, is famous for his book on the runic inscriptions, the *Monumenta Danica* (1643). Thormod Torfæus (1636–1719) and Árni Magnússon (*q.v.*; 1663–1730) introduced the scholarly study of Old Norse literature and Peder Hansen Resen (1625–88), who wrote a description of Denmark, *Atlas Danicus*, edited and translated some of the poetry of the *Edda*; Erik Pontoppidan (1616–78), with his *Grammatica Danica* (1668), and Peder Syv (1631–1702), with *Af Nogle betenkninger om det cymbriske sprog* ("Reflections on the Cimbrian Language," 1663) and *Den Danske Sprog-Kunst* ("Mastery of the Danish Language," 1685), introduced the linguistic study of Danish.

The most important Danish prose work of the 17th century is *Jammers-Minde*, the memoirs of Leonora Christina (1621–98), the daughter of Christian IV, a fascinating human document about her 20 years' imprisonment in the Blue Tower of Copenhagen. The manuscript was first discovered and published in 1869.

Danish poetry in the 17th century tended to follow the classics slavishly, and the favourite forms were the hexameter, the Alexandrine and the sonnet. Simplicity is deliberately avoided; the style is precious; allegories, euphemisms and metaphors abound. Anders Arrebo (1587–1637) translated the Psalms and wrote *Hexaëmeron* (1661), a Danish version of Guillaume Du Bartas' *La Semaine*. The century was rich in occasional poetry celebrating weddings and birthdays or mourning for a deceased paragon of virtue; didactic and pastoral poems were also frequent. Anders Bording (1619–77), an interesting exponent of Danish baroque poetry, was also the founder of the first Danish newspaper, *Den Danske Mercurius* (from 1666), in which the news appeared in rhymed Alexandrines. The only truly great poet was Thomas Kingo (*q.v.*; 1634–1703), a supreme master in almost every kind of poetry. His hymns reflect a violent, passionate character, worldly and yet deeply religious. Among the few playwrights Mogens Skeel (1650–94) deserves mention.

The 18th Century.—Ludvig Holberg (*q.v.*; 1684–1754), a Norwegian by birth and upbringing, is the great name of Danish literature in the first half of the 18th century. His most important contribution is his 32 comedies written for the Danish theatre, which opened in 1722. His first 15 plays are comedies of character, 11 (written 1723–27) are comedies of manner and a final group, mainly written in his old age, are moral allegories. His aim was to create a modern Danish literature on European lines and to entertain by making people laugh at their own follies. He wrote also satires, *e.g.*, *Peder Paars* (1719–20), a mock-heroic poem, and *Niels Klim's Subterranean Travels* (in Latin; 1741). His *Moralske Tanker* ("Moral Thoughts," 1744) and his nearly 500 *Epistler* (1748–54) are the finest examples of a Danish political essay form. He also contributed a number of valuable histori-

cal works. Influenced by English and (mainly) French thinking, he was a sober rationalist, led by reason in all matters, who always preferred to follow a middle course.

Among Holberg's contemporaries the greatest lyrical poets are H. A. Brorson (*q.v.;* 1694–1764), a religious mystic whose Pietist hymns have often a background of personal sorrow or agony, and Ambrosius Stub (1705–58), whose poems are mainly religious and moralizing arias or occasional pieces, witty improvised epigrams or drinking songs. The satirist Christian Falster (1690–1752) was a conservative counterpart to Holberg; Friedrich Eilschov (1725–50) and Jens Schelderup Sneedorff (1724–64), the latter of whom edited *Den patriotiske Tilskuer* ("The Patriotic Spectator"), a Danish *Spectator,* were both rationalist disciples of Holberg. Notable historians were Hans Gram (1685–1748), Jacob Langebek (1710–75) and Erik Pontoppidan the Younger (1698–1764).

A significant revival of Danish literature took place toward the end of the century. The Norwegian Johan Herman Wessel (*q.v.;* 1742–85), one of the greatest humorists to use the Danish language, immortalized his name when, in 1772, he wrote *Kierlighed uden Strømper* ("Love Without Stockings"), a parody directed against the Danish imitations of Italian operas and French tragedies that had superseded Holberg's comedies on the Danish stage, especially those of Niels Krog Bredal (1732–78) and Johan Nordal Brun (1745–1816). His light humorous poems and versified narratives are still very popular. (*See* also NORWEGIAN LITERATURE: *Det Norske Selskab.*)

At the same time a revival of emotional poetry was taking place, influenced partly by German literature (Goethe, Schiller and Klopstock), partly by English literature (Shakespeare, Milton, James Macpherson, Thomas Percy, Edward Young and Thomas Gray). Johannes Ewald (*q.v.;* 1743–81), by many regarded as Denmark's greatest lyrical poet, was the first poet to delve into Scandinavian antiquity and discover the poetic wealth in the myths, in Saxo, in the sagas and in the ballads. *Rolf Krage* (1770) and *Balders Død* (1774–75; Eng. trans., *The Death of Balder*) are his best tragedies; *Fiskerne* ("The Fishermen," 1780) was the first serious Danish drama in which ordinary people were treated heroically. His lyrical poetry varies from the solemn and majestic to the simple and subdued expression of feelings. His memoirs, *Levnet og Meninger* ("Life and Opinions"), were influenced by Laurence Sterne and Jean Jacques Rousseau. Jens Baggesen (*q.v.;* 1764–1826) at first imitated the satires of Holberg and Wessel but gradually developed a style of his own. He is a poet of distinction, although the quality of his poetry varies much. In *Labyrinten* ("The Labyrinth," 1792–93), a charming arabesque, impressionistic in style, he described his travels in Europe in the manner of Sterne.

The end of the 18th century is marked by much literary dilettantism. P. A. Heiberg (1758–1841) is an interesting exponent of a militant radicalism, influenced by the ideas of the French Revolution. His plays (*e.g., De Vonner og de Vanner,* "The Von's and the Van's"), his satirical prose and his poems caused him to be expelled from Denmark and he spent his last 40 years in France as a political refugee. Malthe Conrad Bruun (*see* MALTE-BRUN, CONRAD, 1775–1826), the author of *Aristokraternes Catekismus* ("The Aristocrats' Catechism"), had a similar fate. This was the age of social clubs, and drinking songs abounded. Knud Lyne Rahbek (1760–1830), who founded and edited the periodicals *Minerva* and *Den danske Tilskuer,* was a versatile song writer. Among the plays of the period it will suffice to mention the charming comedy *Gulddaasen* ("The Gold Box") by Christian Olufsen (1763–1827), the idyllic and patriotic plays of Thomas Thaarup (1749–1821) and the historical tragedy *Dyveke* by Ole Samsøe (1759–96).

Among the several historical and critical writers of this period special mention should be made of Rasmus Nyerup (1759–1829), a scholarly philologist, and Werner Abrahamson (1744–1812), aesthete and critic. The popular historical essays, *Store og gode Handlinger af Danske, Norske og Holstenere* (1777; Eng. trans., *Great and Good Deeds of Danes, Norwegians, and Holsteinians,* 1807), by Ove Malling (1747–1829), exercised a great influence, as did the historical works of P. F. Suhm (1728–98).

The Romantic Period.—The romantic movement came to Denmark from Germany, inspired partly by the German Jena romantics, partly by the classicism of Goethe and Schiller. F. W. Schelling's philosophy was interpreted in Denmark by the Norwegian Henrik Steffens (*q.v.;* 1773–1845) but the leading Danish romantics gave it a form very different from the original. A. W. Schack von Staffeldt (1769–1826) was hardly recognized in his lifetime, and his metaphysical poetry lacked popular appeal.

Adam Oehlenschläger (*q.v.;* 1779–1850) became the leader of the movement in Denmark, and his versatile writings, especially between 1802 and 1807, were inspired by a youthful ecstasy. In poetry, drama and prose he gave evidence of poetic genius which has no parallel in Danish literature. *St. Hansaften-Spil* ("Play for Midsummer Eve") and *Aladdin* are among his most important early plays, both embodying the main ideas of Danish romanticism. *Hakon Jarl* ("Earl Håkon") is the best of his many northern tragedies, and among later works his cycle of dramatic poems, *Helge* (1814), is outstanding. N. F. S. Grundtvig (*q.v.;* 1783–1872) is a gigantic figure, not only in Danish literature, but also as an educationalist, a historian, a philological scholar and a politician. His popular and historical songs, his many hymns and his personal poetry give him a lasting place in literature. He shared the romantic enthusiasm for the antiquities of Scandinavia, interpreting the Scandinavian myths as poetic visions; he retranslated both Saxo and Snorri and translated *Beowulf* into Danish before it had even appeared in English. His *Haandbog i Verdens-Historien* ("Handbook of World History") is, like his other historical works, a strange mixture of scholarship, prophetic visions and insanity. B. S. Ingemann (*q.v.;* 1789–1862) inspired contemporary thought with the romantic ideas of chivalry and national pride through his historical novels (1824–36) and through his poetic cycle about *Holger Danske* ("Holger the Dane"). Of more lasting value, however, are his simple and unsophisticated *Morgen og Aftensange* ("Morning and Evening Songs"). Carsten Hauch (*q.v.;* 1790–1872) wrote dramas which are often sinister, tragic and philosophic, frequently in a historical setting; his historical novels reflect his philosophy of resignation. He ranks highest as a contemplative, lyrical poet.

Romantic Realism.—During the first quarter of the 19th century the early romantic movement was unchallenged. Then appeared two men who brought a new element of reason and realism into Danish literature. Poul Møller (*q.v.;* 1794–1838) was the author of the first novel in Danish dealing with contemporary events, *En dansk Students Eventyr* ("Adventures of a Danish Student," 1824), a charming book, full of gay humour. Some of his poems are in the form of dramatic scenes, others in the form of fables, often reflecting personal disillusionment. His brilliant aphorisms also deserve mention. Steen Steensen Blicher (*q.v.;* 1782–1848), an impoverished Jutland parson, was in his early life strongly influenced by Ossian; he translated Macpherson, Pope, Goldsmith and some of Percy's ballads. In *Trækfuglene* ("Birds of Passage," 1838) he interprets human nature with sad resignation; some of his best poems are in the Jutland dialect. His many *noveller,* beginning in 1824 with the masterly *Brudstykker af en Landsbydegns Dagbog* ("The Journal of a Parish Clerk"), strike notes varying from sorrow and resignation to humour and irony.

Minor writers of the same period are Thomasine Gyllembourg-Ehrensvärd (1773–1856), whose novel *En Hverdagshistorie* ("A Story of Everyday Life," 1828) was much admired; A. de Saint Aubain (1798–1865), who wrote novels under the nom de plume of Carl Bernhard; and Carl Bagger (1807–46), whose novel *Min Broders Levnet* ("My Brother's Life," 1835) shocked the literary world by its bold realism.

Poetic Realism.—About 1830 the early romanticism gave way to a poetic realism, less naïve, more contemplative and more concerned with form than with content. The leader of this movement, Johan Ludvig Heiberg (*q.v.;* 1791–1860), was at his zenith the dictator of literary taste in Copenhagen. As a dramatist he attempted to revivify Danish drama by importing French vaudeville (*q.v.*) and in his serious romantic plays, *e.g., Elverhøj* ("The Fairy

Hill") and *Syvsoverdag* ("Day of the Seven Sleepers"), there is an interplay between the worlds of poetic and pedestrian reality. His finest achievement is the verse comedy *En Sjæl efter Døden* ("A Soul After Death," 1841). He was a literary critic of high distinction, strongly influenced by the philosophy of Hegel. Henrik Hertz (*q.v.;* 1797?–1870) also regarded perfection of form as more important than content, as is clearly expressed in his *Gjenganger-Breve* ("Letters of a Ghost," 1830). As a poet he was a clever imitator of style; as a playwright he wrote both light comedies and serious romantic plays, *e.g., Svend Dyrings Hus* ("Svend Dyring's House") and *Kong Renés Datter* (1845; Eng. trans., *King René's Daughter,* 1850).

A revival of lyrical poetry took place in the 1830s and 1840s, led by Christian Winther (1796–1876), Ludvig Adolf Bødtcher (1793–1874) and Emil Aarestrup (1800–56). They are mainly concerned with love and nature, treated in a purely aesthetic manner. Winther was a Zealand poet, who sang the praises of his native island and of woman. His long verse novel *Hjortens Flugt* ("The Flight of the Stag," 1855) is his main work. Bødtcher wrote only a handful of poems, several of which were inspired by the Italian scene; his poetry is delicate, sensitive and artistically sober. Aarestrup, Gallic in his taste, was an epicurean, a lover and connoisseur of beauty; he is Denmark's erotic poet par excellence. Frederik Paludan-Müller (*q.v.;* 1809–76), originally a light and frivolous disciple of Byron, became eventually an uncompromising moralist, condemning the world and the flesh. His main work, *Adam Homo* (1841–48), a poetic epic in 12 cantos, is a bitter contemporary satire. The subjects of his poems are often mythological or biblical; *e.g., Venus, Kalanus* and *Kain.*

Hans Christian Andersen (*q.v.;* 1805–75) wrote novels, *e.g., Improvisatoren* (1835; Eng. trans., *The Improvisatore*), poems, plays and travel sketches; but of lasting value are only his fairy tales and stories, 164 in all, the first 4 published in 1835. Some are based on Danish folk tales, some on historical incidents; the plots of others are from foreign sources; but most of them are his own invention, often springing from some personal event. They were told for children, but their ideas are often better understood by adults. His own story is told in *Mit Livs Eventyr* (1855; Eng. trans., *The Story of My Life,* 1871).

Søren Aabye Kierkegaard (*q.v.;* 1813–55) holds an entirely isolated position in Danish literature, unattached to any group of writers and with hardly any followers in his lifetime. His religious philosophy is expressed in such works as *Enten-Eller* (1843; Eng. trans., *Either-Or,* 1944) and *Stadier paa Livets Vej* (1845; Eng. trans., *Stages on Life's Way,* 1940). He spent his last years in a violent and passionate attack on "official Christianity."

M. A. Goldschmidt (*q.v.;* 1819–87), a Danish Jew, was the editor of a rebellious, antiroyalist weekly, *Corsaren* ("The Corsair," 1840–46). Many of his novels are concerned with Jewish life in the Danish community; *e.g., En Jøde* (1845). The 1850s and 1860s produced hardly any new Danish writers of importance. The poetry of Carl Ploug (1813–94) has little inspiration, and the Grundtvigian songs and light comedies of Jens Christian Hostrup (1818–92) have more popular than literary value. Christian Richardt (1831–92) and H. V. Kaalund (1818–85) did little more than rehash the better-known romantic themes. Edvard Lembcke (1815–97) should be mentioned for his translations of Shakespeare and Byron. The novels of Vilhelm Bergsøe (1835–1911), *e.g., Fra Piazza del Popolo* ("From the Piazza del Popolo," 1866), Carl Brosbøll (1816–1900), who wrote under the nom de plume of Carit Etlar, and H. F. Ewald (1821–1908) are mainly entertaining. The most original novelist of the period was Hans Egede Schack (1820–59), whose novel *Phantasterne* ("The Day Dreamers," 1857) reveals great psychological gifts. Philosophers of some distinction are Frederik Christian Sibbern (1785–1872), Rasmus Nielsen (1809–84) and Hans Brøchner (1820–75).

Radical Realism.—*Det moderne gennembrud* is the Danish term used to describe the new movement beginning about 1870 in which a modern (*i.e.,* naturalistic or realistic) literature emerged—a movement of which Georg Brandes (*q.v.;* 1842–1927) was the spiritual leader. Originally influenced by H. A. Taine, C. A. Sainte-Beuve and John Stuart Mill, he felt it his mission as a critic to awaken the Danes and bring Denmark out of its backwater and isolation. His *Hovedstrømninger i det 19de Aarhundredes Litteratur* (1872–90; Eng. trans., *Main Currents in 19th Century Literature,* 1901–05) caused a great sensation, and his demands that literature should concern itself with life and reality, not with dreams and fantasy, and that it should work in the service of progress, not in the service of reaction, provoked much discussion and influenced, outside Denmark, both Henrik Ibsen and August Strindberg. Among his many critical and scholarly books his various biographies of great men (*e.g.,* Shakespeare, Goethe, Voltaire) should be mentioned; these were to some extent written under the influence of F. W. Nietzsche, whose "aristocratic radicalism" he came to share. J. P. Jacobsen (*q.v.;* 1847–85) was among the first Danish writers to be influenced by Brandes; his novel *Niels Lyhne* and his short stories deal with the problem of dreams versus reality. In *Marie Grubbe* he introduced the naturalism of Gustave Flaubert. Holger Drachmann (*q.v.;* 1846–1908), the greatest lyrical poet of the period, began his career as a staunch supporter of Brandes, against whom he reacted strongly later on. Passionate, impulsive and capricious, he is the author of many fine love poems; much of his poetry and prose is concerned with the sea and with the lives of sailors and fishermen. The novels and peasant stories of Sophus Schandorff (1836–1901) show prose realism of less artistic value. Vilhelm Topsøe (1840–81) depicted contemporary life with subtle irony in his prose works. Edvard Brandes (1847–1931), Georg's brother, discussed topical problems in his plays.

Henrik Pontoppidan (*q.v.;* 1857–1943) holds rank as one of Denmark's greatest novelists. His early stories reveal social injustices; and in several of his short novels he discusses the political, moral and religious problems of his day. But his greatest work is his three long novel cycles, *Det forjættede Land* (1891–95; Eng. trans., *The Promised Land,* 1896), *Lykke-Per* ("Lucky Peter," 1898–1904) and *De Dødes Rige* ("The Kingdom of the Dead," 1912–16). They are all concerned with contemporary Denmark and are most penetrating and convincing, though little flattering, analyses of Danish national character. Herman Bang (1857–1912) was another novelist who cultivated the small things: insignificant people, the gray and lonely and miserable men and women who are normally overlooked because nothing ever seems to happen in their undramatic lives. In his best novels, *e.g., Ved Vejen* ("By the Way-side," 1886) and *Tine* (1889), and in *Det hvide Hus* ("The White House," 1898), a nostalgic recollection of childhood, he displays the virtuosity of his impressionistic technique. Karl Gjellerup (*q.v.;* 1857–1919) began as a disciple of Brandes, whom he later opposed. There is a fine poetic beauty in his best novels, *e.g., Minna* and *Møllen* ("The Mill"), but the metaphysical idealism of his later novels has made them unreadable.

Other notable prose writers toward the end of the century were Gustav Wied (1858–1914), a novelist and playwright, whose wit is cynical and bitter; his "satyr-plays" and his novels *Livsens Ondskab* ("Life's Wickedness") and *Knagsted* are full of malicious humour; Peter Nansen (1861–1918), whose stories are in the style of Maupassant; Carl Ewald (1856–1908), whose nature stories are based on Darwinian philosophy; Otto Benzon (1856–1927) and Gustav Esmann (1860–1904), playwrights; and Karl Larsen (1860–1931), who caught the atmosphere of Copenhagen and drew a picture of Danish "cockneys" with fine linguistic precision. Sven Lange (1868–1930), Einar Christiansen (1861–1939) and Henri Nathansen (1868–1944) are three notable playwrights.

Poetic Revival.—In the 1890s a neoromantic poetic revival took place. Emotions and fantasy were reinstated. The lyric poets of the period called themselves "symbolists," as their object was "to express the inexpressible in symbolic form." Their poems often describe mental processes and religious and mystic experiences. Johannes Jørgensen (1866–1956) was their leader; he became a convert to Roman Catholicism, and many of his prose books are also widely read; *e.g.,* his *Lignelser* ("Parables"), his books of travel, his biographies of saints (*e.g.,* of St. Francis and of St. Catherine of Siena) and his autobiography, *Mit Livs Legende* (1916–28). Viggo Stuckenberg (1863–1905) was a poet

who gave tender expressions of sad resignation. Sophus Claussen (1865–1931) was a lustful and sensual lover of female beauty, a pantheistic lover of nature and a sophisticated and capricious aesthete, whose poems are often obscure riddles. Helge Rode (1870–1937) was a religious mystic; as well as poetry he also wrote plays and critical works attacking modern intellectualism. Ludvig Holstein (1864–1943) was more akin to Goethe and Oehlenschläger than to his own generation of symbolists. Other notable neoromantic poets of the same period were Sophus Michaëlis (1865–1932), Thor Lange (1851–1915) and Niels Møller (1859–1941).

Several women made important contributions to Danish literature toward the end of the century and after. Gyrithe Lemche (1866–1945) is well known for her novel cycle *Edwardsgave.* Agnes Henningsen (1868–) is a brilliant prose writer, whose novels are often concerned with the erotic experiences of the emancipated woman. Karin Michaëlis (1872–1950) was a fine psychologist; among her many novels *Den farlige Alder* (1910; Eng. trans., *The Dangerous Age,* 1911) is best known.

The 20th Century.—The two greatest Danish novelists of the beginning of the 20th century were Martin Andersen Nexø (*q.v.;* 1869–1954) and Johannes V. Jensen (*q.v.;* 1873–1950). Andersen Nexø's fame is based almost entirely on his two great epics of proletarian life, *Pelle Erobreren* (1906–10; Eng. trans., *Pelle the Conqueror,* 1913–16) and *Ditte Menneskebarn* (1917–21; Eng. trans., *Daughter of Man,* 1920–23). All his novels and short stories are concerned with the lives of poor people. His four volumes of reminiscences (1932–39) rank among the finest in Danish literature. Jensen, a north Jutlander, expressed his Darwinian philosophy in his long novel cycle *Den lange Rejse* (1908–22; Eng. trans., *The Long Journey,* 3 vol., 1922–24), an ambitious epic of man from the baboon stage to modern times. His *Himmerlands Historier* contain forceful descriptions of the people and scenery of northern Jutland, and his novel *Kongens Fald* (1901; Eng. trans., *The Fall of the King,* 1933) ranks high; his nine volumes of *Myter* ("Myths") are a happy mixture of fiction and essay. He was also a great and original lyric poet and a prolific essayist.

Another Jutlander was Jeppe Aakjær (1866–1930), whose novels of social criticism are less important than his poetry, which has a wide popular appeal. Two other notable Jutland poets were Johan Skjoldborg (1861–1936) and Thøger Larsen (1875–1928).

Jakob Knudsen (1858–1917) was the Carlyle of Denmark, one who believed in the inequality of man and in the necessity of authority and obedience; he discusses Christian and moral problems in his novels, *e.g., Den gamle Præst* ("The Old Priest") and *Lærer Urup* ("Schoolmaster Urup"). The novels of Marie Bregendahl (1867–1940), Harry Søiberg (1880–1954) and Thomas Olesen Løkken (1877–1955) all contain faithful descriptions of Jutland.

Harald Kidde (1878–1918) is a solitary, introspective and melancholy novelist, preaching a gospel of renunciation and humility, as, for example, in *Aage og Else* and *Helten* ("The Hero"). Knud Hjortø (1869–1931) is a keen and intelligent observer, whose novels are mainly psychological. Provincial life is described in a baroque and fanciful manner in the novels of Johannes Buchholtz (1882–1940); *e.g., Egholms Gud* (1915; Eng. trans., *Egholm and His God,* 1921) and *Clara van Haags Mirakler* (1916; Eng. trans., *The Miracles of Clara van Haag,* 1922). Other noteworthy novelists are Hans Povlsen (1886–), Otto Rung (1874–1945), Poul Levin (1869–1929), J. Anker Larsen (1874–1957), Thit Jensen (1876–1957) and Astrid Ehrencron Kidde (1874–1960).

Two important lyrical poets were Valdemar Rørdam (1872–1946) and Kai Hoffmann (1874–1949).

After World War I.—The most significant poets of the 1920s were Tom Kristensen (1893–), whose novels—*e.g., Livets Arabesk* ("Life's Arabesque," 1921) and *Hærværk* ("Havoc," 1930)—are also important, Otto Gelsted (1888–), Emil Bønnelycke (1893–1953), Hans Hartvig Seedorff (1892–), Harald Bergstedt (1877–) and Per Lange (1901–). Jacob Paludan (1896–) is an important novelist, whose main works are *Fugle omkring Fyret* (1925; Eng. trans., *Birds Around the Light,* 1928) and Jørgen Stein (1937). The novels of Hans Kirk (1898–), especially *Fiskerne* ("The Fishermen," 1928), represent social realism at its best. Harald Herdal (1900–) is a disciple of Andersen Nexø; his proletarian novels reveal the rottenness and hypocrisy of modern society. Mogens Klitgaard (1906–45) and Leck Fischer (1904–56) have both been concerned with the lower middle classes in their novels and short stories.

The novels of Jørgen Nielsen (1902–45) are set among Jutland peasants, and their themes are suppressed feelings: hatred, sin and fear. Similar problems, but in a different milieu, are treated in the novels of Michael Tejn (1911–). Aage Dons (1903–) concentrates on feeling and penetrating analyses of the depths and conflicts of the human soul. H. C. Branner (1903–) is an important novelist and playwright, who in *Rytteren* (1949; Eng. trans., *The Riding Master,* 1951) and *Ingen kender Natten* (1955; Eng. trans., *No Man Knows the Night,* 1958) deals with the loneliness of men, the dangers of fear and of power; he is a superb short-story writer, of outstanding psychological penetration. Martin A. Hansen (1909–55) recalled Johannes V. Jensen in his early novels but later works, *e.g., Løgneren* (1950; Eng. trans. *The Liar,* 1954), showed a tendency toward an anti-intellectual mysticism, related to that of the youngest generation of post-World War II poets. Knud Sønderby (1909–) is a novelist, short-story writer and playwright with a brilliant style and a deep psychological understanding. Hans Scherfig (1905–) writes novels, usually disguised as detective stories, full of acid satire. Other noteworthy prose writers are Karl Bjarnhof (1898–), Erik Aalbæk Jensen (1923–) and Hans Lyngby Jepsen (1920–).

Nis Petersen (1897–1943) held a high position as a poet and was also a distinguished novelist. His *Sandalmagernes Gade* (1931; Eng. trans., *The Street of the Sandalmakers,* 1933) is set in ancient Rome and *Spildt Mælk* (1934; Eng. trans., *Spilt Milk,* 1935) in Ireland at the time of the rebellion. Karen Blixen (1885–1962), whose first book, *Seven Gothic Tales,* was first published in English under the nom de plume of Isak Dinesen in 1934, is a refined, aristocratic writer, with a subtle irony, and with an unusual elegance and sensitivity. Her books *Out of Africa* (1937), *Winter's Tales* (1942) and *Last Tales* (1957) published simultaneously in English and Danish, should also be mentioned. Two Faroese novelists have also made important contributions to contemporary Danish literature: Jørgen-Frantz Jacobsen (1900–38), whose novel *Barbara* was published in 1939 (Eng. trans. 1948), and William Heinesen (1900–).

Sven Clausen (1893–1961) and Svend Borberg (1888–1947) represent the post-World War I generation of Danish playwrights, influenced by German expressionism, by symbolism, by Luigi Pirandello and by Sigmund Freud. Kaj Munk (*q.v.;* 1898–1944), a dramatist of unusual qualities, revived the "heroic" Shakespearean and Schillerian drama. Among his best plays are *En Idealist* (1928; Eng. trans., *Herod the King,* 1955) and *Ordet* (1932; Eng. trans., *The Word*). He was a religious agitator who used the stage as a pulpit and all his dramas are concerned with the problems of God and man. Kjeld Abell (1901–61) was an iconoclast in both form and content. His first plays mark a complete break with naturalistic drama, and there is always a deep and radical perspective underlying his remarkably witty and sparkling dialogue. His most important plays are *Melodien, der blev væk* (Eng. trans., *The Melody That Got Lost,* 1937), *Anna Sophie Hedvig* (1939) and *Dage paa en Sky* ("Days on a Cloud," 1947). C. E. Soya (1896–) is yet another brilliant playwright as well as a short-story writer and a novelist.

Kai Friis Møller (1888–1960) was a distinguished poet and critic, also a fine translator of French and English poetry. Paul la Cour (1902–56), a lyrical poet, was influenced by the modern French intellectual school. Other poets with established names are Hulda Lütken (1896–1946), Jens August Schade (1903–), Alex Garff (1904–), Tove Ditlevsen (1918–), also a fine novelist and short-story writer, and Morten Nielsen (1922–44). The most interesting younger lyrical poets of the mid-20th century were Ole Sarvig, Ove Abildgaard, Ole Wivel, Halfdan Rasmussen, Frank Jæger, Thorkild Bjørnvig, Erik Knudsen, Jørgen Nash, Grethe Heltberg and Grethe Risbjerg Thomsen. The leading lit-

erary scholars and critics of the century were Axel Olrik (1864–1917), Vilhelm Andersen (1864–1953), Valdemar Vedel (1865–1942), Hans Brix (1870–1960), Vilhelm Grønbech (1873–1948), Paul V. Rubow (1896–) and Sven Møller Kristensen (1909–).

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DANNECKER, JOHANN HEINRICH VON (1758–1841), German neoclassical sculptor, in whose works the influence of Canova and the study of the antique are apparent, was born at Stuttgart, on Oct. 15, 1758. His father was employed in the stables of the duke of Württemberg. Dannecker studied under local late-rococo masters and in 1780 was made sculptor to the ducal palace.

In 1783 Dannecker left for Paris, and placed himself under Augustin Pajou; in 1785 he went to Rome, where he worked for five years. Goethe and Herder were then in Rome, and they, as well as Canova, who was the hero of the day, became his friends. Subsequently he returned to Stuttgart, where he lived for the remainder of his life.

The Ariadne (1806, Bethmann museum, Frankfurt), was the most popular of his works. Many illustrious persons were modeled by him, including Friedrich Schiller, of whom he did three portrait busts.

Dannecker was director of the Gallery of Stuttgart, and received many academic and other distinctions. He died in Stuttgart on Dec. 8, 1841.

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D'ANNUNZIO, GABRIELE (1863–1938), Italian poet, celebrated not only for his poems, novels and dramas but also for his two important interventions in political affairs, was born in Pescara, Abruzzi, on March 12, 1863. In 1879, while still at school, he published a collection of poems, *Primo vere*. This was followed by new poems and short stories in 1882 and then by the long series of lyrics, stories and novels (the last-named including *Il piacere*, 1889, Eng. trans., *The Child of Pleasure*, 1898; *L'innocente*, 1892, Eng. trans., *The Intruder*, 1898, new ed. 1919; and *Il trionfo della morte*, 1894, Eng. trans., *The Triumph of Death*, 1896, new ed. 1923) which established his literary reputation. At this time he lived mainly in Rome, where he also proved himself brilliant as a journalist.

In 1896, when he was beginning to write for the stage, D'Annunzio made the acquaintance of the actress Eleonora Duse (*q.v.*), whose lover he soon became. Duse took the leading role in the Parisian production of D'Annunzio's drama *Sogno d'un mattino di primavera* (1897; Eng. trans., *The Dream of a Spring Morning*, 1902) and—after he had preferred Sarah Bernhardt for the Parisian production of his tragedy *La città morta* (in a French version; 1898; Eng. trans., *The Dead City*, 1902)—in the Italian productions of his next two tragedies, *La Gioconda* (1899; Eng. trans., *Gioconda*, 1901, new ed. 1921) and *Francesca da Rimini* (1901; Eng. trans., 1902), as well as in the Italian production of *La città morta*. Another actress, however, was given the leading role in *La figlia di Iorio* (1904; Eng. trans., *The Daughter of Jorio*, 1907), which is D'Annunzio's greatest tragedy; and thereafter his association with Duse, the earlier part of which he had already portrayed in his novel *Il fuoco* (1900; Eng. trans., *The Flame of Life*, 1900, new ed. 1932), moved steadily toward a close.

Meanwhile D'Annunzio, after serving for a time as a deputy in the Italian parliament (1897–1900), had settled in Tuscany. From there, in a revival of his poetic inspiration, he published three books, *Maia* (1903), *Elettra* and *Alcyone* (both 1904), in the lyrical series *Laudi del cielo, del mare, della terra e degli eroi* (1903–12). New plays and a new novel followed; but these failed to bring him the money required for his extravagant way of life, and in 1910 he was obliged to leave Italy in order to escape from his creditors. Settling in France, he wrote some plays in French; and for one of these, *Le martyre de Saint Sébastien* (1911), Debussy provided an important score of incidental music.

On the outbreak of World War I, D'Annunzio came forward as an advocate of Italian intervention on the side of the Allies; and in May 1915 the Italian government, being already resolved on such intervention, facilitated his return to Italy to prepare public opinion. D'Annunzio's influence, enhanced as it was by his earlier patriotic poems *Odi navali* (1892–93) and *Canzoni della gesta d'oltremare* (1912), was effective. When war was declared, he served with distinction in the army and then in the air force.

After the Armistice of 1918 the national hero came forward as a nationalist leader. On Sept. 12, 1919, with fewer than 300 volunteers, he occupied Fiume (Rijeka), which the Italian government and its Allies at the peace conference, having taken it from Austria-Hungary, were proposing to incorporate in the newly formed Yugoslav state. Enthusiastically received by the Italian population, he maintained himself there as "commandant" and, in defiance of the powers, proclaimed on Sept. 8, 1920, "the Italian regency of the Carnaro." On Christmas day 1920, however, Italian government forces bombarded his headquarters; and three days later he abdicated his authority. Even so, his action had established the Italian interest in the city.

Despite the impetus given to Fascism by the Fiume episode (*see* ITALY: *History*), D'Annunzio exercised no influence on Italian politics after 1922. The last years of his life were spent in princely retirement at Gardone, on Lake Garda, where he died on March 1, 1938.

D'Annunzio's adventurous and successful career, the scandal of his amours, his daring in wartime, his eloquence and his political leadership in two national crises, all contributed to make him one of the most striking personalities of his day. The faults of his moral character and the sequels to his political activity, which made even his less good plays excessively popular and caused the occasional redundance of his style to be overlooked, have affected his literary reputation adversely. Yet he was a poet, and at times a very good one.

Apart from certain books autobiographical in character, such as *Notturno* (1921) and *Le faville del maglio* (1924–28), there is not much in D'Annunzio's vast output of prose that can be read without tedium: he was too receptive of the various currents of contemporary thought and style, so that his work is liable to reflect indiscriminately the influences of other writers—from Dostoevski to Nietzsche, from Maeterlinck to Maurice Barrès. The same can be said of most of his plays. One of them, however, *La figlia di Iorio*, is a great work of poetry, a powerful peasant tragedy of the Abruzzi mountains, rooted in the primitive fears, passions and superstitions of D'Annunzio's own countrymen.

As a poet D'Annunzio clearly derives his powers from his great emotional susceptibility. Already in *Primo vere* and *Canto novo*, when his technique was still modeled on Carducci's classical prosody, he had shown an astonishing gift in rendering with precision and power the healthy exuberance and youthful intensity of a boy in love with nature and with women. Though he turned to morbid and decadent themes in *La chimera* (1890) and in *Poema paradisiaco* (1893), he recovered the vitality of his inspiration and found a new musical, modern form for its expression in the great work of his maturity, the *Laudi*, especially in its third book, *Alcyone*. Some of the poems in this book, in which D'Annunzio proclaims his sensuous, joyful feeling of communion and even identification with nature ("La pioggia nel pineto," "Meriggio")

are among the masterpieces of modern Italian poetry and have had great influence on later poets. On the whole *Alcyone* may be called the best Italian book of poems since Leopardi's *Canti*.

For D'Annunzio's complete works see the "national edition" by A. Sodini, 48 volumes with one volume supplement (1927–36). For a portrait of D'Annunzio *see* ITALIAN LITERATURE.

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DAN TAKUMA (1858–1932), a Japanese engineer and businessman of the samurai class, one of the most powerful members of Japan's so-called "unseen government" during the 1920s. In 1871 he went to the United States where he studied mining engineering, returning to Japan in 1878. For a short time he taught at Tokyo university but later he was employed successively in the bureau of industry and by the House of Mitsui when it acquired, in 1888, the government mine at which he was working. From the management of the mine, which he turned into a rich source of profit for the Mitsui family, he joined the Mitsui Trading company when it was founded in 1909. As manager of that company he became the guiding genius of the Mitsui empire. He was assassinated on March 5, 1932, by nationalists who regarded him as a symbol of the evil power of high finance in government. (T. C. SH.)

DANTE (full name DANTE or DURANTE ALIGHIERI) (1265–1321), the greatest poet of Italy, if not of medieval and modern times, and author of the greatest Christian poem, the *Divina Commedia* or *Divine Comedy*. The loftiness of his art is revealed by the immense variety of his literary output and by the exceptional breadth and depth of his interests. The *Divina Commedia* is in itself an epitome of medieval civilization, though in certain respects it also belongs, with the works of Petrarch and Boccaccio, to that profound cultural renewal which established the new humanism and opened the way to modern civilization.

The son of Alighiero di Bellincione and his wife Bella, Dante was born in Florence under the zodiacal constellation of the Twins (see *Paradiso,* canto xxiii, lines 112–17), *i.e.,* between May 15 and June 15, 1265. The sources of our information about Dante's ancestry are his own lines in *Paradiso* (xv–xvi) and a few legal documents which have survived. His great-great-grandfather, Cacciaguida, died in Conrad II's service in the Holy Land during the Second Crusade (1147) and Dante traced his ancestry farther back, giving it a legendary connection with the Roman origins of Florence (*Inferno,* xv, 73–78). His family were ancient city nobility, not wealthy country landowners but part of the economic life of the commercial and industrial commune. Dante's grandfather, Bellincione, was a moneylender in Florence and Prato, and his father Alighiero carried on the same business until his death (before 1283). These activities were nothing to be proud of, which explains why the poet seldom refers to his nearest kin. The family's importance in the political life of Guelph Florence is proved—at least in the case of Dante's father and grandfather—to have been negligible by their not being exiled after the defeat of the Guelphs at Montaperti (Oct. 1260).

At the time of Dante's birth the Florentines were devoting all their energies to territorial and economic expansion, which in later years the poet justly condemned (*Paradiso,* xvi, 49–78) as the basic cause of the internal conflicts lacerating the life of the city. These conflicts were chiefly between the Guelph and the Ghibelline factions, which were, broadly speaking, the party of the pope and the party of the emperor. The Guelphs were dominant in 1266 and remained so well into the 14th century.

Boyhood and Early Studies.—Dante's mother died when he was a small child: his father remarried later and the poet's childhood was enlivened only by the company of an elder sister, who soon married, and of Francesco and Tana (Gaetana), his half-brother and half-sister by his father's second marriage. Dante's study of grammar and rhetoric began early and his natural bent for poetry was fostered by the contacts he made as a boy in cultured Florentine society. The most important of these was with Brunetto Latini (*q.v.*), who returned to Florence from exile in 1266 and died there in 1294, having held several important public appointments. Even if Brunetto Latini was not in the strictest sense Dante's teacher, he taught him, at any rate, on the poet's own admission, "how man makes himself eternal" (*Inferno,* xv, 85)—*i.e.,* how a man may make a lasting mark for himself by means of his works. *Detto d'Amore* and *Fiore,* two bold and assured versions of the *Roman de la Rose* in Italian verse, written at no great distance in time from each other, might be evidence of such an apprenticeship in the arts of rhetoric and poetry. Both show the influence of Latini's verbal technique and of the popularizing style so dear to him, and if they were written by Dante, reveal the effect of his teaching on the young poet.

Another literary influence was that of the Florentine poets who wrote in the wake of the Sicilian school and of Guittone d' Arezzo (*q.v.*), a circle whose poems are in the 13th-century Vatican Codex 3793; their compositions are certainly related, even intimately so, to the verse which the young poetry-reader Dante wrote before he adopted the *stil novo* ("new style"; *see* ITALIAN LITERATURE: *The Beginnings: The "Stil Novo"*). But the most important influence on the actual development of Dante's art was the poetry and the friendship of Guido Cavalcanti (*q.v.*), to whom Dante sent the sonnet "A ciascun' alma presa e gentil core." Dante married shortly afterward—probably about 1285—Gemma Donati (assigned to be his bride as early as 1277). Almost ten years later the sonnet appeared at the beginning of the *Vita Nuova,* which is dedicated to Cavalcanti. Thus Dante's poetic experiments developed first along the lines of the poetry of the Sicilian school and of Guittone (as in his correspondence with Dante da Maiano) and then, suddenly, under the influence of Cavalcanti (and in the light, graceful lines of some of the *ballate* there can be heard in the notes of acute distress and tormented love the stirrings of new elements of style); but the poet acquired his own marked character later when, with the so-called "rhymes of praise" for Beatrice he freed himself from the patterns of traditional love poetry, and, developing to the full the lesson of Guido Guinizelli (ever after recognized as his master, *Purgatorio,* xvi, 97–98), emerged from the "vulgar crowd" (*Inferno,* ii, 105) with the canzone "Donne ch'avete intelletto d'amore," distinguishing himself from the other vernacular poets by the nobility of his inspiration and his mastery of style.

The "Vita Nuova" (The New Life).—The theme of Dante's first work of importance was his love for Beatrice (Folco Portinari's daughter, later the wife of Simone de' Bardi: she died on June 8, 1290). Written about 1293 and conceived within a purely literary framework as a *prosimetrum* (*i.e.,* work partly in prose and partly in verse), modeled on Boethius' *De consolatione philosophiae,* it brought together in the framework of a commentary and narrative in prose 31 compositions written between 1283 and 1291, arranged in an imaginative and conceptual order arising from his memories and his reflections on the events and the fundamental stages of that love, from the first meeting with Beatrice, which occurred when he was nine years old, to the second, nine years later, when a greeting from the "wonderful lady" left the young poet "as if intoxicated."

Love now completely dominated Dante and almost destroyed his vital powers. Anxious, however, to conceal from the world the true object of his love, he composed "certain trifles in verse" for two other ladies. As a result, people passed comments, Beatrice refused her salutation and the poet, thus deprived of that "which was the goal of all his desires" (*Vita Nuova,* xviii, 4), discovered after a period of deep discouragement his only happiness (which no one could take away from him) in the disinterested praise of his lady, expressed poetically in the series of compositions which begin with "Donne ch'avete."

On Beatrice's death in 1290 the poet almost went out of his mind, but found solace briefly with a gentle and compassionate young woman. But the memory of Beatrice overcame him again; and he directed all his thoughts to her in heaven. After a "wonderful vision" (probably foreshadowing the glorification of Beatrice "on the throne that her merits assigned to her," *Paradiso,* xxxi, 69), Dante decided to write no more about her until he was able to do so in a more worthy manner and to say of her "What hath

not before been written of any woman."

The *Vita Nuova* is not only rich in undoubtedly autobiographical detail but also displays much variety of literary style, including features of the *stil novo* and some deriving from Provençal culture, and in the prose section shows signs of the influence of philosophical thinking—apparently evidence of Dante's new interests (he had begun the philosophical studies of which he speaks in *Convivio*, II, xii, 1–5). The work is important both for its poetic value and also as part of the tradition of Italian literary prose; but above all it throws light on the artistic and conceptual influences and the historio-biographical elements which, 20 years later, were to give life to the figure of Beatrice, one of the essential personages of the *Divina Commedia*. In fact in the *Vita Nuova* she already appears as the first of the great inspiring Muses of modern poetry, comparable in importance to Laura, the inspiration of Petrarch.

After the "Vita Nuova"; Political Life up to the Time of Dante's Exile.—The death of Beatrice was followed by a period of hard study. This was the basis of Dante's whole theoretical outlook and of his practical activities: side by side with the poet there appeared the robust, if not perhaps original, thinker of the more complex works of his maturity. Boethius and Cicero opened a new world to him; he frequented "the schools of the religious and the disputations of the philosophers" (*Convivio*, II, xii, 7) in Franciscan and Dominican establishments. His thought was enriched and his knowledge of the classical and medieval texts and authors fundamental to his development (Virgil, Lucan, Horace, Ovid; the *Ethics* of Aristotle in the commentary of St. Thomas Aquinas; Albertus Magnus, Bonaventura and Aquinas himself) gave rise to the allegorical poems conceived in praise of philosophy as *scientia* ("Voi che'ntendendo il terzo ciel movete" and "Amor che ne la mente mi ragiona"), and those which are doctrinal, celebrating two moral virtues—nobility and grace.

The new themes of the latter ("Le dolci rime" and "Poscia ch'amor") reflect not only, like their predecessors, the broadening of his culture and of his range of enquiry; their clear-cut criticisms of current ideas and ways of life also arise from daily experience of the class jealousies underlying the violence of the aristocracy.

The Guelph nobility provided much of the manpower in the successful military enterprises undertaken by Florence against the Ghibellines of Pisa and Arezzo (Dante himself took part in the battle of Campaldino against the Aretines—June 11, 1289—and witnessed two years later the surrender of the Pisan infantry at Caprona—*see Inferno*, xxi, 95, xxii, 4–6; *Purgatorio*, v, 92), which put fresh heart into the aristocracy. They had lost power through the establishment of the constitution of the *secondo popolo* and the nomination of six *priori* of the guilds (*see* FLORENCE: *History*) and wished to regain their former positions of supremacy. The *Ordinamenti di Giustizia* (Jan. 1293) were enforced to lessen their influence, but in 1295 a new law passed by the signoria which expelled the originator of the *Ordinamenti*, Giano della Bella, allowed the nobles to take office provided they had joined, even only nominally, one of the guilds, and were not knights. It was at this period that Dante entered political life, enrolling in the guild of physicians and apothecaries (probably chosen because of his philosophical studies). As a member of the special council of the captain of the people, for the six-month period from Nov. 1295 to April 1296 (his first experience of public life) he was not very active: he never made a speech. At that time he had purely literary preoccupations.

The first of his four *"rime petrose"* ("Io son venuto al punto della rota") written for a lady "Pietra," who harshly rejected his love, were written in Dec. 1296; they are no longer considered evidence of an ardent sensual passion, but the beginning of a more mature period of experiments in metre and style (in which he modeled himself on one of the Provençal troubadours, Arnaut Daniel—a difficult task for a Tuscan poet), far removed from the youthful poetry of the *stil novo*, and pointing, in their energetic use of language and their inventiveness, toward the stylistic virtuosity of his major work—an outstanding example, in short, of Dante's linguistic ability, which before his maturity had helped him to write (besides the poems of the *Vita Nuova*) the humorous, realistic sonnets of the *Tenzone* (correspondence) with Forese Donati, and which was to be established later in the stylistic complexity of the *Commedia*.

After 1295 (when Boniface VIII was elected to the papacy) events forced Dante into the midst of the city's affairs and he became an important and responsible figure in Florentine politics. The Guelph nobility had split into two factions, the Whites (led by the Cerchi family) and the Blacks (led by the Donati): the new pope apparently attempted to reconcile them, but made a secret agreement with the Blacks, who were hoping to destroy the popular commune, to settle the argument in their favour and to further his own plans for territorial aggrandizement in Tuscany. By early 1300 the Florentines had clear evidence of these intrigues and the signoria (White in sympathy) struck sharply against the traitors, despite the fierce opposition of the pope. Dante's position we are better able to guess than to establish by evidence, lacking the minutes of the council's deliberations between July 1298 and Feb. 1301. Thereafter he upheld a policy of independence and autonomy. On May 7, 1300, he was sent as ambassador to San Gimignano to consolidate the Guelph league in the war supporting the pope against the Aldobrandeschi of Santa Fiora, but also to strengthen the ties uniting the members of the league against the pope's attempts to become the dominant partner in the league. He was then nominated as *priore* for the period from June 15 until Aug. 14, 1300, which was a recognition of his acute political vision. On June 23 the consuls of the guilds were attacked by the Black nobles. The *priori*, to ensure peace, banished equal numbers of leaders of both parties, including Cavalcanti, the poet's "first friend," who was exiled. Meanwhile, on June 27 Cardinal d'Aquasparta, who had been sent as pacifier by Boniface with the secret purpose of aiding the Donati, arrived in Florence. When his mission failed, the pope decided to ensure the triumph of the Blacks and requested Charles of Valois, brother of Philip the Fair of France, to invade Tuscany. Dante, realizing that conflict was imminent, endeavoured in the council meetings between April and Sept. 1301, to secure the recall of the troops sent against the Aldobrandeschi. After his election as *priore* he was the leader of those Whites most resolute in opposing the pope and the Angevins; but his proposals did not please the majority, who still hoped for a compromise. Even when Charles was at the gates and on Oct. 4, 1301, was joined by the banished Blacks, the signoria chose to send ambassadors to Boniface. Dante was among them, despite his having proposed a quite different policy. He departed in late October and was never again to re-enter his beloved Florence.

On Nov. 1 Charles of Valois entered the city and gradually the Blacks returned. Private vendettas broke out: murder, arson, rapine and forced marriages followed. The pope's full authority over the commune was recognized and the Whites were tried and accused of Ghibellinism and barratry (*i.e.*, fraud in administering public affairs). On Jan. 27, 1302, Cante Gabrielli da Gubbio, nominated *podestà* by the Blacks, condemned Dante (guilty only of opposing the aims of the pope) to pay 5,000 florins and to remain outside Tuscany for two years; on March 10, as he had not presented himself to pay, he was condemned to death.

Writings and Life in Exile.—At the time of his condemnation Dante was returning from Rome. He joined the other exiles (Whites and Ghibellines) who had been sheltered by the Ghibelline Ubaldini and were preparing to re-enter Florence by force. On June 8, 1302, at San Godenzo, with 16 other Florentines, he signed an undertaking to set to rights the losses caused by the war. But the failure of the exiles' first attempt to regain Florence made new military preparations and political arrangements necessary. Dante went as ambassador to the Ordelaffi at Forlì and to Bartolomeo dalla Scala at Verona (1303). The death of Boniface VIII in October aroused new hope in the hearts of the exiles (now gathered in the Aretino), especially because the new pope, Benedict XI, sent Cardinal Niccolò da Prato to Florence to compose the differences in March 1304. Negotiations followed (documented by Letter I which Dante sent to the cardinal on behalf of the Whites), but they broke down because of the intransigent attitude of the Blacks. The cardinal was received with scorn and left the city. The Whites

and the Ghibellines moved against Florence. Their disunity resulted in defeat at La Lastra above Florence (July 20, 1304) and their hopes of speedy victory collapsed. By this time Dante had already "made a party for himself" (*Paradiso,* xvii, 69), after serious disagreements with the other Whites on the policy to adopt. Patriotism was stronger in him than partisanship. Such is the feeling of the great canzone of his exile "Tre donne intorno al cor mi son venute" (1304), wholly inspired by love of justice and a desire for reconciliation, a feeling which also animated the poetry of the episode of Farinata degli Uberti (*Inferno,* x). With his separation from the "wild party" Dante's true exile begins. He was forced to travel, poor and alone, through almost the whole of Italy (*Convivio,* I, iii). There is little reliable evidence of his wanderings. Between 1304 and 1306 he was in Bologna, a city favourable to study. Here two works rich in passages expounding his teachings, the *Convivio* (in Italian) and the *De vulgari eloquentia* (in Latin), which reveal his ardent return to philosophical and rhetorical studies, were probably planned and composed. Dante wished to establish his reputation as a scholar with these works and also to obtain the revocation of his condemnation. Both books are permeated by a deep nostalgia for his distant native city and his hopes of returning there.

The *Convivio* ("The Banquet," *c.* 1304–07), planned as a banquet of knowledge in 15 books, in the form of a commentary on 14 allegorical and ethical canzoni, did not get beyond the fourth book; but it offers to the reader a clear view of the problems which absorbed Dante, and of his spiritual and cultural maturity. He demonstrates his love for the Italian vernacular in the introduction, affirming in moving tones its aptness for the expression of the loftiest thoughts. In the second book he refers again to the episode of the "Donna gentile" (*cf. Vita Nuova*) and interprets it (when commenting allegorically on the canzone "Voi che'ntendendo") as a conflict between his love of Beatrice and his love of philosophy. And it is precisely to this glorification of philosophy that the third book, which comments on the canzone "Amore che nella mente mi ragiona," is dedicated. Regarded as "a loving use of wisdom" which proceeds directly from God and reflects His perfections, philosophy is defined in its essence and analyzed in its effects on man's conduct. Finally, the fourth book expounds the canzone "Le Dolci rime," the central theme of which is the nobility of man, which is not tied to hereditary privilege or to wealth but to goodness of nature and to possession of the moral and intellectual virtues by the individual. The judgment of men and events according to a fundamentally ethical standard was central to Dante's thought as the *Commedia* was to show. Difficult to read on account of the loftiness of its themes and its lengthy philosophical digression, the *Convivio* was conceived as an encyclopaedia of the knowledge of the time, modeled on Latini's *Tresor.* The work contains themes and conclusions which were later developed more fully, *e.g.,* the digressions on the four levels of significance in writing (II, i) and on the authority of the emperor and the necessity of the empire for the well-being of humanity (IV, iv–ix).

The "De vulgari eloquentia."—The nice problem of how to raise the status of the Italian vernacular to that of a literary language like Latin, is the theme of *De vulgari eloquentia,* which was intended to be in four books but broke off in the middle of the second. Dante opposes to *locutio vulgaris* (language as means of communication, variable in time and space), *gramatica* (literary language, stable in being fixed by rules). When the three Romance languages (Provençal, French and Italian) have been examined, attention is concentrated on the last, to select one of its many dialects for elevation to the status of a literary language. Having examined them all, Dante finds evidence of this language (defined as the "illustrious vulgar tongue") only in examples of the work of those poets (*e.g.,* the Sicilians, the Bolognese school and the Florentines of the *stil novo*) who could detach themselves from their local manner of speech. The illustrious vernacular is therefore the language of high culture, or rather of elevated lyric, employed by Dante himself in the philosophical and ethical canzoni which followed the *Vita Nuova.* The highest of the styles recognized by the rhetoricians—the tragic, with its elevated themes of arms, love and virtue—is appropriate to this vulgar tongue. The treatise breaks off with an examination of the canzone. It was intended by Dante as a theoretical and practical justification of his own literary language. The concept of the continuous evolution of languages (in book i), and the idea, which is the foundation of book ii, that poetry is the ideal imitation of the great Latin classics and a fiction which beneath formal beauty offers to the reader a hidden content of thought, are particularly to be noted.

The *Convivio* and *De vulgari eloquentia* remained unfinished. On Oct. 2, 1306, the commune of Bologna expelled the Florentine exiles, a measure which was not unexpected. Dante, for his part, had already left the city. On Oct. 6, 1306, he concluded peace at Sarzana between Marchese Franceschino Malaspina and the bishop of Luni. Reliable evidence for his subsequent movements is wanting. (It can no longer be held that he went to Paris, still less to Oxford.) Strong indication of a stay at Lucca is to be found in a legal document of 1308, in which Dante's eldest son Giovanni, who with Pietro and Jacopo had followed their father into exile at the age of 15, is named as a witness. But Dante's reference to Gentucca (*Purgatorio,* xxiv), a girl of Lucca, is better evidence. Having returned to the Casentino, he sent shortly afterward to Moroello Malaspina the canzone "Amore da che convien," with an explanatory letter (IV). He was probably in the Casentino when he learned of the election of Henry of Luxemburg as German king (1308). After being exiled he had long meditated over the events which had overtaken him. He had soon become convinced (by the time he was writing the *Convivio*) that those events and the disorder connected with them had occurred only because the political guide willed by providence "for the perfection of human life" (*Convivio,* IV, ix) was lacking, since there was no emperor. Such an "imperial majesty," "possessing everything and no longer being able to desire anything" (IV, iv) would have imposed a rule of justice on mankind, curbing its passions and above all its cupidity. It would have limited the aims of the church of Rome in the temporal field and would have thus brought back to the earth the peace which was the bequest of Christ and which alone permits men to realize their potentialities on a social and collective basis, and thence to attain happiness on this earth. The emperor's mission is one willed directly by God; it is therefore sacred even if in its means and end it is distinct from that of the pope, the guide in spiritual matters. The heart of the exile exults, therefore, while the deliverer prepares to come to Italy. And when Clement V agrees to crown the new emperor in Rome, the poet makes himself the mouthpiece of the general expectation and delight in Letter V ("Universis et singulis," 1310), urging the princes and peoples of Italy to rejoice at the coming of the *Rex pacificus.* Only Florence, allied to Robert of Naples, opposes the emperor; and the poet throbs with indignation in Letter VI (March 31, 1311) against the "most wicked Florentines" and then turns at once to Henry, to whom homage had already been paid in Milan: he should crush the head of the viper which attempts to bite its mother (Letter VII, April 17, 1311). For this reason Dante was excluded from the amnesty conceded by Florence on Sept. 2, 1311, when Henry was approaching the city to besiege it. But from reverence for his native city, which had indeed been a stepmother to him, he did not appear among the exiles who encamped with the imperial troops on the plain of San Salvi, and his name is missing from the list of the condemned published by the commune in March 1313.

The "Monarchia" and Later Minor Works.—The Latin treatise *Monarchia*—in which, in three well-reasoned books, Dante expounded the theories and conclusions he had reached during his years of meditation on the destiny of man and on man's temporal and spiritual goals—is connected with Henry's invasion of Italy. Books I and II, taking up again what had been foreshadowed in the *Convivio* (IV), show the necessity of monarchy for the well-being of the world and prove that the Roman people acquired the empire with good title and by the divine will. Book III investigates whether the imperial authority depends directly on God or whether on a minister or vicar of his. Declaring (as do the *Constitutiones* published at that time by Henry), that the imperial authority proceeds immediately from God, the treatise concludes by affirming that God has ordained the whole of humanity for two

ends, one of which is attainable in time, the other in eternity, with the aid of two guides: the emperor (guide to temporal felicity, figured imaginatively by the terrestrial paradise) and the pope, who alone can open to men the gates of that paradise which is eternal happiness (III, xvi).

The rift which soon opened between Henry and Clement V and the sudden death of the emperor at Buonconvento (Aug. 24, 1313), while on the march toward Naples against the Angevins, abruptly dashed the hopes of the poet, who, after staying from some time in Tuscany (perhaps with Uguccione della Faggiuola, lord of Lucca), returned about 1316 to Verona where Cangrande della Scala (the imperial vicar nominated by Henry VII in 1312) was laying the foundations of a powerful Ghibelline state in northern Italy. To these years belong the last three letters known to us: Letters XI (June 1314, to the Italian cardinals in conclave after the death of Clement V, urging them to elect an Italian pope who would bring the seat of the papacy back from Avignon to Rome), XII (May 1315, to a Florentine friend: Dante refuses an amnesty because its conditions are regarded as humiliating) and XIII (*c.* 1316, in which he dedicates to Cangrande the *Paradiso*, which he had just begun, and gives the beginning of a commentary on it, together with the general framework of the *Commedia*). This is the final stage in the life of Dante: he left Verona about 1318 and went to Ravenna as guest of Guido da Polenta. In the peace of Ravenna his surviving children gathered round him: Pietro, Jacopo and Antonia (who after the death of her father was to become a nun, taking the name of Sister Beatrice). He composed two Latin eclogues there in reply to Giovanni del Virgilio, who had urged him to write a poem in Latin verse on a historical theme and had invited him to Bologna, promising him the poetic laurel. There is evidence of a brief stay at Verona in the *Quaestio de aqua et terra* (Jan. 1320), debated and decided in the church of Sant' Elena, in which Dante grapples with a favourite scholastic problem (whether water could in some places be higher than the dry land), showing the impossibility of the hypothesis. On his return from Venice, where he had been sent as ambassador by Guido da Polenta (on the occasion of a dangerous dispute with this neighbouring power) the poet, who had only very recently finished the *Paradiso*, was struck down by malaria and died during the night of Sept. 13–14, 1321. But he left to Italy and to the world the "Comedy" which posterity judged to be divine.

The "Commedia."—Dante worked on this from the time when he broke off writing the *Convivio* and *De vulgari eloquentia*, as if on a vast fresco depicting his sorrows and hopes, his fierce hatreds and his cherished beliefs in poetic terms which would reaffirm clearly and effectively his ethical and political conception of the world, of the ends and duties of man within the twofold order of Nature and Grace. A poet above all, he felt that only in poetry, which goes beyond the closed abstractness of a scientific treatise, would he be able to express fully his dream—resulting from deep experience and suffering—of a spiritual and civil renewal of the whole of humanity. This complex work, which was begun about 1307, is a poem unique of its kind (although within the tradition of the great medieval allegorical poems by Martianus Capella, Bernard Silvestris, Allan of Lille and above all of Virgil's *Aeneid*, which was considered allegorical in the middle ages. Divided into three *cantiche* (the first composed by 1310, the second by 1314, the third between 1315 and 1321), it is written in the vernacular language and is very long: 14,233 hendecasyllables in *terza rima* (*q.v.*; a rhyme scheme connected with the popular *serventese:* ABA, BCB, CDC, etc.), arranged in 100 cantos (one being a prologue to the entire work, and each *cantica* having 33 cantos). The title, in accordance with medieval vocabulary, is *Commedia* (*Inferno* xvi, 128; xxi, 2; Letter XIII, 10), because the subject, horrible in the *Inferno*, becomes desirable and pleasing in the other two *cantiche*, the *Purgatorio* and the *Paradiso*. The literal subject of the work is the journey Dante makes through the world beyond the grave, repeating by divine grace the experience of Aeneas in his descent to Avernus (*cf. Aeneid*, vi) and also undergoing an experience analogous to that of the apostle Paul, who ascended to the third heaven (*Inferno*, ii, 13–30). At the age of 35 years, on the evening of Good Friday 1300, the poet finds himself wandering astray in a dark wood. After a night of anguish, he sets out in the morning toward a hill illuminated by the sun, but three wild beasts (a leopard, a lion and a wolf) bar his path and force him back toward the darkness of the wood. Virgil, however, appears to aid him, having been sent by three "blessed ladies" (the Virgin Mary, St. Lucy, Beatrice), and Virgil leads Dante to salvation, guiding him through the infernal realm and the mountain of Purgatory, at the summit of which the Roman poet is replaced by Beatrice, who then conducts Dante (raising him from heaven to heaven by the brilliant and loving power of her glance which is that of a blessed soul who contemplates God) as far as the Empyrean, where the poet enjoys for a brief moment the supreme vision of the divinity.

The Inferno, a dark and deep chasm, is subdivided into nine circles descending to the centre of the earth and gradually becoming smaller. Enclosed within it are mythical and historical personages of all times from classical and biblical antiquity to 1300; poets and philosophers, heroes, emperors, popes, politicians and ecclesiastics, queens and famous women, and Florentine citizens of the two factions. Their punishments are inspired by the Aristotelian classification of vices according to three kinds of evil disposition (incontinence, malice, bestiality—*cf. Inferno*, xi, 22–90), and they are placed in accordance with the gravity of the offense and of the punishment (which is greater the lower one descends). At the bottom of the Inferno and therefore farthest from God is Lucifer who, when he fell from heaven, originated the infernal chasm. He is visualized as having three faces and six wings (a deformed trinity of evil opposed to the divine Trinity). He munches with his three mouths Judas, betrayer of Christ, and Brutus and Cassius, betrayers of Caesar.

Purgatory, a mountain surrounded by the waters of the southern hemisphere, rises toward heaven, above the four elements. Divided into an ante-purgatory and seven terraces or ledges (on each of which, in order of decreasing gravity, souls expiate one of the seven deadly sins, from pride to lust), the mountain is crowned at its summit by the "divine, thick and living forest" of the Terrestrial Paradise (the counterpart of the "wild wood"). Here Dante meets Beatrice, who has descended from heaven; and here is fulfilled the rite of confession and purification of the poet who thereby becomes "pure and worthy to ascend to the stars" (*Purgatorio*, xxxiii, 145). In the Ptolemaic conception of the universe, Paradise is subdivided into nine concentric heavens (Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn, Fixed Stars, Primum Mobile) which rotate around the earth. In the tenth heaven or Empyrean, which embraces them all, the blessed reside in a "mystical rose" enjoying in proportion to their merits the vision of God; and thence they descend to appear to the poet in the various heavens (corresponding to grades of spiritual perfection) in order that he may the better understand, in this metaphorical way, the gradations of their beatitude. Having reached the Empyrean, Dante sees Beatrice return to the seat of glory (it is the glorification of her promised in the *Vita Nuova*); she is succeeded by St. Bernard, who obtains for Dante (by the intercession of the Virgin Mary) the possibility of intuiting the principal mysteries of the Christian faith, contemplating them directly for a brief moment in God: the unity and trinity of God and the incarnation of Christ—an exalted experience which makes the poet feel later the inadequacy of the imagination to describe his own supreme vision. The "sacred poem" concludes on this note, in the name of "the Love that moves the sun and the other stars."

The *Commedia* is a sublime work of poetry. For greatness of conception and construction, for concrete invention, prismatically reflected (within the framework of the imaginary journey) in every episode and character of the poem and sustained by the perfect and sensitive adaptation of the style to the subject, it has shown no signs of the wear and tear of time after many centuries and for artistic mastery and impassioned moral power even today it is only equaled by the great poems of classical antiquity and in the sublime poetry of the Bible. This is fully realized by anyone who closely studies the book and is moved by the sentiments which inspired Dante to compose immortal episodes, lyrically attuned to the changing moods of his soul, the imaginative power of which infuses life into the various characters and expresses in them, in

many varied ways, his own inner life. But Dante also intended the poem to have a precise allegorical significance which is not superimposed from outside, but is rather the conceptual nucleus around which the poetic images flower in all their beauty.

To understand its range (and together with it the value of the message entrusted by Dante to the *Commedia*) it suffices to re-read the last chapter of the *Monarchia* (III, xvi) which expounds the basic symbolism of the poem. Ordained by God for two ends, natural and supernatural, man can attain happiness on this earth (figured by the Terrestrial Paradise) provided he lives in accordance with the moral and intellectual virtues. The second goal (blessedness not on earth but in eternity, which consists in the vision of God in Paradise) is acquired, on the other hand, by living in this life on the plane of grace, according to the three theological virtues. It is the task of the emperor to guide the human race to happiness on this earth; it is the duty of the pope, who has been entrusted with the revelation of God's word, to lead mankind to the blessedness of Paradise. The perfect harmony between the symbols of the Terrestrial and of the Celestial Paradise explained in the *Monarchia* and the images which mark the fundamental stages of the poem show how the imaginative representation of Dante's journey—on the allegorical plane—is no other than the poet's conscious grasp of a concrete, existential reality: that of our life here and now, of human nature with its passions, contradictions and conflicts: poetic knowledge of man and his purposes which is expressed in Dante's own no less real spiritual experience. The tragic obscurity of the "dark wood" (symbol of the uncultivated life, life without reason and virtue), dominated by the "three wild beasts" (the three radical passions of human nature subsequent to the original sin—lust, pride, avarice) is abandoned by Dante under the guidance of Virgil (the poet of the Roman empire who sang in the *Aeneid* of the fulfilment of an ideal of piety and natural justice, and in the fourth eclogue foretold—it was believed in the middle ages—the advent of Christ) in order to regain that state of natural perfection (Terrestrial Paradise) which is proper to one who lives according to reason and virtue, but which at the same time disposes the Christian soul, illuminated and sanctified by the theological virtues, actually to live the life of grace and contemplation (Paradise). The poetic experience of the *Commedia* on the allegorical plane is therefore the history of Dante's own soul: of his finding in himself, in his noble conscience and his deeply spiritual nature, the solution of the grave political, moral and religious problems which tormented him after his exile. The two guides willed by providence are, it is true, missing through lack of an emperor and of adequate spiritual guidance by the pope who by his confusion of the two offices has violated the providential order, so that the chair of Peter is vacant in the sight of God (*Paradiso*, xxvii, 254); but man can still by his unaided powers, if he meditates on his own duties and destiny as an immortal soul, rediscover the "straight way" of a moral life which leads him to perfection. In short, readers of the *Commedia* were to discover in the poem, as in a great, sacred allegory, an *exemplum* which should lead them to meditate on the evil of the tragedy of the contemporary scene and should at the same time indicate the solutions: the empire as the sole remedy and bridle for human avarice; the necessity of a return on the part of the church to purity and evangelical poverty. In this sense, taken with Letter XIII, to Cangrande, the purpose of the *Commedia* can be said to be to "remove those living in this life from the state of misery and lead them to the state of felicity" (li. 15), because Dante's exceptional poetical experience could be repeated at the level of ordinary life, by anyone who wished to move with equal resolve toward the same spiritual goal.

For a portrait of Dante *see* ITALIAN LITERATURE.

See also references under "Dante" in the Index.

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Portraits of Dante: The repainted figure in a fresco of the podestà's chapel in the Bargello, Florence, is probably authentic and was probably executed by Giotto from a sketch made early in the poet's life. The Torrigiani mask now in the same chapel is probably a 15th-century work derived from a high relief on the tomb (removed during the 16th century). *See* further R. T. Holbrook, *Portraits of Dante from Giotto to Raffael* (1911); R. Altrocchi, "The Present State of Dante's Iconography," *Italica*, vol. xii (1935); W. Goetz, *Das Dantebildnis* (1937); P. L. Rambaldi, "Dante e Giotto nella letteratura artistica sino al Vasari," *Miscellenea d'arte* (special Giotto sexcentenary no., 1938).

(FR. M.)

DANTON, GEORGES JACQUES (1759–1794), one of the most complex and controversial statesmen of the French Revolution, was born at Arcis-sur-Aube, in Champagne, on Oct. 26, 1759, the son of Jacques Danton (d. 1762), an attorney of the *bailliage*, and of Marie Madeleine Camus, his second wife. Educated by the Oratorians at Troyes (from 1773), he went in 1780 to read law in Paris, becoming a clerk to an attorney in the *parlement*. After obtaining his degrees at Reims, he returned to Paris to practise. In March 1787, he bought the office of advocate in the *conseil du roi*, having borrowed half of the money to pay for it. He then married Antoinette Charpentier.

At the outbreak of the Revolution, Danton enrolled in the civic guard of the Cordeliers district (July 1789) and was elected president of the district (October). In Jan. 1790, when the arrest of J. P. Marat was ordered for an offense against the press laws, Danton roused his district to defend him. After the suppression of the districts and the creation of the *sections*, Danton, who had been a member of the provisional commune of Paris, was excluded from the commune in its final form (Sept. 1790). It was during this time that he became prominent in the club of the Cordeliers (*q.v.*). On Jan. 31, 1791, he was elected administrator of the *département* of Paris, but he rarely attended this assembly and had no influence in it. From this time, however, he began speaking in the Jacobin club. On June 21, 1791, he accused La Fayette of complicity in Louis XVI's flight to Varennes and called on him to resign the command of the national guard in Paris. Though Danton's signature does not appear on the famous petition of the Cordeliers which resulted in the massacre on the Champs-de-Mars (July 17, 1791), his arrest was ordered on Aug. 4, for reasons still obscure, but he escaped first to Arcis, then to Troyes and finally to London.

Appointed elector for the Théâtre Français section, Danton returned from England for the elections to the Legislative Assembly. In Dec. 1791, he was chosen as second assistant to the *procureur* of the Paris commune. In the great controversy between Brissot and Robespierre, Danton at first supported Robespierre and the cause of peace as against war, but soon fell silent, leaving Robespierre to face the Girondins alone. In the commune he supported the mayor J. Pétion de Villeneuve and the *procureur* L. P. Manuel in their campaign against La Fayette and the Feuillants. On June 18, 1792, after Louis XVI had dismissed the Girondin ministry, Danton demanded that La Fayette be called to account for himself before the assembly, but he took no part in the manifestation on the Tuileries on June 20. What he did to organize the movement against the monarchy which culminated in the insurrection of Aug. 10 remains very obscure, though he later claimed to have prepared it himself. In any case, the Girondins took him next day into the provisional executive council, which shows that they credited him largely with the success of the insurrection.

Minister of Justice.—In the provisional executive council Danton was minister of justice. His revolutionary past and his personal character now made him the dominating figure in the new government. As the Prussians advanced toward Paris, it was Danton who expressed the will to fight and to win. When, on Aug. 28, 1792, J. M. Roland proposed the withdrawal of the government to the Loire, Danton opposed him, as retreat would have meant the moral collapse of France. On that day he proved his unshakable powers of leadership. The legend that Danton was personally responsible for the September massacres (when the populace, on the news of the siege of Verdun, broke into the prisons), is an invention of the Gironde: like all the terrified Girondins, Danton simply let them happen. "No human power," he later said, "could have prevented the overflowing of the national vengeance."

Danton and the Girondins.—On Sept. 6, 1792, Danton was elected to the Convention as deputy for Paris by 638 votes out of 700. He then left the executive council and resigned his ministry. Inclined to conciliation, he did not share Robespierre's invincible hatred of the Girondins, to whom indeed he offered his support. At heart a man of the centre, he wanted the Convention to abandon extreme measures. While he opposed the federalists, he also denounced the tendency toward dictatorship, and in October he promised Théodore Lameth that he would try to save Louis XVI (in order to ensure peace). The Girondins, however, rejected his overtures. Madame Roland envied his ascendancy and, with her intransigent faction (Charles Barbaroux, François Buzot, J. B. Louvet and others), sought to crush opposition. By demanding from Danton an account of his secret expenses as minister, which he was not able to give, and by accusing him of robbing the *garde-meuble* (the repository of the crown's valuables), the Girondins and Madame Roland launched a persecution that finally drove him toward the Mountain.

Sent on a mission (Nov. 30, 1792) to Gen. C. F. Dumouriez (*q.v.*) in Belgium, Danton took no part in the opening of Louis XVI's trial. He was present, however, on Jan. 15, 1793, and voted for death without reprieve. He had already said to Lameth in October: "Can a king be saved once he has been brought to trial? He is dead when he appears before his judges."

On Jan. 31, 1793, Danton declared himself for the annexation of Belgium, formulating the doctrine which the Convention was thenceforth to adopt: that the republic should spread to the frontiers "demarcated by nature." That day he was sent again to Belgium, but his wife's death within a fortnight brought him back to Paris until the end of February. When the Austrian successes against Dumouriez began, Danton hurried back to Paris to raise the alarm. To save Belgium, he appealed, as in 1792, for a new effort by the patriots of Paris. When they declined to leave the capital exposed to treachery, he opposed the creation of a special tribunal to ensure security—the future Revolutionary tribunal (*q.v.*). This was set up (March 10), but his next proposal (March 11), for a committee invested with executive power, was rejected by the Convention when the Girondins accused him of aiming at dictatorship. When Dumouriez sent a threatening letter to the Convention (March 12), Danton went again to Belgium to remonstrate with him. On his return to Paris he gave no warning of the intentions of Dumouriez. The general's final defeat and treason in April added bitterness to the conflict between the Gironde and the Mountain.

As long as he could, Danton had tried to reunite the republican parties, but his interviews with Dumouriez laid him open to suspicion. The Girondins not only questioned these, but continued clamouring for his accounts. On April 1, 1793, when David Lasource raised the matter again with especial vehemence, Danton finally declared his break with the party that had wanted to save Louis XVI and ranged himself on the side of the Mountain.

Danton's Committee of Public Safety.—On April 6, 1793, the Convention set up the committee of public safety, which Danton had demanded. In this committee (with men like Bertrand Barère and Pierre Joseph Cambon, more or less Montagnards), Danton was the dominant member, with almost ministerial powers. Regardless of his speech of April 1, he tried still to conciliate the Girondins and the Mountain, but his hestitation only postponed the crisis. On May 27, however, he persuaded the Convention to suppress the commission of twelve that the Girondins had instituted to counteract the Paris commune. Finally came the events of May 31–June 2, the rising of the Paris sections and the overthrow of the Girondins in Paris. If he did nothing to instigate the rising, at least Danton declared his approval of it: "But for the cannons of May 31, but for the insurrection, the plotters would have triumphed" (June 13).

Despite the danger of foreign invasion and the spread of civil war in France, after June 2, 1793, Danton and the committee of public safety hesitated to take extraordinary measures. On June 6, he even suggested suppressing the committees of surveillance. Moreover, since his return to power, he had been making overtures for peace to Lord Grenville, the British foreign secretary. These, however, were scornfully rejected. His negotiations, in fact, could have made sense only if France had either won a victory or been prepared to capitulate under a show of reaching a compromise, and some of the Montagnards thought that he was planning to surrender Marie Antoinette and her children or even to restore the monarchy. As the crisis grew worse, his critics lost patience, and on July 10, when the committee of public safety's term expired, the Convention elected a new committee without Danton.

The Terror and the Indulgents.—In the summer of 1793, while the popular movement was giving strength to the Revolutionary government and as the Terror was beginning, Danton still raised his voice occasionally. It was he who proposed the decree of Aug. 12 for the internment of suspected persons. On Sept. 5, however, he dismayed the popular militants by having the meetings of the hitherto permanent sectional assemblies reduced to two per week. On Oct. 12, however, he withdrew to Arcis.

On his return to the Convention (Nov. 21), Danton found the anti-Christian movement in full swing. Against this, he was at one with Robespierre and the extremists were confounded when the Convention disavowed the movement by decreeing that freedom of worship remained (Dec. 6). Danton and his friends now took the offensive with Camille Desmoulins (*q.v.*), in *Le Vieux Cordelier*, as their spokesman. In fact they were challenging not only Hébert and the anti-Christian faction but the whole government policy and the regime of the Terror: in Danton's view the Revolution, no longer in danger, could now afford clemency.

Danton probably did not mean to set himself up as the leader of a faction, but the tactics and the aims of the "Indulgents," as those who shared his desire for clemency were called, were in conformity with his past policy and conciliatory opportunism. The Indulgents, moreover, attracted a number of questionable adherents whose main concern for clemency was in order to escape the scaffold themselves. Also, the fact that Danton was suspected of corruption brought the whole group into suspicion. When Danton claimed that his friend Fabre d'Églantine and the other deputies arrested for complicity in the fraud over the liquidation of the Compagnie des Indes should be given a hearing, Billaud-Varenne clearly threatened Danton himself in his reply (Jan. 13, 1794).

The Fall of Danton.—For two months the feud between the Indulgents and the Exagérés or Hébertists went on. Then the committee of public safety resolved to put a stop to it. The first to fall were the Hébertists (March 17–24, 1794). Then Billaud-Varenne and Collot d'Herbois persuaded Robespierre to strike the opposite faction likewise. Danton and his friends were arrested in the night of March 29–30, and Saint-Just read to the Convention the report that Robespierre had helped him to draw up against them. An imaginary plot to rescue them was alleged in order to silence Danton's defense. Condemned to death, Danton and the others were guillotined on 16 Germinal year II (April 5, 1794). To the executioner he said: "Show my head to the people, it is worth the trouble." The people, however, were almost unmoved.

Conclusions.—The question whether Danton took money corruptly cannot be passed over. Historians now agree that evidence from Mirabeau and Antoine Talon proves beyond doubt that he did so, and the further evidence from Brissot, Bertrand de Molleville and La Fayette can be accepted on essential points. In the case of Louis XVI's trial, Danton's corruption seems most probable.

Danton's character was complex: his self-interested flexibility, his caution and his venality cannot be doubted but he also possessed a statesman's realism. His wild enthusiasms, his carelessness and his sudden changes of plan show a violent temperament without intellectual or moral discipline. His sudden gestures of generosity and of compassion may perhaps be linked with a pleasure-loving disposition that could not long sustain distrust or hatred.

If any judgment can be given on Danton's politics, his real attachment to the nation and to the revolutionary cause cannot be denied: he served the Revolution well during the crisis of Aug.–Sept. 1792. His policy in the following months, when he worked for a general peace, is understandable but highly controversial. The same may be said of his direction of the committee of public safety, though his indecision in the spring of 1793 only exacerbated the conflict between the Gironde and the Mountain. In the last part of his life his policy of moderation served only to weaken the efforts at general mobilization, and his opposition to the committee of public safety precipitated the crisis in which he himself was destroyed. It can be argued that his trial was right and necessary. Even so, it dealt a fatal blow to the Mountain and opened the way to the fall of the Revolutionary government.

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(1914); G. Lefebvre, "Sur Danton," *Annales historiques de la Révolution française* (1932). (A. So.)

DANUBE (Ger. DONAU; Slovak DUNAJ; Hung. DUNA; Bulg. and Serbo-Croat DUNAV; Rum. DUNĂREA; Russ. DUNAY; Lat. DANUBIUS and in the lower part of its course ISTER), is the most important river of central and southeastern Europe.

It rises in the Black Forest mountains of Germany and empties into the Black sea, receiving tributaries on the right bank from the eastern Alps, the Dinaric Alps and the Balkan mountains and on the left bank from the Franconian Jura, Bohemian Forest (Böhmer Wald or Cesky Les), the Czech-Moravian plateau, the Carpathians and the Transylvanian Alps. It is 1,776 mi. long, drains an area of 315,444 sq.mi. and is the most important river of Europe as regards the volume of its outflow although it is inferior to the Volga in length and drainage area. The river is first called the Danube at Donaueschingen in the Black Forest, where the Brigach, the Breg and a smaller stream meet at an altitude of 2,187 ft. It is navigable for special river craft below Ulm (1,505 ft. above sea level), and is fed by at least 300 tributaries, many of which are large rivers.

The river can be divided into three sections: the upper course, above Bratislava, Czech.; the middle course, between Bratislava and the Iron Gate in Rumania; and the lower course, below the Iron Gate.

The Upper Course.—The direction of the river in its upper course is determined by the structure of the Alpine foreland. Rising in the crystalline rocks of the Black Forest, it flows eastward across a narrow belt of Jurassic rocks to Sigmaringen and then to Regensburg, its bed being in the soft Molasse (Upper Oligocene and Miocene rocks). Below Regensburg the river flows southeastward along the southern flanks of the Bohemian massif and flows in part upon the crystalline rocks of the latter and in part upon the Molasse, but at Krems, Aus., it turns eastward across the Molasse and after passing Vienna it flows through the gap which separates the eastern Alps from the Carpathians.

The valley of the Danube above Sigmaringen is narrow, the scenery being wild and beautiful, especially above Tuttlingen, where castles crown every possible summit on the neighbouring hills. Below Immendingen much water escapes by subterranean fissures into the Aach river, a tributary of the Rhine. After it is joined at Ulm on the right bank by the Iller, which rises in the Allgäuer Alpen, the Danube attains a width of 78 yd. and an average depth of 3 ft. 6 in. and becomes navigable downstream for specially constructed craft of 100 tons. Near Donauwörth (1,330 ft.) it receives on the right bank the Lech, while at Regensburg (949 ft.) it is joined on the left bank by the Naab. Below Regensburg at Deggendorf it is joined by the Isar, on the banks of which stands Munich. At Passau, Ger. (800 ft.), it enters Austria and is joined on the right bank by the Inn. Both the Isar and the Inn drain a large portion of the eastern Alps.

From Passau to Linz the Danube is hemmed in by mountains, but its valley becomes wider below Linz where the river subdivides into several arms which unite again at the once-famous whirlpool near Grein. Below Grein, the river flows through another narrow defile as far as Krems but once more subdivides as it passes toward Vienna. The district between Linz and Vienna is renowned for its beauty and for the numerous places of historical and archaeological interest along the banks. At Vienna the river is 316 yd. wide, and 429 ft. above sea level. Below the town is the district of Marchfeld, a low-lying country across which the Danube frequently subdivides to form numerous islands. It is joined by a left-bank tributary, the March (Morava), which drains Moravia. Before reaching Bratislava, the Danube passes through the narrow gap between the lower spurs of the Alps and the Carpathians and enters upon the middle section of the river. At this gap the river also flows out of Austria and for a few miles is entirely in Czechoslovakia, but it soon becomes the boundary between that country and Hungary.

The Middle Course.—The Danube flows for the first 100 mi. of its middle course upon alluvial and Quaternary deposits of the Little Hungarian Plain which is separated from the Great Hungarian Plain by the Bakony Hegyseg ridge, the innermost arc of the Carpathian mountain system. The Danube breaks through the ridge east of Esztergom, Hung. After leaving Bratislava, it divides into three channels forming two main islands, the northern and larger (Velky Ostrov Zitny, Great Schütt) being Czechoslovak, the smaller (Szigetköz, Little Schütt), Hungarian. The northern branch is joined at Komarano by the Slovak tributary the Vah, which rises in the Carpathians. Higher upstream at Györ (Raab), Hung., the southern branch of the divided Danube is joined by the Raab (Rába) river which rises in the Styrian Alps. The three channels join again at Komarno, Czech., and farther down the Danube receives two more Slovak tributaries, the Hron, whose confluence is opposite Esztergom, and the Ipel (Ipoly), whose lower part marks the Czechoslovak-Hungarian frontier. Between Esztergom and Vác the valley becomes narrow until at Vác the river turns to flow southward for 230 mi. across the Great Hungarian Plain, meandering in the wide alluvium-filled valley and frequently dividing into two or more streams. Passing Budapest, Sztalinvaros, Baja and Mohács, the river leaves Hungary and enters Yugoslavia.

About 8 mi. E. of Osijek, the Danube is joined by the right-bank tributary, the Drava (Drau), which rises in Italian Tirol and drains a large portion of the eastern Alps. The Danube again flows eastward at Vukovar, along the northern edge of the Fruska Gora. Between Novi Sad and Belgrade it receives the left-bank affluent, the Tisa, which, rising in the Carpathians, drains the greater part of the western slopes of the mountains, as well as the Great Hungarian Plain. At Belgrade, the Danube is joined by the right-bank affluent, the Sava, which, rising in the Julian Alps, flows eastward and drains Slovenia, Croatia and part of Bosnia. Serbia is drained by the Morava, which joins the Danube east of Smederevo, also on its right bank.

The character of the valley changes suddenly at Bazias, where the Danube meets the Rumanian frontier. Between Bazias and Turnu Severin the river has worn a channel through the mountain ridge which joins the Carpathian arc with the Balkan mountains. Until comparatively recent geological times, the Great Hungarian Plain formed an inland sea, whose effluent followed the present course of the Danube through the Cazane (Kazan) defile and the Iron Gate. By the lowering of its channel through the gap (the level at Orsova is 42 ft. above sea level) this sea was drained. Hemmed in by precipitous rocks, the river passes through the stupendous Cazane defile (162 yd. wide), then widens out to nearly a mile at Orsova, becoming narrower again at the Iron Gate. The river has been cleared of numerous obstructions to make navigation possible along this stretch.

The Lower Course.—The lower course of the Danube stretches from the Iron Gate to the Black sea. From Ram to the junction with the small right-bank tributary, the Timok, the Danube forms the boundary between Yugoslavia and Rumania. From the Timok to Silistra, Bulg., it forms the boundary between Rumania and Bulgaria, then flows through Rumanian territory. East of Galati, Rum., the river forms the boundary between Rumania and the U.S.S.R. (Ukraine).

Along its lower course, the Danube flows over Quaternary deposits covered by river sands and gravels. Its north bank is low, flat and marshy with numerous small lakes, but its south bank is crowned by low heights which make excellent townsites; *e.g.*, Vidin, Lom, Nikopol, Svishtov, Ruse and Silistra (all in Bulgaria). Between Giurgiu in Rumania and Ruse a double-deck railway and road bridge, of 37 spans and a total length of 7,400 ft., was inaugurated in June 1954.

The river receives many tributaries along this stretch. On its left bank the Jiu, the Olt and Dâmbovita are the most important, draining the Transylvanian Alps, and on its right bank the Iskur and the Yantra, draining the northern ridges of the Balkan mountains. At Cernavodă, Rum., the river is crossed by the railway from Bucharest to Constanta, the Black sea port. Turning, the Danube flows northward flanked by the Dobruja hills, which form an isolated remnant of the Hercynian foreland of Europe.

Through Rumania as far as Brăila, the river subdivides into several channels, and spreads out over the surrounding country to form numerous lakes. The river changes its direction again at

Galati, the chief port on the delta of the Danube, and flows eastward toward its mouths. Seagoing vessels having a register less than 4,000 tons can ascend the river as far as Brăila, but those of less than 600 tons can sail as far as Turnu Severin. Two left-bank affluents, the Siret and the Prut, which drain the eastern side of the Carpathian mountains, enter the river near Galati. For 30 mi. in an easterly direction from Galati, the Danube flows in a single channel until it breaks into the several branches of its delta. Along the northern shore of the river from Galati to the sea there are many shallow lakes, indicating the poor drainage of the region. The most important mouths of the river from north to south are Kiliya, Sulina and St. George. The amount of silt brought down to the delta each year is estimated at 108,000,000 tons. As the currents of the Black sea along the delta coast flow from north to south, silt from the Kiliya tends to block the mouths of the other channels.

The delta of the Danube, which is about 1,000 sq.mi. in area, is a wilderness of swamps and marshes covered by tall reeds, through which the silt-laden distributaries of the river slowly meander. The monotony of the wasteland is relieved by isolated elevations covered by oak, beech and willow, many of them marking ancient coast lines. The most important towns in the delta region are Izmail and Kiliya on the Soviet bank of the Kiliya branch, Sulina, Rum., at the mouth of the Sulina branch and Tulcea, Rum., on the St. George branch. The Kiliya branch breaks up into a wide delta which is continually advancing seaward and it is estimated that its various mouths pour 3,000 cu.ft. of sediment per minute into the sea. The Sulina branch breaks off from the St. George branch 7 mi. below Tulcea. The St. George branch again subdivides before entering the sea.

At one time ships drawing only eight feet of water experienced great difficulty in entering, as the depth of water in the channels rarely exceeded eight feet and the numerous sand banks and bars added to the difficulty of shipping. However, engineering works were undertaken to make the channels navigable by larger craft.

International Regulation.—*The European Commission.*—Before World War II the administration of the Danube was controlled by the single European Commission of the Danube, an institution set up with a provisional character by the treaty of Paris in 1856. Its headquarters were at Galati, and it administered the Danubian delta only, eight interested nations being represented on it. In the treaty of Bucharest (May 1918) the Central Powers reduced membership to "states situated on the Danube or the European coasts of the Black sea."

The treaty of Versailles (June 1919) reinstated the commission in "the powers it possessed before the war." It went on that "as a provisional measure, only representatives of Great Britain, France, Italy and Rumania shall constitute this commission." The commission acquired definite character when the Danube statute was signed in Paris on July 23, 1921. In the future, subject to the unanimous consent of the states represented on the commission, any European state which was able to prove its possession of sufficient maritime commercial and European interests at the mouths of the Danube could be represented on it although, in actual fact, the representation was not increased.

The International Commission.—The treaty of Versailles, art. 347, provided that "from the point where the competence of the European commission ceases," *i.e.*, from above Brăila, "the Danube system referred to in art. 331," *i.e.*, as far as the highest navigable point at Ulm, "shall be placed under the administration of an international commission." This was to include two representatives of German riparian states, one representative of each other riparian state and one representative of each nonriparian state represented in the future on the European Commission of the Danube. From 1920–39 the "nonriparian states" were France, Italy and Britain.

On July 23, 1921, the statute was signed. Many of its provisos simply followed the lines of the "convention on the regime of navigable waterways of international concern" concluded at Barcelona, Spain, on April 20, 1921. Art. i declared navigation on the Danube system to be unrestricted and open to all flags, on a footing of complete equality, from Ulm to the Black sea, and the internationalized portions of the Danube tributaries were defined. The International commission had to see that art. i was not infringed by any riparian state or states, to draw up a program of

COURSE OF THE DANUBE RIVER AND TRIBUTARIES, SHOWING ITS RELATIVE IMPORTANCE TO THE WHOLE OF EUROPE

public works for the improvement of the waterway on the basis of proposals submitted by the riparians, controlling and if necessary modifying the annual programs of the riparian states for current works of maintenance. The cost of such works was to be borne by the riparian state concerned, assisted, if the commission so decided, by other states interested.

Improvement costs might be covered by navigation dues, to be imposed (with the commission's authorization) by the riparian state which had executed the works, or by the commission itself, if it had executed them itself. The principle of equality for all flags was to be upheld regarding the levying of dues and customs duties. Goods and passenger traffic either in transit or between ports of the same riparian state were to be unrestricted. Uniform police regulations were to be drawn up and applied by each riparian on its own territory. A special approved joint service of Rumania and Yugoslavia was to take over the maintenance and improvement of the Iron Gate section, with headquarters at Orsova.

The commission was to determine its own procedure and administer its own budget, the presidency being held for six months by each delegation in turn. Its seat was to be at Bratislava for the first five years, and thereafter it might be established at other towns on the Danube, selected at its discretion, for five-year periods in rotation. Its property and members were to enjoy diplomatic privileges and it was to fly its own flag. Every effort was made to ensure uniformity between the workings of the International and the European commissions, and between different signatory states.

The convention came into force on June 30, 1922. Economic depression and international friction during the years between World Wars I and II seriously limited many planned improvements. The old Ludwigskanal was enlarged, however, to form the Rhine-Main-Danube canal; this made navigation possible from the Atlantic ocean to the Black sea through the European continent.

By 1940, Germany had gained control of the whole of the Danube. In September of the same year the two Danube commissions were declared dissolved and for the rest of World War II river administration was solely in the hands of the riparian states under German presidency. With the defeat of Germany, the question of the Danube once more came up for international review.

The Soviet-Controlled Commission.—The Council of Foreign Ministers of the United States, Great Britain, France and the U.S.S.R. issued in New York, on Dec. 16, 1946, a declaration that after the coming into force of the peace treaties with Bulgaria, Hungary and Rumania a conference should be held "to work out a new convention regarding the regime of navigation on the Danube." The peace treaties with the three Danubian countries, signed in Paris on Feb. 10, 1947, included an identical article stipulating that "navigation on the Danube shall be free and open for the nationals, vessels of commerce, and goods of all states, on a footing of equality in regard to port and navigation charges and conditions for merchant shipping."

The nonriparian powers, Great Britain, France and the United States, upheld the 1921 convention, but their attempt to obtain riparian recognition of this view failed at a conference which met in Belgrade from July 30 to Aug. 18, 1948. Germany was not represented because it was without a government and Austrian delegates were there only in a consultative capacity. Thus, the U.S.S.R., having become a riparian state, and with its satellites in the majority, on Aug. 2 proposed the establishment of a new Danube commission, composed of one representative from each Danubian state. Staffed by Danubian nationals only, its headquarters were to be at Galati. Expenses were to be shared by the riparian states. A Russian was appointed secretary and was responsible only to the U.S.S.R. The 1921 convention was declared null and void, its assets were taken over by the new commission and the use of Danubian waters for nonriparian naval vessels was prohibited. At the Galati conference held on Dec. 9–17, 1953, a Yugoslav was elected secretary and representatives from Hungary and Bulgaria as chairman and vice-chairman, respectively. Henceforth, each member country was to be represented on the body of elected offices at least once in nine years. The commission's headquarters were moved to Budapest.

After May 1954, Austria was able to conclude navigation agreements with countries downstream, and by the Austrian state treaty, signed in Vienna on May 15, 1955, its assets in the Danube Shipping company were restored. Austria joined the commission in Jan. 1960, and in the same year a passenger service was inaugurated between Vienna and Izmail. Navigation on the Danube is nominally free for commercial vessels and goods of all states on a footing of equality.

Traffic.—Brăila and Galati have been the usual points for transshipment between seagoing vessels and barges. From those ports much traffic moves inland by rail. Danube traffic had never equaled that on the Rhine. Besides economic and political problems, there were many natural physical obstacles to overcome. Channel silting on the delta, swift currents and dangerous reefs at the Iron Gate, a long winter freeze-up, low water in late summer and the recurring danger of floods on the upper course of the river in spring and early summer all impeded development.

Following World War II, with the entry of the U.S.S.R. into the Danubian trading sphere, together with the effect of increased industrialization in the Soviet-controlled states, the character of river trade changed. Grain and Rumanian oil, once the chief commodities carried, were replaced by ores, especially bauxite from Hungary to the U.S.S.R. and iron ore from the U.S.S.R. to Hungary and Czechoslovakia. The over-all volume of trade decreased, however, compared with pre-1939 figures. *See* also references under "Danube" in the Index volume.

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DANVERS, a town of Essex county, Mass., U.S., 17 mi. N.E. of Boston, of which it is a residential suburb. Manufacturing industries include shoes, leather and metal products. A state hospital for the insane and a county agricultural school are located there. The town originated from a grant to Gov. John Endecott and Rev. Samuel Skelton of the Salem church in 1632, and was named a separate district in 1752 from part of Salem known as the "Village and Middle parishes." Salem village was the centre of the witchcraft delusion in 1692 (*see* SALEM). Danvers was incorporated as a township in 1757, but the supposed opposition of King George II caused the privy council to disallow the incorporation in 1759. This is commemorated on the city's seal by the inscription "The King Unwilling." In 1775 Danvers was made a town, and after 1950 was governed through a representative town meeting, a board of selectmen and a professional town manager. Danvers was the birthplace of Israel Putnam, the distinguished Revolutionary War general.

In 1855 South Danvers became a separate town, and was renamed Peabody (*q.v.*) in 1868. Part of Beverly was annexed to Danvers in 1857. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (J. F. Co.)

DANVILLE, a city of eastern Illinois, U.S., and seat of Vermilion county, is located at the junction of the north and south forks of the Vermilion river, 4 mi. from the Indiana state line and 124 mi. S. of Chicago. The city stands on the site of a Piankashaw Indian village and a number of trails passed through or terminated there in the early days. The location of salt deposits a few miles west of the village provided the chief incentive for early white settlement. Shortly after Vermilion county was organized in 1826 Dan Beckwith and Guy W. Smith, two early settlers who were interested in the salt works, offered to donate the land necessary for a "seat of justice." The offer was accepted and the new county seat was named Danville in honour of Beckwith. It was incorporated as a city in 1869.

The city is the commercial centre of a prosperous agricultural, mining and manufacturing region. In addition to farm products and strip mining of coal, manufactures include automotive and electrical supplies, castings, chemicals, clothing, fireworks, food products, hardware and machine tools. Points of interest nearby include Lake Vermilion and Kickapoo State park (4 mi. W.). For comparative population figures *see* table in ILLINOIS: *Population.* (R. M. Su.)

DANVILLE, a city in Virginia, U.S., is on the southern border of the piedmont area of the state; it lies in, but is politically independent of, Pittsylvania county. It gained importance as the centre of a bright-leaf tobacco area and of cheap hydroelectric power, created by harnessing the falls (pinnacles) of the Dan river, on whose banks the city stands. Its site was discovered by William Byrd II in 1728 and the first settlement clustered around a general store and ordinary (tavern) that attracted persons passing between the tidewater region of Virginia and the North Carolina towns. It was chartered as a town in 1793 and incorporated as a city in 1870. In 1950 it adopted the council-manager form of local government.

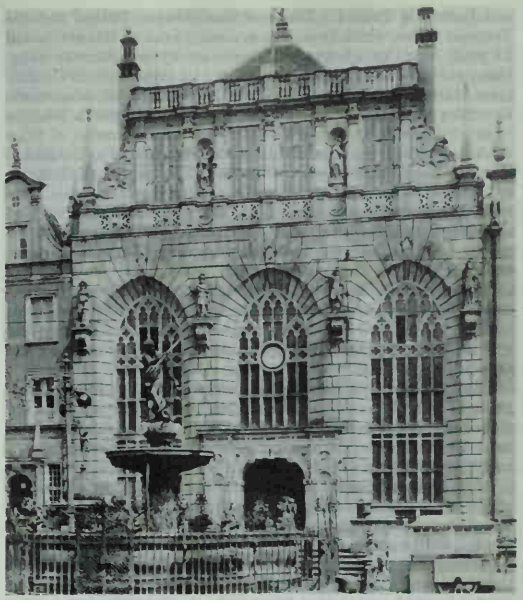
Danville became a terminal point for river navigation early in the 19th century, and the Richmond-Danville railroad, opened in 1848, was extended during the Civil War to link with a railroad reaching into the lower south. Its flue-cured tobacco market, established in 1869, became the largest establishment of its kind in the world. Two major cotton mills, established in 1882, grew into the largest single-unit textile factory in the world. Municipal ownership since 1875 of gas, water and electric utilities provided the city with a great financial asset of low service charges and solvency. The town made a mark in history when Jefferson Davis and his cabinet made it the Confederate capital for seven days after their flight from Richmond on April 2–3, 1865. Stratford and Averett junior colleges, Danville Technical institute and Virginia Polytechnic institute extension are located there. Industries extend from the manufacture of high-quality cloth and tobacco to millwork, mattresses and sausages. For comparative population figures *see* table in VIRGINIA: *Population.* (F. B. S.)

DANZIG (GDANSK), a major Polish town on the Bay of Gdansk at the Vistula mouth on the Baltic sea, is the capital of the province (*wojewodztwo*) of Gdansk and a see of a Roman Catholic bishop. Pop. (1960 census) 286,500. Area 155 sq.km. (60 sq.mi.).

Danzig lies on the border of three physiographic types of landscape: a morainous elevation which is part of the Pomeranian lakelands, the Vistula delta and dunes of the Vistula sandy spit (*mierzeja* or *Nehrung*). The oldest part of the town came into being on the Vistula delta, at the foot of the morainous elevation, and thus used the drier terrain provided by the alluvial fan of the Motlawa and Radunia rivers, which flow into the Leniwka or Martwa (Dead) Vistula (a branch of the Vistula proper) in the modern town. The old city constitutes the central part of Danzig and contains many architectural monuments which were carefully rebuilt after war damage. The old port of Danzig arose on the Martwa Vistula, about 5 km. (2 mi.) from the coast. As a result of much obstruction in the Leniwka river, the port was moved to the river mouth itself in the 17th century and was known as Nowy Port (New Port). Later urban areas were developed on the morainous elevation, where the subsoil is healthier and more suited for building. In its expansion, the town incorporated several separate settlements along the edge of the elevation. This orographic line, consisting of almost uninterrupted settlements, marks the main communications axis of the Danzig, Sopot and Gdynia conurbation. The part of Danzig which contains most of its seats of learning (Wrzeszcz) is situated there; it has a medical school, the school of engineering, a higher school of fine arts, a higher pedagogical institute and the maritime institute, as well as the residential sector of Oliwa, with its famous cathedral and fine botanical garden. Oliwa, Jelitkowo and Brzezno are also popular holiday resorts. Danzig has four theatres, a concert hall and an opera house.

Danzig is an important industrial centre comprising shipbuilding, metallurgical, chemical, timber and food-processing plants. Pride of place is taken by the shipyards. In 1948 the first ocean-going ship was launched there, the first ship of this kind built in Poland. In March 1961 the 308th ship was launched, rounding off 1,000,000 tons of shipping built in Danzig.

Between World Wars I and II Danzig was mainly a port for bulk cargoes (coal, iron ore, timber), but after World War II it developed into a port for mixed cargoes. Between 1946 and 1960 its cargo turnover rose from 3,994,000 to 5,914,000 metric tons.



JAMES SAWDERS

ARTUS HALL AT DANZIG DATING FROM THE 15TH CENTURY

The number of ships entering the port more than doubled during the same period.

History.—Danzig's history, more than that of any other city of eastern Europe, reflects the 1,000-year-old Polish resistance to the German *Drang nach Osten* ("thrust toward the east"). As the capital of eastern Pomorze (Pomerania), a Polish principality, Gdansk was conquered by the Teutonic Order in 1308; 146 years later it became part of Poland and so remained for 339 years. Between 1793 and 1807 it was part of Prussia. Then for seven years it was a free city linked with the duchy of Warsaw, returning to Prussia in 1814; 105 years later it was again a free city linked with Poland. In 1939 it was annexed by Germany but in 1945 it was unconditionally restored to Poland.

Gdansk is first mentioned as *urbs Gyddanyzc* in 997 and was then part of Poland. In 1148, under the bull of Pope Eugenius III, in which it is called *castrum Kdanzc*, the city, together with eastern Pomorze, was included in the Polish diocese of Wloclawek. Sometime earlier, Subislaw, a local ruler, built a castle there. In 1185 the first parish church, St. Catherine's, was founded. With the eastward extension of the shipping and trade of Lübeck, a market of German merchants developed and in 1227 Duke Swientopelk founded a Dominican abbey and the church of St. Nicolas. About 1260 Swientopelk granted Danzig its municipal autonomy. In 1294 Msciwoj (or Mestwin) II, son of Swientopelk, died without issue, having bequeathed his duchy in 1282 to his cousin Przemyslaw II, duke of Great (or western) Poland.

By the late 13th century Danzig was an important link in the chain of Hanseatic towns which carried on trade between eastern and western Europe. As such, it was coveted by the Teutonic Order, already established east of the lower Vistula. In 1308 the knights invaded Pomorze and on Nov. 14 they seized Danzig and put its Polish inhabitants to the sword. The kings of Poland, however, never renounced their rights to Pomorze. Wladyslaw Jagiello, calling himself *Pomoraniae dominus et haeres*, defeated the Teutonic Knights at Grunwald in 1410 but failed to secure Pomorze and Danzig. In 1454 the nobility and towns of Pomorze appealed to Poland for help against the Teutonic Knights and offered their submission to the Polish crown. King Casimir IV Jagiello, on March 6, proclaimed the incorporation of Pomorze

and Danzig in Poland. The new war between Poland and the Teutonic Order, which broke out in consequence of this act, lasted 13 years. On Oct. 19, 1466, the order finally surrendered, recognizing the act of 1454. As a reward for its loyal services Casimir granted local autonomy to Danzig, then a city of 30,000 inhabitants. Becoming the main port of Poland, it rapidly attained a position of great prosperity. Between 1474 and 1490 the number of ships entering the port rose from 405 to 720 and in 1492 Poland exported through Danzig 25,600 tons of grain. The town hall, built in 1357–82, was enlarged in 1486–92. Many new churches were built, the biggest being that of St. Mary, founded in 1343 and completed in 1502, with a tower 259 ft. high. This Flemish-Gothic monument, built of brick, is one of the largest Christian churches in the world.

In 1541 grain exports amounted to 150,000 tons and only Amsterdam could then compare with Danzig as an emporium of world-wide trade in grain. In 1754 Danzig numbered 77,000 inhabitants and was the most populous city in eastern Europe; its annual grain exports were more than 200,000 tons.

Danzig's links with Poland, however, were cut by the first partition of 1772. It became surrounded by Prussian territory and a Prussian customhouse was established in the mouth of the Vistula. The number of ships entering the port dropped between 1770 and 1782 from 1,988 to 145. At the second partition of Poland, in 1793, Danzig became part of Prussia. In 1807, by the treaty of Tilsit, Napoleon made Danzig a free city, garrisoned by two Polish regiments from the duchy of Warsaw. The city's economic position was not satisfactory, for it was territorially separated from Poland by a Prussian "corridor." The senate of Danzig therefore sent a delegation to Paris and London in 1813 and to Vienna in 1814 to ask that "Danzig be again territorially united with Poland." But the Congress of Vienna ended by partitioning Poland once more among Russia, Prussia and Austria, and Danzig became the chief town of the province of West Prussia. Cut off from its natural hinterland, Danzig ceased to be the great centre of the Baltic trade, the relative importance of which also declined sharply. Some industrialization, especially shipbuilding, provided a measure of compensation for lost greatness.

The Free City, 1919–39.—The treaty of Versailles restored eastern Pomorze to Poland. Danzig was made a free city under the protection of the League of Nations, with a territory of 731 sq.mi. and a population (1929 census) of 407,500, including 15,890 Poles. The free city was included within the Polish customs frontiers. Poland was granted the free use of all waterways and of all railways of Danzig, and authority to conduct the city's foreign relations. The democratic constitution was approved and guaranteed by the League, represented in Danzig by a high commissioner. There was a *Volkstag* (legislative assembly) elected by universal franchise; responsible to it was a city government or senate headed by a president.

This complicated regime never worked satisfactorily because the free city's German government adhered to the general line of German policy toward Poland, seeking through permanent conflict to bring about a revision of the territorial settlement of Versailles. Unable, therefore, to rely on any good will from Danzig, the Poles decided to build a port of their own at Gdynia (*q.v.*), 10 mi. to the north, on Polish territory. Although Gdynia's trade developed quickly, Danzig continued to prosper economically. In 1913 the ships entering the port of Danzig totaled 924,837 net registered tons; by 1938 this figure had risen to 4,796,000. The annual amount of imports and exports rose between 1913 and 1938 from 2,112,100 to 7,127,000 metric tons. These figures were the more remarkable when compared with the traffic of Gdynia where the goods turnover rose from 10,167 tons in 1924 to 9,173,000 tons in 1938.

The prosperity of Danzig did not make the political conflict less bitter. This conflict was exacerbated by the rise of the German National Socialist party. On May 28, 1933, the Nazis gained 38 out of 72 seats in the *Volkstag* and accordingly formed the new city government. Hermann Rauschning, a Conservative, the new president of the senate, attempted to reach a direct understanding with Poland. He resisted the pressure of Albert Forster, the Nazi gauleiter, who wanted a nazification of the free city's political regime. On Nov. 23, 1934, Rauschning was forced to resign and was succeeded by Arthur Greiser, Forster's subordinate. New elections to the *Volkstag* were held on April 7, 1935, and this time the Nazis obtained 43 seats. On Oct. 24, 1938, Hitler considered the time ripe for demanding the return of Danzig to Germany. Poland refused and this led to mounting Polish-German tension. On Sept. 1, 1939, Germany attacked Poland and on the same day Hitler proclaimed the reincorporation of Danzig in his greater German *Reich*.

Restoration to Poland.—In March 1945 Danzig was a theatre of heavy fighting between the German and Soviet armies, and about half its houses were either destroyed or rendered uninhabitable. The picturesque medieval centre of the city with its narrow streets and gabled houses suffered greatly. In addition, industrial plants were dismantled by the Soviet authorities. When, in Aug. 1945, Danzig was returned to Poland, the city was in ruins. Rebuilding soon started and by the later 1950s was nearly completed. Care was taken to restore all historic monuments to their former condition. Among the buildings restored were the town hall, Artus hall (1477–81) and St. Mary's church, which was returned to the Roman Catholics.

See also references under "Danzig" in the Index volume.

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DAPHNAE, the Greek name of an ancient fortress town called Tahpanhes in the Bible (modern Tall al Dafana), situated 10 mi. W. of Qantara in northeastern Egypt. It was excavated by Sir Flinders Petrie in 1886. There, in the 7th century B.C., on earlier ruins of the Ramesside period, Psamtik I built a massive fort and enclosure surrounded by a wall 40 ft. thick and in it established a garrison of mercenaries, mostly Carians and Ionian Greeks. After the destruction of Jerusalem (587 B.C.) many Jewish fugitives, including Jeremiah, came to Tahpanhes (Jer. xliii). Its decline started when Ahmose II, in the 6th century B.C., gave Naukratis the monopoly of Greek trade.

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DAPHNE, in Greek mythology, personification of the laurel, a tree whose leaves, formed into garlands, were peculiarly associated with Apollo. The myth explains the laurel's special position by supposing that once Apollo loved a beautiful girl, Daphne. Daphne, daughter of a river god, lives a pastoral existence in Thessaly, the Peloponnese or Syria, rejecting every lover, even Apollo.

When the god pursues her, Daphne prays to Earth or her father to rescue her, whereupon she is transformed into a laurel. Apollo appropriates the laurel for poets and, in Rome, for triumphs (Ovid, *Metamorphoses* i, 452 ff.). Daphne was also loved by Leucippus who, disguised as a woman, was through Apollo's jealousy exposed and killed. (WM. S. A.)

DAPHNE, a genus of much cultivated, showy and sometimes evergreen Eurasian shrubs belonging to the family Thymelaeaceae and containing about 50 species. *D. laureola,* spurge laurel, a small, widely cultivated shrub, with green flowers in the leaf axils towards the ends of the branches and ovoid black, poisonous berries, is found in the British Isles and in southern Europe. *D. mezereum,* mezereon, a rather larger shrub, 2 to 4 ft. high, has deciduous leaves, and bears fragrant pink flowers in clusters in the axils of last season's leaves, in early spring before the foliage. The bright red ovoid berries are cathartic; the whole plant is acrid and poisonous. It is a native of Europe and north Asia and is found apparently wild in copses and woods in Britain.

These and several other species of the genus are cultivated in the open air and as greenhouse plants. *D. cneorum,* garland flower, is a hardy evergreen trailing shrub, with pink sweet-scented flowers. *D. odora* (China and Japan) is a hardy evergreen with showy, rosy-purple, fragrant flowers. *D. indica* (China), with red blos-

soms, and *D. japonica* (Japan), with white or pinkish-purple flowers, are grown as greenhouse evergreens.

DAPHNEPHORIA, a festival held every ninth year at Thebes in Boeotia in honour of Apollo Ismenius or Chalazius. It consisted of a procession in which the chief figure was a boy, of good family and noble appearance, whose father and mother must be alive. Immediately in front of the boy walked one of his nearest relatives, carrying an olive branch hung with laurel and flowers and having on the upper end a bronze ball from which hung several smaller balls. Another smaller ball was placed on the middle of the branch or pole, which was then twined round with ribbons. Then followed the *Daphnephoros* ("laurel bearer"); *i.e.*, the young priest of Apollo Ismenius. There is little doubt that the branch was a kind of Maypole. Then followed a chorus of maidens carrying supplient branches and singing a hymn to the god. The *Daphnephoros* dedicated a bronze tripod in the temple of Apollo.

DAPHNIS, the legendary hero of the shepherds of Sicily, and reputed inventor of bucolic poetry. According to his countryman Diodorus, and Aelian in his *Varia Historia*, Daphnis was the son of Hermes and a Sicilian nymph and was found by shepherds in a grove of laurels (whence his name). He won the affection of a nymph, who made him promise to love none but her, threatening that if he proved unfaithful he would lose his eyesight. He failed to keep his promise and was smitten with blindness. Daphnis, who endeavoured to console himself by playing the flute and singing shepherds' songs, soon afterward died, or was taken up to heaven by his father Hermes, who caused a spring of water to gush out from the spot where his son had been carried off. Ever afterward, the Sicilians offered sacrifices at this spring. In Theocritus, Daphnis apparently has offended Eros and Aphrodite, and in return has been smitten with unrequited love; he dies, although Aphrodite, moved by compassion, endeavours, but too late, to save him.

It is erroneous to suppose that every shepherd called Daphnis in pastoral poetry is this particular Daphnis.

DAQAHLIYAH, AD, an Egyptian *muhafazat* (governorate) in the Nile delta reaching the Mediterranean sea in the northeast, is bounded by the Damietta branch of the Nile to the west and Ash Sharqiyah governorate to the east and south. Area 1,336 sq.mi. Pop. (1960) 2,016,000. The capital is Al Mansurah (*see* Mansurah, Al). The governorate takes in part of the very fertile middle delta land but in the north it includes the greater part of Lake Manzala (Buhayrat al Manzilah) and the contiguous saline marshes. Reclamation of these marshes and the lagoon area was proceeding slowly in the 1960s, with rice as the main crop of the reclaimed farmland. Ad Daqahliyah is Egypt's second principal rice-growing governorate but cotton becomes the most important crop in the centre and south of the governorate, accounting for 25% of the cultivated land. Other major crops include corn (maize), wheat and clover. About 60% of the occupied population is engaged in agriculture. The principal waters for irrigation are obtained from the Mansuriyah (paralleling the Nile) and Buhiyah canals. Much of the drainage of the irrigated land is pumped northward into Lake Manzala where fishing is an important occupation. The principal industries are related to the agricultural resources, namely cotton ginning, flour and rice milling, oil pressing, textile manufactures. Rice mills are established at Al Mansurah, Dikirnis, Al Manzalah and Fariskur, and there are textile mills at Mit Ghamr. There are no mineral resources. The principal towns are Al Mansurah, Al Matariyah, Mit Ghamr and As Sinbillawayn. (A. B. M.)

DAQUIN, LOUIS CLAUDE (1694–1772), French harpsichordist, organist and composer of keyboard music, some of which remains popular.

He was born in Paris, July 4, 1694, and was a godson of the famous composer Elisabeth Jacquet de La Guerre, whose husband probably taught him to play the organ. The boy was a prodigy, playing before Louis XIV at the age of six. At 12 he was a professional organist and his life story is a record of successive appointments, culminating in that of organist to the chapel royal in 1739. He had already published (1735) his *Premier Livre de pièces pour le clavecin*, which contains his one really famous piece, "Le Coucou." He also published the successful *Noëls pour l'orgue et le clavecin.*

He lived all his life in or near Paris, and died there, June 15, 1772. His playing is said to have been remarkable for neatness and precision and though his music lacks breadth and vision, some of it has gentle charm.

See A. Pirro, *Les Clavecinistes* (1924). (Cs. Ch.)

DAR'A (Der'a; anc. Edrei), a small town in Syria and administrative centre of the governorate (*muhafaza*) of the same name, lies on the Jordan frontier. It is situated at a height of 1,742 ft. above sea level, on the Wadi Jride, south of the Yarmuk. The town, 61 mi. N.E. of Amman, the capital of Jordan, is a focal point for road and rail communications between Amman, Jerusalem and Damascus. Population (1960) of the governate was 167,049. The railway station is to the north of the wadi and the town south of it. There are no local industries, but Dar'a serves as a market for the surrounding district and as a garrison centre. The country is open and cultivated, growing mainly barley. The area to the east is largely desert country occupied by the Beni Sakr, one of the major Jordanian tribes.

The decisive battle of Yarmuk was fought in 636 near Dar'a at the junction of the Yarmuk and its tributary Al Ruqqad. This led to the annihilation of the Byzantine forces under Theodorus and the capture of Syria by the Arabs. During World War I Dar'a junction was the scene of fierce fighting and was eventually captured by irregular Arab forces. (M. V. S.-W.)

DARAB, chief town of a district in Fars, Iran, is situated 4,000 ft. above sea level in a well-watered intramontane basin at the southern foot of high ranges. Pop. (1956) 9,101. The climate is mild in winter and allows the cultivation of citrus fruits and date palms besides other fruits, wheat and barley, rice, cotton and fine quality tobacco, all irrigated. Large stretches of the lower lands, however, are still used for winter pastures by the Baharlu tribe. The salt mines have been important for centuries. Once on the main highway from Shiraz to Hormuz, Darab is a short distance from the motor road to Bandar Abbas.

Modern Darab lies 5 mi. N.E. of the ruins of the ancient city of Darabgird, the chief place of the southeastern quarter of Fars which included Fasa, Neyriz, Furg, Tarom and Lar. Its layout was circular, a mile in diameter, with a citadel (or fire temple) crowning a rock in the centre, and four gates. Persian legend recounts that it was founded by Darab, father of Darius III Codomannus (336–330 B.C.). (H. Bo.)

D'ARANYI, JELLY (1895–), British, originally Hungarian, violinist, a grandniece of Joseph Joachim (*q.v.*), known for her performances of modern music, was born at Budapest on May 30, 1895. She was a pupil of Jenö Hubay and first appeared in Vienna in 1909. Béla Bartók's two sonatas for violin and piano were written for her, and Maurice Ravel dedicated to her his *Tzigane* for violin and orchestra. Her playing was fiery and temperamental. She settled in London in 1913. With her sister, Adila Fachiri (1888–1962), she was known for performances of J. S. Bach's double concertos. They also gave the first performance of Gustav Holst's concerto for two violins.

DARBHANGA, a town and district in Bihar state, India. The town, headquarters of the district, is an elongated place, 6 mi. long and covering 7 sq.mi., on the left bank of the Little Baghmati river. Pop. (1961) 103,016. It is surrounded by mango groves and large artificial tanks and is an important agricultural market. The only notable building is the residence of the local maharaja in extensive grounds (55 ac.). The town has three colleges affiliated to Bihar university, including a medical college. Although only about 60 mi. N.E. of Patna, it can only be reached from there after crossing the Ganges river by ferry.

Darbhanga District extends from the Nepal frontier to the Ganges. Area 3,345 sq.mi. Pop. (1961) 4,413,027. The district consists of a moist alluvial plain with the Ganges, Burhi Gandak, Baghmati, Little Baghmati, Balan, Little Balan and Tiljuga as the principal rivers. It has suffered from destructive floods for many years as a result of the constant migration of the Kosi river. Rice is the staple crop; other important crops are wheat, barley, maize, gram, oilseeds, sugar cane, tobacco and good mangoes. The dis-

trict is served by the North Eastern railway. Roads are poor. The township of Pusa (*q.v.*) in western Darbhanga has an agricultural research institute specializing in mycology and pestology. It was formerly the seat of the Indian Agricultural Research institute which was moved to New Delhi after the Bihar earthquake of 1934.

The Darbhanga raj, a hereditary and extensive estate since the 16th century, was acquired by the government after India became independent in 1947. (E. AH.)

D'ARBLAY, FRANCES: *see* BURNEY, FANNY.

DARBOUX, (JEAN) GASTON (1842–1917), French mathematician who made contributions to geometry, was born at Nîmes on Aug. 13, 1842. His father died in 1849, and under the guidance of his mother, and with her encouragement, he was educated at the École Normale, Paris.

Pasteur became interested in Darboux and created a teaching post for him at the École Normale. After acting as assistant to Joseph Bertrand in the chair of mathematical physics at the Collège de France (1866–67), he taught at the *lycée* Louis le Grand (1867–72), at the École Normale (1872–73) and at the Sorbonne (1873–90). Darboux, besides being an excellent teacher and a notable mathematician, was a very capable administrator. He died in Paris on Feb. 25, 1917.

Practically all his mathematical work was in geometry. His early papers (1864 and 1866) were on orthogonal surfaces; these were followed by a memoir on partial differential equations of the second order (1870), which embodied a new method of integration. In his treatise *Sur une classe remarquable de courbes et de surfaces algébriques* (1873) Darboux developed the theory of the class of surfaces called cyclides. *Leçons sur la théorie générale des surfaces et les applications géométriques du calcul infinitésimal* (4 vol., 1887–96) is one of Darboux's most important works; dealing with infinitesimal geometry, it embodies most of his previous research work. In 1898 the publication of *Leçons sur les systèmes orthogonaux et les coordonnées curvilignes* was begun. He was the author of a number of papers and memoirs on the approximation to functions of very large numbers, on discontinuous functions and on other subjects.

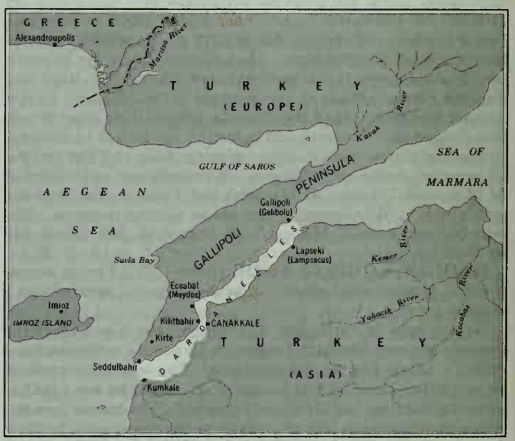
DARBOY, GEORGES (1813–1871), French prelate, the third archbishop of Paris to be killed between 1848 and 1871 (*see* AFFRE, DENIS AUGUSTE), was born at Fayl-Billot, Haute-Marne, on Jan. 16, 1813. He was appointed bishop of Nancy in 1859 and archbishop of Paris in Jan. 1863. Appointed chief almoner to Napoleon III in 1864, he became a senator and a member of both the privy council and the council of regency. A strenuous upholder of episcopal independence in the Gallican tradition, Darboy sought to establish control over the Jesuits and other religious orders within his diocese. This led to friction with Pope Pius IX, which was further embittered when, at the Vatican council of 1870, Darboy strongly opposed the dogma of papal infallibility as inopportune, though in the end he accepted it. During the Franco-German War he organized relief for the wounded, remaining at his post during the siege of Paris and the Commune. On April 4, 1871, he was arrested as a hostage by the Communards and imprisoned. When Adolphe Thiers refused to exchange him for Auguste Blanqui, Darboy was shot in the prison of La Roquette together with four priests on May 24. He died blessing his executioners and uttering words of forgiveness.

See J. A. Foulon, *Histoire de la vie et des oeuvres de Mgr. Darboy* (1889).

DARCY, THOMAS DARCY, BARON (*c.* 1467–1537), English soldier and one of the most powerful noblemen on the Scottish border, became implicated in the 1536 rebellion against Henry VIII's ecclesiastical policy. A son of Sir William Darcy (d. 1488), he was summoned to parliament as a baron probably in 1504, certainly in 1509, and was made warden of the east marches toward Scotland in 1505. Darcy led troops to Spain to help Ferdinand and Isabella against the Moors in 1511; he took part in the siege of Thérouanne during Henry VIII's French campaign (1513). He was also a member of the royal council, dividing his time between London and the north. He brought accusations against his former friend, Cardinal Wolsey, in 1529, but after Wolsey's fall he himself came under suspicion. Disliking the separation from Rome, Darcy asserted that matrimonial cases should be determined by spiritual authority (1532) and he corresponded (1535) with Eustace Chapuys, ambassador of the emperor Charles V, about a possible Catholic invasion of England. Detained in London by the king, he was not allowed to return to Yorkshire until late in 1535; the northern rising known as the Pilgrimage of Grace broke out about a year later. Darcy held Pontefract castle against the rebels for a short while only; he surrendered it to them sooner than its strength warranted, and went with them to Doncaster, where he was regarded as one of the rebel leaders. Darcy may have helped to suppress a renewal of the rising under Sir Francis Bigod early in 1537, but the king believed, probably with good reason, that he was guilty of fresh treasons, and he was seized and hurried to London. Tried by his peers, he was found guilty of treason and beheaded on June 30, 1537. (G. R. E.)

DARCY'S LAW: *see* PERMEABILITY (FLUID).

DARDANELLES (Turk. CANAKKALE BOGAZI), the strait (anciently called the Hellespont) that unites the Sea of Marmara with the Aegean. The city of Dardanus in the Troad, where Mithradates VI and Sulla signed a treaty in 85 B.C., gave the strait its name. The shores are formed by the peninsula of Gallipoli in Europe on the northwest and by Asia Minor on the southeast; it extends for a distance of about 38 mi. with a breadth of from $\frac{3}{4}$ to 4 mi. and has an average depth of 30 fathoms and a maximum depth of 50 fathoms in the narrowest central section. There is a rapid surface current from the Sea of Marmara to the Aegean and a compensatory undercurrent below a certain depth. The waters of the Dardanelles are rich in various kinds of fish, and the fishes caught are used in the canning industry, which is mainly located in Canakkale and Gallipoli (Gelibolu). At the Aegean extremity stand the castles of the Seddulbahir and Kumkale, respectively in Europe and Asia; and near the Marmara extremity are the towns of Gallipoli on the northern shore and Lapseki (Lampsacus) on the southern. The most famous castles of the Dardanelles are Canakkale, Sultankalesi, or the Old Castle of Anatolia, and Kilitbahir, or the Old Castle of Rumelia. The strait has long been famous in history since the passage of Xerxes' army by a bridge of boats. It is the scene of the story of Hero and Leander and of Byron's successful attempt to rival Leander. The strategic importance of the strait has always been very great, since it is the gateway to Istanbul and the Black sea from the Mediterranean. Although easily capable of defense, the strait was forced by the English admiral Sir J. T. Duckworth in 1807; and during World War I a British submarine under the command of Lieutenant Commander Stoker penetrated through the Turkish mine fields and sank a Turkish battleship off the Golden Horn. Its



STRAIT OF THE DARDANELLES BETWEEN THE SEA OF MARMARA AND THE AEGEAN

strategic importance has given to it an international political importance that has found expression in what is known as the Straits (Dardanelles and Bosporus) question (*q.v.*). *See* DARDANELLES CAMPAIGN; *see* also references under "Dardanelles" in the Index. (N. TU.; S. ER.; E. TU.)

DARDANELLES CAMPAIGN, in World War I, an Anglo-French operation against Turkey in 1915, intended to force the 38-mile-long Dardanelles channel and to occupy Constantinople. Plans for such a venture were considered by the British authorities between 1904 and 1911, but both military and naval opinion was against it. When war between the Allies and Turkey began early in Nov. 1914 the matter was re-examined and classed as a hazardous, but possible, operation.

On Jan. 2, 1915, in response to an appeal by the grand duke Nicholas, commanding the Russian armies, the British government agreed to stage a demonstration against Turkey to relieve pressure on the Russians on the Caucasus front. The Dardanelles were selected as the place, a combined naval and military operation being strongly supported by the then first lord of the admiralty, Winston Churchill. On Jan. 28 the Dardanelles committee decided on an attempt to force the straits by naval action alone, using mostly obsolete warships too old for fleet action. On Feb. 16 this decision was modified, as it was agreed that the shores of the Dardanelles would have to be held if the fleet passed through. For this purpose, a large military force under Gen. Sir Ian Hamilton was assembled in Egypt, the French authorities also providing a small contingent. The naval bombardment began on Feb. 16, but was halted by bad weather and not resumed until Feb. 25. Demolition parties of marines landed almost unopposed, but bad weather again intervened. On March 18 the bombardment was continued; but, after three battleships had been sunk and three others damaged, the navy abandoned its attack, concluding that the fleet could not succeed without military help.

Troop transports assembled off the island of Lemnos, and landings began on the Gallipoli peninsula at two places early on April 25, 1915, at Cape Helles (29th British and Royal Naval divisions) and at "Anzac" beaches (Australian and New Zealand troops). A French brigade landed on the Anatolian coast opposite, at Kum Kale, but was later withdrawn. Small beachheads were secured with difficulty, the troops at "Anzac" being held up by Turkish reinforcements under the redoubtable Mustafa Kemal, later to become famous as Atatürk. Large British and Dominion reinforcements followed, but little progress was made. On Aug. 6, another landing on the west coast, at Suvla bay, took place, but after good initial progress the assault was halted.

In May 1915 the first sea lord, Admiral Lord Fisher (*q.v.*), had resigned because of differences of opinion over the operation. By Sept. 1915 it was clear that without further large reinforcements there was no hope of decisive results, and the authorities at home decided to recall Hamilton to replace him by Lieut. Gen. Sir Charles Monro. The latter recommended the withdrawal of the military forces and abandonment of the enterprise, advice which was confirmed in November by the secretary of state for war, Lord Kitchener, when he visited the peninsula. This difficult operation was carried out by stages and successfully completed early on Jan. 9, 1916.

Altogether the equivalent of some 16 British, Australian, New Zealand, Indian and French divisions took part in the campaign. British Commonwealth casualties, apart from heavy losses among old naval ships, were 213,980. The campaign was a success only in so far as it attracted large Turkish forces away from the Russians. The plan as such was a good one: it failed to produce decisive results because of poor military leadership in some cases, faulty tactics including complete lack of surprise, the inexperience of the troops, inadequate equipment and an acute shortage of shells.

The campaign had serious political repercussions. It gave the impression throughout the world that the Allies were militarily inept. Before the evacuation had been decided Henry Asquith's Liberal administration was superseded by his coalition government. Winston Churchill, the chief protagonist of the venture, resigned from the government and went to command an infantry battalion in France. In the end the campaign hastened Asquith's resignation, and his replacement as prime minister by David Lloyd George, in Dec. 1916.

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DARDANUS, in Greek legend, son of Zeus and the Pleiad Electra, mythical founder of Dardania on the Hellespont and ancestor of the Dardans of the Troad and, through Aeneas, of the Romans. His original home was supposed to have been Arcadia. Having slain his brother Iasius or Iasion (according to some legends, Iasius was struck by lightning), Dardanus fled across the sea. He first stopped at Samothrace and, when the island was visited by a flood, crossed over to the Troad. Being hospitably received by Teucer, he married his daughter Batea and became the founder of the royal house of Troy.

DARDIC LANGUAGES, the name assigned to languages spoken immediately to the south of the Hindu Kush mountains, include the Kafir languages spoken in Kafiristan, Afg.; Khowar, spoken in the Chitral country in Pakistan, and the Shina languages, which include the Shina of Gilgit, India; Kohistani, spoken in the Kohistan of the Indus and Swat rivers; and Kashmiri. Of all these Kashmiri is the only one which has received any literary cultivation. The Dardic languages (also known as the Piśāca or Pisacha languages) are Indo-European by origin, but are neither Iranian nor Indo-Aryan. They have developed phonetic peculiarities and possess, almost unaltered and in common use, words which in India are seldom found except in Vedic Sanskrit. In each there is a small element of Burushaski. *See* also BURUSHASKI LANGUAGE; INDO-ARYAN LANGUAGES; KASHMIRI LANGUAGE.

BIBLIOGRAPHY.—For the general question of the Dardic languages, *see* G. A. Grierson's *The Piśāca Languages of North-western India* (1906); *Linguistic Survey of India,* vol. viii, pt. ii. For the different languages of this group *see* G. W. Leitner, *Dardistan* (1877); J. Biddulph, *Tribes of the Hindoo Koosh* (1880); D. J. O'Brien, *Grammar and Vocabulary of the Khowār Dialect* (1895); J. Davidson, *Notes on the Bashgali (Kāfir) Language* (1901); T. G. Bailey, *Grammar of the Shina Language* (1924); G. Morgenstierne, *Report on a Linguistic Mission to Afghanistan* (1926), *Notes on Phalūra, an Unknown Dardic Language of Chitral* (1941). (ET. B.)

DARDISTAN, a conventional name for the region inhabited by the so-called Dard races in the north of West Pakistan and northern Kashmir. It includes Chitral, Yasin, Panyal, the Gilgit valley, Hunza and Nagar, the Astor valley, the Indus valley from Bunji to Batera, the Kohistan-i-Malizai, *i.e.,* the upper reaches of the Panjkora river, and the Kohistan (highland) of Swat. The Dard races are referred to by Pliny and Ptolemy and are supposed to be people of Aryan origin who ascended the Indus valley from the Punjab plains, reaching as far north as Chitral, where they dispossessed the Khos. They have left traces in the different dialects, Khowar, Burushaski and Shina, spoken in Gilgit.

See G. W. Leitner, *The Races and Languages of Dardistan,* 2nd ed. (1877).

DARES PHRYGIUS, in the *Iliad* a Trojan priest of Hephaestus, is the reputed author of a pre-Homeric account of the Trojan war. Of this account the Latin *Daretis Phrygii de excidio Troiae historia* (probably 5th century A.D.; language and style contradict the indication of the preface that Cornelius Nepos [1st century B.C.] was the translator) purports to be a version: whether it is indeed translation or original work is uncertain. The work aims at authenticity and excludes supernatural agencies. Its supposed origin won for this account wide acceptance in the middle ages, and in some quarters up to the 17th century: together with the work of Dictys Cretensis (*q.v.*) it was the main source of medieval handlings of the Trojan story, being rivaled (in the 12th and 13th centuries) only by the *Excidium Troiae* whose anonymity led to its disregard.

See edition by F. Meister in the Teubner series (1873). (D. R. BR.)

DAR ES SALAAM, capital and principal seaport of Tanganyika, Africa, lies on the Indian ocean 48 mi. S. of Zanzibar. Pop. (1957 census) 128,742 (93,363 Africans, 29,986 Asians, 4,479 Europeans, 914 others). There are two rainy seasons—March to May and October to December. The coolest months are June to September.

Extensive commercial, industrial and residential development took place after World War II and most of the old Arab and German buildings were replaced with modern multistoried buildings. Azania front and Main avenue, containing the town hall, government offices and the law courts, the main post office, St. Joseph's Roman Catholic cathedral and the Lutheran church, face the harbour. Behind these is the commercial area, with the main shopping centres, banks, shipping offices, motion-picture theatres, hotels and the railway station. Government house is on Ocean road, overlooking the ocean, and residential estates have been developed beyond the commercial area.

Notable modern buildings include a group hospital, technical institute and the high court. The botanical gardens surround a museum (housing examples of African arts and crafts, weapons and clothing) and a public assembly hall.

A modern airport, opened in 1954, is 8 mi. from the town centre. Dar es Salaam is the coastal terminus of the Central railway which runs approximately 780 mi. to Kigoma on the eastern shore of Lake Tanganyika.

The port is the outlet for most of the produce of Tanganyika including tobacco, tea, coffee, hides and skins, minerals, wattle bark, pyrethrum, peanuts and sisal. It is also a transit port for the Republic of the Congo. Local industries include vegetable oil and flour milling; soap, paint, metal box, cigarette and shoe manufacture; and meat canning.

The town dates from about 1862, when the sultan of Zanzibar developed the fishing village of Mzizima and the neighbouring inland creek as a safe port and trading centre, and as a site for a summer palace. The Arabs gave it the name of Dar es Salaam, "house or haven of peace." The German East Africa company was allowed by the sultan to use the port as a trading base and in 1889 the imperial German government garrisoned the town. In 1891 the German imperial commissioner transferred the seat of his government from Bagamoyo to Dar es Salaam and from then until 1914 there was slow but steady development of town and railway. The town was captured by the British in 1916 and became a base for the conquest of the rest of Tanganyika. The British civil administration assumed responsibility in 1919. Dar es Salaam became the capital of independent Tanganyika in 1961. The town was an extraprovincial district of the former Eastern region until 1962 when it was itself created an administrative region. After a further reorganization in 1963 Dar es Salaam became a district within the newly created Coast region. (P. E.)

DARESTE DE LA CHAVANNE, ANTOINE ELISABETH CLÉOPHAS (1820–1882), French historian, whose reputation rests on his authoritative *Histoire de France* (9 vol., 1865–79), was born in Paris, Oct. 28, 1820. Educated at the École des Chartes, he became professor of history at Grenoble in 1847, and at Lyons in 1849, remaining there for many years, and eventually becoming rector. His other works include *Histoire de l'administration en France* (2 vol., 1848), *Histoire des classes agricoles en France* (1854) and *Histoire de la Restauration* (2 vol., 1879). His general history was considered the best of its kind before Ernest Lavisse's *Histoire générale du IVe siècle jusqu'à nos jours* (1893–1901). He died at Lucenay-lès-Aix (Nièvre), Aug. 6, 1882.

DARFUR, the westernmost province in the Republic of the Sudan, extends from latitude 9° to 20° N. and from longitude 21° 50′ to 27° 50′ E. It has an area of 191,648 sq.mi.

It is formed of Archean crystalline rocks in the west and Nubian sandstone in the north. To the east and southeast are extensive superficial deposits of sand, and in the extreme southeast and south are alluvial clays. In the centre are outcrops of recent volcanic rocks. A plateau 2,000 to 3,000 ft. above sea level, Darfur is almost featureless in the east and southeast. To the west and north are low, irregular hills and in the centre bold, rugged volcanic uplands as Jabal Marra (10,134 ft.) and Jabal Meidob (3,500 ft.).

A tropical continental climate prevails. Rains (between May and October) diminish from a total of about 35 in. along the southern border to nothing at latitude 20° N. Altitude tempers the heat: at Al Fasher (2,395 ft.) the mean temperature for January is 69.5° F. and for June, 87° F. The highest part of Jabal Marra has a montane climate. There are no permanent rivers except some short streams on the southwestern flank of Jabal Marra, but large watercourses radiating from the central volcanic uplands, *e.g.*, the Wadi Azum, the Wadi al Ku and the Wadi Nyala, drain westward and southward and are in flood after heavy rains.

The vegetation is broadly that of tropical savanna. In the south moderately tall grasses accompany thickets of deciduous and semideciduous trees, and in some watercourses there are evergreen trees such as mahogany. In the central zone shorter grass accompanies various species of Acacia and the plant mantle thins until at 17° 30′ N. the desert appears. Jabal Marra has a distinctive montane flora. Clay and silt soils occur along the Bahr al Arab in the south, on terraces fringing some of the larger western watercourses and locally at the foot of Jabal Marra. Elsewhere are sandy soils, deep to the southeast but otherwise generally thin except locally in the northern centre. In the far north are desert sand dunes not fixed by vegetation.

In 1956 the population was 1,328,765. The chief tribal groups are those of western Darfur (of which the Fur form a majority), numbering 758,000, and the Baggara, numbering 268,000. Arabic was spoken by about half the population and western Darfur languages (among the Fur and in Dar Masalit) by 554,000 persons. The Negroid Fur, from whom the province is named, occupy the centre. To the east are the Berti and Bergid; to the west are the Masalit and in the north the Zaghawa and Meidob or Midohi, Negro-brown and of mixed origin, akin to the Tebu of Tibesti. The larger Arabic-speaking tribes are partly or wholly nomadic and include camel-owning tribes in the north and Baggara (cattle owning) in the south, the latter mainly Negroid. The chief areas of settled population are in the west, close to the main watercourses, and in the central uplands and piedmont zones as far north as latitude 14° 30′ N. The northern desert fringe, the southeast and the south are used only by nomadic peoples. Al Fasher, the province's capital, had a population of 26,161 in 1956.

The province is divided into five administrative districts: Central (administered from Al Fasher), Southern (Nyala), Western (Zalingei), Northern (Kutum) and Dar Masalit (Geneina, also the seat of the sultan of Dar Masalit).

Agriculture is based upon two species of millet, sesame, peanuts, maize (corn), various vegetables, fruits and cotton. Wheat is grown at higher altitudes on Jabal Marra. The pastoral tribes own great numbers of camels, sheep and goats (in the north) and cattle and horses (in the south). They travel far during their migrations.

Economic development has been retarded by lack of communications. Trucks spend four days on journeys between Nyala or Al Fasher and El Obeid, bearing quantities of tobacco, gum arabic, peanuts, ostrich feathers, *semn* (clarified butter), hides and skins for export. Camels, sheep and cattle are also driven eastward along routes provided with watering points. The extension of the railway to Nyala, completed in March 1959, will stimulate both agricultural and pastoral production. Air services connect Geneina, Nyala and Al Fasher with El Obeid and Khartoum. (J. H. G. L.)

History.—In prehistoric times the extreme north, then not so desiccated as now, was sparsely inhabited by people related to and culturally connected with the predynastic inhabitants of the Nile valley. Darfur was probably within the sphere of the Egyptian caravans which traded from Aswan about 2500 B.C., and although the people who now call themselves Daju or Dagu in Darfur and Kordofan (*q.v.*) are Negroid, it is probable that the Daju who were the first traditional rulers of Darfur were in some ways connected with ancient Egypt. Pottery and stone axes related to those of the Nile valley in 2000 B.C. have been found in the Wadi Howar in the extreme north. Slaves, ostrich feathers, ivory and ebony no doubt found their way to Egypt during the New Kingdom and to Napata and Meroe during the time of the kingdom of Cush.

On the fall of Meroe in about A.D. 350 the royal family of Cush probably fled west and may have given a dynasty to Darfur, for the pattern of divine kingship found there when history begins may derive originally from Egypt—probably via Cush. Meroe was succeeded on the Nile by the Christian kingdoms of Nubia (*q.v.*), and

evidence indicates that the red-brick ruins at Ain Farah in northern Darfur were those of a Christian monastery, which no doubt imported from Nubia the fine date palms that still grow in the vicinity. Thus the Tungur, traditionally once rulers of Darfur who succeeded the Daju and came from the Nile, are seen to have been missionaries or colonizers from Nubia. An early form of the name Tungur was probably Tumagera, which may mean "the great ones of Tibesti (Tu)," where there are still Tumagera. This suggests that Christianity reached Darfur via Tibesti and Ennedi rather than across the plains from the east, and certainly accords with the tradition that the inhabitants of Ain Farah eventually fled to Ennedi. Abu Sofian and Zankor, in northern Kordofan, where there are also red-brick remains, must have been links between Christian Darfur and the Nile. The most likely date for the Christian period in Darfur is from A.D. 900 to 1200. It was no doubt the eastward advance of Islam from Kanem that brought an end to Christianity in Darfur. By 1240 the king of Kanem was claiming control of his trade route with Egypt as far as Sai on the Nile; this is, therefore, the most probable date for the beginning of the influence of Kanem-Bornu, which is evident in the titles and form of administration of the historical Keira sultanate of Darfur (although Kuru, its legendary founder, claimed descent from the Tungur). Indeed it is by no means impossible that Darfur was a province of either Kanem or Bornu (*q.v.*) at one or more of their great periods.

There are stone ruins in Turra on Jabal Marra that are the traditional palaces of Kuru, of Suleiman Solong (*c.* 1640–70) and of his son Musa (*c.* 1670–82). The first historic mention of the name Fur occurs in 1664 in the account by J. M. Vansleb of a visit to Egypt. Fur appears to be the name given by the Keira sultans to the Negroid inhabitants who accepted Islam and their rule. As the dynasty became more and more Negroid through intermarriage with concubines, its members became known as Fur. After Musa, each sultan had his capital or *fasher* in a different place, until Abdal-Rahman al-Rashid (1787–1802) chose the present site of Al Fasher. Sultan Ahmed Bukr (1682–1722) spread Islam by building mosques, conquered the Gimr and defeated a Wadai army at Kebkebia. His brother and successor, Abulgasim, was defeated in battle with Wadai. Another brother, Mohammed Teirab (1752–57), died on a campaign in which he reached the Nile near Shendi. He was succeeded by his brother Abdal-Rahman al-Rashid, who in 1799 wrote to congratulate Napoleon on his defeat of the Mamelukes in Egypt and was asked by Napoleon to send 2,000 black slave recruits for his army. Mohammed al-Fadhl, his son, whose reign lasted until 1839, devoted himself largely to the subjection of the semi-independent Arab tribes who lived in the country. In 1821 he lost the province of Kordofan to the Egyptians. Of his 40 sons, the third, Mohammed Husain, was appointed his successor. In the later part of his reign Husain became involved in trouble with the Arab slave raiders who had seized the Bahr el Ghazal, looked upon by the Fur sultans as their especial "slave preserve." The Negroes of Bahr el Ghazal paid tribute of ivory and slaves to Darfur, and these were sold by the Darfurians to the Egyptian traders along the Arbain road to Asyut. Husain died in 1873 and the succession passed to his youngest son, Ibrahim, who soon found himself engaged in a conflict with Zubayr, the chief of the Bahr el Ghazal slave traders, and with an Egyptian force from Khartoum. Ibrahim was slain in battle in the autumn of 1874.

Under Egyptian rule, various revolts were suppressed, and in 1881 Slatin Bey (Rudolf Carl Slatin) was made governor of the province. Slatin defended the province against the forces of the mahdi but was obliged to surrender (Dec. 1883), and Darfur was incorporated in the mahdi's dominions. Following the overthrow of the khalifa at Omdurman in 1898 the new (Anglo-Egyptian) Sudan government recognized (1899) Ali Dinar, a grandson of Mohammed al-Fadhl, as sultan of Darfur. A rising attempted by Ali Dinar in 1915 brought about a punitive expedition in which he was killed (Nov. 1916), and Darfur then became a province of the Sudan. Into it was incorporated in 1922 the small, hitherto independent state of Dar Masalit, which continued to enjoy a measure of self-government under a sultan.

The first European traveler known to have visited Darfur was W. G. Browne, who spent two years (1793–95) at Kobbe. Gustav Nachtigal in 1873 spent several months in Darfur.

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(A. J. AL.)

DARGOMYZHSKI, ALEKSANDR SERGEEVICH (1813–1869), Russian composer of songs and declamatory opera, was born Feb. 14 (new style; 2, old style), 1813, in a village near Tula. He grew up in St. Petersburg as a talented amateur musician, playing the violin and piano and dabbling in composition. Acquaintance with Glinka (1833) turned his thoughts more seriously toward composition and in 1839 he completed his first opera, *Esmeralda* (after Victor Hugo), though it had to wait eight years for performance. The next, *The Triumph of Bacchus*, was not performed till 1867, but his third opera, *Rusalka* (after Pushkin), was successfully produced in 1856. Some of Dargomyzhski's best songs date from the late 1850s; in these he developed an individual vein of humour and satire. A little later came three orchestral pieces notable for their harmonic experiments. After 1866 Dargomyzhski was occupied with a more striking experiment: a setting of Pushkin's play *The Stone Guest*, just as it stood, to a species of declamatory musical prose, with entire passages composed in the whole-tone mode. This work aroused the interest of Balakirev and his circle, particularly Mussorgsky, who was deeply impressed by Dargomyzhski's slogan of "the note as the direct expression of the word"; when Dargomyzhski died (in St. Petersburg, Jan. 17 [N.S., 5, O.S.], 1869) the score was completed by Cui and orchestrated by Rimski-Korsakov. *The Stone Guest* is no more than an important historical landmark, a stimulating experiment, but some of Dargomyzhski's songs are of lasting value.

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(G. AB.)

DARIÉN, the name traditionally given the area comprising the easternmost part of the Isthmus of Panamá. It lies chiefly within the republic of Panamá (*q.v.*) of which it is a province but also includes the region of Urabá gulf in the departments of Antioquia and Chocó (*qq.v.*) of Colombia. This hot, humid, forested area has always been sparsely populated. In the Colombian section the largest settlement is the small port of Turbo, which is connected with the interior by a motor road.

The area was first reached by Rodrigo de Bastidas in 1501 and was seen by Columbus on his last voyage two years later. The first European settlement of South America, Santa María de la Antigua del Darién, was attempted on the western side of Urabá gulf. It was founded in 1510 by the expedition of Alonso de Ojeda, who had previously attempted to form a settlement at Cartagena bay. It was from this failing colony that Vasco Núñez de Balboa (*q.v.*) made his famous march westward in 1513, reaching the Pacific ocean at San Miguel gulf. A few years later some members of the colony moved far to the west on the Pacific side, where in 1519 they founded the city of Panamá (*q.v.*). The Darién colony then gradually declined and was subsequently abandoned. The end of the 17th century witnessed a Scottish attempt at colonization. A trading company under William Paterson founded a settlement in this area about half way between the Spanish strongholds of Porto Bello and Cartagena (*qq.v.*). This colony too was short-lived.

(T. E. N.)

Darién gulf is the southernmost extension of the Caribbean sea, between Panamá and Colombia. Urabá gulf, the inner section of the Darién gulf between Punta Caribana and Cabo Tiburón, Colombia, is a shallow, mangrove-lined arm of the sea 20 mi. wide and 50 mi. long into which protrudes the delta of the Atrato river.

(Js. J. P.)

DARÍO, RUBÉN (1867–1916), pen name of FÉLIX RUBÉN GARCÍA-SARMIENTO, who was the leader of the important Spanish American literary movement known as Modernism. He was born in Metapa, Nic., Jan. 18, 1867, and died at León, in the same coun-

try, Feb. 5, 1916. Most of his life was spent in other countries of Spanish America and in Europe, on diplomatic missions and as a newspaper correspondent.

He was the author of many volumes of excellent journalistic prose, originally published as articles in *La Nación* of Buenos Aires and many other periodicals; of approximately 100 short stories and tales, of artistic types largely original with him; several volumes of penetrating literary criticism; and much verse of varying quality. His chief fame, however, rests upon three great collections, chiefly of verse, in which he gave expression to his literary theories.

The first of these, *Azul*, consisting of short stories, descriptive sketches and verse, was first published in Chile in 1888. The author had only recently become acquainted with the Parnassian movement (*q.v.*) in French literature, and the volume represents to a considerable degree his attempt to apply to Spanish the tenets of that group. In the prose portions he discards the traditional long Spanish sentence, of complicated grammatical structure, in favour of short and simple sentences. Both prose and poetry are largely concerned with objective description, based upon the principles of graphic and plastic art, and both deal largely with the exotic, the chief interests being classical mythology, France and the orient. All in all, the volume is purely concerned with art for art's sake. An enthusiastic review of it by the great Spanish critic Juan Valera helped to assure its favourable reception on both sides of the Atlantic, and it was soon recognized as the herald of a new era in Spanish American literature. In a second edition, in 1890, he added several short stories and a number of sonnets of sensationally new types, particularly notable being the use, in most of them, of the alexandrine line, as in French, instead of the traditional Spanish hendecasyllable.

Darío's second great collection, *Prosas profanas* (1896), consisted entirely of verse. It follows to some extent the Parnassian trend established by *Azul*, but places its chief emphasis upon the type of Symbolism (*see* SYMBOLISTS, THE) newly developed in France. The subject matter is still largely exotic, but the scenes and personages treated often have a symbolic rather than an objective significance. Like *Azul*, the volume is concerned with art strictly for its own sake, with little relation to everyday life.

By 1905, the date of publication of *Cantos de vida y esperanza*, world events and his own advancing age had brought about a profound change in Darío's outlook on life. Technically and artistically, the book maintains and even surpasses the standard of excellence set by *Prosas profanas*. Now, however, the poet was vitally concerned with things outside the realm of art: the supposed threat of North American imperialism after the defeat of Spain in 1898; the solidarity of Spanish-speaking peoples; the future prosperity of Spanish America; the age-old problems of human existence as such.

Throughout most of his career Darío experimented boldly with many forms of verse, and probably introduced more innovations in metre than any other Spanish-speaking poet. Many of his metrical novelties were wholly Spanish in origin; others were adaptations from the French. From the standpoint of artistic resourcefulness and technical perfection, Darío is considered by many to be the greatest poet who ever wrote in Spanish. By any standard he must be considered as one of the great figures of universal literature.

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(E. K. M.)

DARIUS (Old Persian *Darayavaush*), the name of three kings of the Achaemenid dynasty of Persia.

DARIUS I the Great, who reigned from 522 to 486 B.C., was the son of Hystaspes (*q.v.*), the satrap of Parthia. The principal contemporary sources for his history are his own inscriptions, especially the great inscription of Bisitun (*q.v.*), in which he tells how he gained the throne. The accounts of his accession given by Herodotus and Ctesias are in many points evidently derived from this official version but are interwoven with legends; *e.g.*, that Darius and his fellow conspirators left the question as to which of them should become king to the decision of their horses and that Darius won the crown by a trick of his groom.

According to Herodotus, Darius when a youth was suspected by Cyrus the Great of plotting against the throne. Later he was in Egypt with Cambyses as a member of the royal bodyguard. After the death of Cambyses in the summer of 522 B.C., Darius hastened to Media where, in September, with the help of six Persian nobles, he killed Bardiya (Smerdis; *q.v.*), who had usurped the throne the previous March. In the Bisitun inscription Darius defended this deed and his own assumption of kingship on the grounds that the usurper was Gaumata, a Magian, who had impersonated Bardiya, a son of Cyrus the Great, after Bardiya had been secretly murdered by Cambyses. Darius therefore claimed that he was restoring the kingship to the Achaemenid house. He himself, however, belonged to a collateral branch of the royal family, descended from Teispes, and as his father and grandfather were alive at his accession it is unlikely that he was next in line to the throne. Certain modern scholars consider that he invented the story of Gaumata in order to justify his actions and that the murdered king was indeed the son of Cyrus.

Darius did not at first gain general recognition but had to impose his rule by force. His assassination of Bardiya was followed, particularly in the eastern provinces, by widespread revolts, which threatened to disrupt the empire. In Susiana, Babylonia, Media, Sagartia and Margiana independent governments were set up, most of them by men who claimed to belong to the former ruling families. Babylonia rebelled twice and Susiana three times. In Persia itself a certain Vahyazdata, who pretended to be Bardiya, the son of Cyrus, gained considerable support. These risings, however, were spontaneous and unco-ordinated, and notwithstanding the small size of his army, Darius and his generals were able to suppress them one by one. In the Bisitun inscription he records that in 19 battles he defeated nine rebel leaders, who appear as his captives on the accompanying relief. By 519 B.C., when the third rising in Susiana was put down, he had established his authority in the east. In 518 Darius visited Egypt, which he lists as a rebel country, perhaps because of the insubordination of its satrap, Aryandes, whom he put to death. He also removed Oroetes, the disloyal satrap of Sardis.

Having restored internal order in the empire, Darius undertook a number of campaigns for the purpose of strengthening his frontiers and checking the incursions of nomadic tribes. In 519 B.C. he attacked the Scythians east of the Caspian sea and a few years later conquered the Indus valley. In 513, after subduing eastern Thrace and the Getae, he crossed the Danube into European Scythia, but the Scythian nomads retired before him, devastating the country, and he was forced by failure of supplies to abandon the campaign. The satraps of Asia Minor completed the subjugation of Thrace, secured the submission of Macedonia and captured Lemnos and Imbros. The approaches to Greece were thus in Persian hands as was control of the Black sea grain trade through the straits, of major importance for Greek economy. The conquest of Greece was a logical step to protect Persian rule over the Asiatic Greeks from interference by their European kinsmen. According to Herodotus, Darius, before the Scythian campaign, had sent ships to explore the Greek coasts, but he took no military action until 499 B.C., when Athens and Eretria supported an Ionian revolt against Persian rule. After the suppression of this rebellion, Mardonius, Darius' son-in-law, was charged with an expedition against Athens and Eretria, but the loss of his fleet in a storm off Mt. Athos (492 B.C.) forced him to abandon the operation. In 490 B.C. another force under Datis, a Mede, destroyed Eretria and enslaved its inhabitants but was defeated by the Athenians at Marathon (*q.v.*). Preparations for a third expedition were delayed by an insurrection in Egypt and Darius died in 486 B.C. before they were completed.

Although Darius consolidated and added to the conquests of his predecessors, it was as an administrator that he made his greatest contribution to Persian history. He completed the organization of the empire into satrapies, initiated by Cyrus the Great, and fixed the annual tribute due from each province (*see* SATRAP). During his reign ambitious and far-sighted projects were undertaken to

promote imperial trade and commerce. Coinage and weights and measures were standardized and land and sea routes developed. An expedition led by the Carian captain Scylax of Caryanda sailed down the Indus river and explored the sea route from its mouth to Egypt, and a canal from the Nile to the Red sea, probably begun by Necho, was repaired and completed.

While measures were thus taken to unite the diverse peoples of the empire by a uniform administration, Darius followed the example of Cyrus in respecting native religious institutions. In Egypt he assumed an Egyptian titulary and gave active support to the cult. He built a temple to Amon in the Kharga oasis, endowed the temple at Edfu and carried out restoration work in other sanctuaries. He empowered the Egyptian Udjahorresne, who had served under Cambyses, to re-establish the medical school of the temple of Sais, and he ordered his satrap to codify the Egyptian laws in consultation with the native priests. In the Egyptian traditions he was considered as one of the great lawgivers and benefactors of the country. In 519 B.C. he authorized the Jews to rebuild the temple at Jerusalem, in accordance with the earlier decree of Cyrus. He also continued the privileges granted by Cyrus to the Greek sanctuaries; a Persian official was reprimanded for exacting tribute and forced labour from the priests of the temple of Apollo near Magnesia on the Maeander. In the opinion of some authorities the religious beliefs of Darius himself, as reflected in his inscriptions, show the influence of the teachings of Zoroaster, and the introduction of Zoroastrianism as the state religion of Persia is probably to be attributed to him.

Darius was the greatest royal architect of his dynasty, and during his reign Persian architecture assumed a style that remained unchanged until the end of the empire. In 521 B.C. he made Susa his administrative capital, and there he restored the fortifications and built an audience hall (*apadana*) and a residential palace. The foundation inscription of his palace describes how he brought materials and craftsmen for the work from all quarters of the empire. At Persepolis, in his native country of Fars (Persis), he founded a new royal residence to replace Pasargadae. The fortifications, *apadana,* council hall, treasury and a residential palace are to be attributed to him, although not completed in his lifetime. He also built at Ecbatana and Babylon.

DARIUS II Ochus reigned from 423 B.C. until his death at Babylon in 404 B.C. The son of Artaxerxes I by a Babylonian concubine, he seized the throne from his half-brother, Secydianus (or Sogdianus), who had murdered Xerxes II, the son and successor of Artaxerxes. He executed Secydianus and also his own full brother, Arsites, who rebelled against him. Ochus, who had previously been satrap of Hyrcania, adopted the name of Darius on his accession; he was also known as Nothos ("the bastard").

Darius was dominated by eunuchs and by his half-sister and wife, Parysatis, a cruel and ambitious woman who exercised an evil influence on the conduct of government. During his reign intrigue and corruption were rife at the Persian court, and revolts by the satrap of Hyrcania and in Media, although quickly suppressed, were symptomatic of the discontent caused by his rule. After the Athenian disaster at Syracuse in 413 B.C., Darius judged the moment opportune to recover the Greek coastal cities of Asia Minor, which had been under Athenian control since 448 B.C. The satraps of Asia Minor, Tissaphernes and Pharnabazus, were ordered to collect arrears of tribute, and an alliance against Athens was formed with Sparta, which recognized Persian sovereignty over the Greek communities in Asia. In the ensuing war the greater part of Ionia was recovered, but elsewhere the allies had less success, partly due to the policy of Tissaphernes, who, foreseeing that a victorious Sparta might be as dangerous to Persian interests as Athens had been, gave its forces only limited support. In 407 B.C., however, after the victories of Alcibiades, Darius decided to put all his resources behind Sparta. He appointed his son, Cyrus the Younger (*q.v.*), as commander in chief of Asia Minor in place of Tissaphernes and gave him funds to recreate the Spartan fleet. As a result Lysander in 405 B.C. broke the Athenian power at Aegospotami.

DARIUS III Codommanus, who reigned from 336/335 to 330 B.C., was the last king of the Achaemenid dynasty. He belonged to a collateral branch of the royal family, his father being Arsames, son of Ostanes, a brother of Artaxerxes II. He was placed on the throne by the eunuch Bagoas (*q.v.*), who had poisoned Artaxerxes III in 338/337 and Arses in 336/335 B.C. When Darius asserted his independence, Bagoas also attempted his murder but was forced by the king to drink the poison himself. Darius had earlier distinguished himself in single combat against a Cadusian rebel, for which he had been rewarded with the satrapy of Armenia.

In 338 Philip of Macedon had formed the League of Corinth for the purpose of liberating the Greek cities under Persian rule, and early in 336 had sent an advance force into Asia Minor. In July, however, he was assassinated, according to Alexander at the instigation of Darius. In the spring of 334 B.C. Alexander crossed the Hellespont. Darius, although he had sent subsidies to the Greek states in an attempt to raise them against Alexander, had made no serious military preparations to resist the invasion. Alexander defeated a Persian army at the Granicus and by the following year had won most of Asia Minor and reached Cilicia. Darius advanced against him but was defeated at Issus in the autumn of 333 B.C. and fled from the field, abandoning his mother, wife and children.

While Alexander was at Marathus, Darius sent him a letter requesting the return of his family and offering friendship and alliance. Alexander rejected the overture and demanded that Darius recognize him as overlord. Later Darius wrote again, offering a large ransom for his family, cession of all the Persian empire west of the Euphrates and the hand of his daughter in return for an alliance. Alexander again refused. In 331, having completed the conquest of Syria, Phoenicia, Palestine and Egypt, Alexander marched into Mesopotamia. Darius made no attempt to resist his crossing of the Euphrates and Tigris but offered battle at Gaugamela, east of Mosul. On Oct. 1, 331 B.C., he was decisively defeated and, as at Issus, turned his chariot and fled, although his subordinates fought on (*see* GAUGAMELA, BATTLE OF). He escaped to Ecbatana and then, on the approach of Alexander, retired toward Bactria, but was deposed and killed by Bessus, the satrap of Bactria, in July 330 B.C.

The name Darius was also borne by many later dynasts of Persian origin, among them kings of Persis; Darius of Media Atropatene, who was defeated by Pompey the Great; and Darius, appointed king of Pontus by Mark Antony in 40 B.C.

(J. M. M.-R.)

DARJEELING, a town and district of West Bengal, India. The town lies 305 mi. N. of Calcutta and is connected with that city by road, rail and air. Pop. (1961 est.) 40,405. Darjeeling is a hill station and vacation resort to which the West Bengal governor and ministry move for a short while in summer. It is situated on a long asymmetrical mountain ridge of the Sikkim Himalayas which runs northward from Tiger hill, with its almost flat top at an average elevation of 7,500 ft., and bifurcates into Lebong spur and

R. J. CHINWALLER FROM BLACK STAR

HILL STATION OF DARJEELING, WEST BENGAL, INDIA, AT AN ELEVATION OF 7,500 FT. IN THE SIKKIM HIMALAYAS

Birch Hill spur before descending into the Rangit valley (3,000 ft.). A magnificent view of snow-clad Kangchenjunga (28,146 ft.) can be had from Darjeeling on a clear day, and from the top of Tiger hill, or from Jalapahar, Mt. Everest (29,028 ft.) can just be seen. Darjeeling has a moderately cool but rainy summer, a fine autumn and a dry winter with occasional snowfall. Chaurasta (the Mall), on the ridge (7,002 ft.), is the main shopping centre and the most attractive promenade. A little higher up, on the east, is Observatory hill (7,139 ft.), which commands a good view. Birch hill with its natural park is a beauty spot which contains the Institute of Mountaineering. Lloyd Botanic gardens were laid out in 1865. There are three colleges, affiliated to Calcutta university, and a natural history museum.

DARJEELING DISTRICT embraces 1,160 sq.mi. and had a population of 624,879 in 1961. It has two contrasting types of landscape: mountain ranges rising northward almost vertically from plains to over 10,000 ft. (Sandakphu, 11,911 ft.), and the gravelly plains of the Terai on the south between 250 and 1,000 ft., cut into flat-topped terraces by innumerable hill streams. Narrow belts of flat alluvial plains and low foothills of Tertiary sandstone and coal-bearing Gondwana rocks are also included within the district. The mountains are principally composed of hard rocks, gneisses and schists of Archean age, and the deep Tista valley has been carved out of softer rocks, slates and phyllites. The chief rivers from west to east are the Mechi, Balasan, Mahanadi, Great Rangit and Tista. Darjeeling district has a wide range of climate, from tropical to subalpine, which is reflected in its natural vegetation. Rainfall is excessive, over 100 in. a year, and hence wherever the surface is exposed on the south conifers are replaced by evergreen oaks. Forests yield valuable timber. The economy of the district is based mainly on tea, which is grown as a plantation crop from the Terai plains right up to the altitude of Darjeeling railway station (6,700 ft.). There are also plantations of cinchona trees and a quinine factory at Mungpo, 10 mi. S.W. of Kalimpong. Cardamom is another cash crop, which is grown at altitudes from 1,000 to 5,000 ft. Rice is the main food crop of the plains and hills up to 5,000 ft.

Siliguri (pop. [1951] 32,480) on the Terai is the largest market town, and has a flourishing timber industry. It is served by the Assam link of the North East Frontier railway, and is also the terminus of the Darjeeling Himalayan railway. Kalimpong (*q.v.*; pop. [1951] 16,677), on the main trade route between India and Tibet through Sikkim, is 25 mi. E. of Darjeeling town by road. Kurseong (pop. [1951] 11,719) is another hill station (4,680 ft.). Baghdogra is the terminus of the airline between Calcutta and Darjeeling. (S. P. C.)

DARK AGES, a term formerly used to cover the whole period between the end of classical civilization and the revival of learning in the 15th century. The use of the term implied an exclusive respect for classical standards in literature and art and a corresponding disparagement of all that was achieved between the decline of ancient culture and the work of Renaissance scholars, writers and artists. With the progress of medieval studies in the 19th century it became impossible for historians to dismiss one of the great constructive periods in human activity with an epithet implying contempt for its achievements, and the phrase became obsolete. It remains, nevertheless, the fact that the six centuries following the collapse of the Roman empire are in a special sense dark through the insufficiency of historical evidence. Even so, it is necessary to remember that intellectual work of the highest quality was done by exceptional individuals in ages when life was insecure and its environment discouraging to thought. The ages which form the prelude to medieval history are dark when compared with the time which followed, but the foundations of medieval civilization were laid in these obscure centuries. *See* MIDDLE AGES, THE. (F. M. S.)

DARLAN, JEAN LOUIS XAVIER FRANÇOIS (1881–1942), French naval officer, was born at Nérac, Lot-et-Garonne, Aug. 7, 1881. He entered the French naval school in 1899 and advanced through the various ranks, becoming a rear admiral in 1929, vice-admiral, admiral and on June 24, 1939, admiral of the fleet. He was chief of staff of the navy from Dec. 31, 1936, and commander in chief of the French navy from Aug. 28, 1939. After the German attack on France in 1940, additional duties were given him, and from Feb. 1941 he was vice-president of the council of ministers and minister of foreign affairs. He gave up his ministerial duties to become commander in chief of all French military forces in 1942. In November of that year he was assigned the post of high commissioner in Africa, where he ended French opposition to the U.S. and British invasion forces in Algeria and Morocco. Darlan was an officer of character and ability who received much undeserved abuse in the British and United States press. He was slain in Algiers on Dec. 24, 1942. (J. B. HN.)

DARLEY, GEORGE (1795–1846), Irish poet, only slightly esteemed by his contemporaries but praised by 20th-century writers for his power to evoke, in his unfinished lyrical epic, *Nepenthe,* a symbolic dream-world of unusual intensity. Born in Dublin, and educated at Trinity college, he was prevented from academic and social success by an incurable stammer, which, growing worse as he grew older, sapped his self-confidence, destroyed his pleasure in society and confirmed his tendency to ineffectual despondency. In 1822 he settled in London, and published his first book: poems, entitled *The Errors of Ecstasie and other Pieces.* Through the *London Magazine,* to which he contributed criticism, verse and short stories, he became intimate with leading writers, especially Lamb and Henry Cary. A volume of short stories and verses (1826) and the verse drama, *Sylvia* (1827), described by Lamb as "a very poetical poem," met with little success, and Darley, discouraged, turned to the writing of mathematical textbooks which achieved the fame denied to his poetry, and also wrote on art and drama for the *Athenaeum.* In 1835 the first two cantos of *Nepenthe* were privately printed: Mary Russell Mitford voiced the general impression when she said, "there is no reading the whole . . . there is an intoxication about it which turns the brain." Yet it is this unfinished work which ensures Darley's fame, for modern poets find its dream imagery, recalling Coleridge in its cloudy fire, its tumultuous, yet skilfully contrived, metrical effects and its symbolic self-revelation interesting as examples of late romanticism and as foreshadowings of 20th-century tendencies. It marked the peak of Darley's achievement: two tedious verse dramas *Thomas à Becket* (1840) and *Ethelstan* (1841) and an edition of Beaumont and Fletcher (1840) completed his output, and he died in London, Nov. 23, 1846.

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DARLING, CHARLES JOHN, 1ST BARON (1849–1936), English judge with unusual insight into human nature, was born at Colchester, Essex, on Dec. 6, 1849. Called to the bar by the Inner Temple in 1874, he became a queen's counsel in 1885 and sat in parliament as Conservative member for Deptford from 1888 until appointed a queen's bench judge in 1897, when he was knighted. His appointment was much criticized, but he later justified it. On the bench he too often strove after humour, with indifferent success. He retired in 1923, becoming a peer in 1924. Darling died at Lymington, Hampshire, on May 29, 1936.

His published works include *Scintillae Juris* (1877), *Seria ludo* (1903), *On the Oxford Circuit* (1909), *Crime and Insanity, Murder and Its Punishment, Musings on Murder* (1925).

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DARLING, GRACE HORSLEY (1815–1842), British heroine, famous for her courageous rescue of survivors from the wrecked "Forfarshire," was born at Bamburgh, Northumberland, on Nov. 24, 1815, daughter of William Darling who became keeper of the Longstone (Farne islands) lighthouse. On the morning of Sept. 7, 1838, the luxury steamship "Forfarshire" struck on the rocks near the Longstone. Seeing a few survivors, and considering the seas too treacherous for the mainland lifeboat, Grace and her father managed to row the mile from the lighthouse in their coble, and by a combination of daring, strength and skill to rescue four men and a woman. Darling then returned with two of the men to take off the remaining four survivors. Grace won nationwide fame; she and her father were given the gold medal of the Humane society

and large subscriptions were collected for them. But she remained at the lighthouse, and died of tuberculosis at Bamburgh on Oct. 20, 1842.

DARLING RIVER, Australia, the longest tributary of the Murray, rises in the Eastern highlands (*q.v.*) near the New South Wales-Queensland border. The river was named after the governor of New South Wales, Sir Ralph Darling (1775–1858). It has a total length of 1,702 mi. Though most of it usually remains a normally flowing river, only its upper reaches are really perennial. In the latter part of the 19th century the Darling was of importance to navigation, but this traffic has long been superseded by the railway. West of the river increasingly poor pastoral country extends into the "far west" of New South Wales. The 2,000 acre-feet storage scheme at Menindee lakes will improve local stock and domestic supplies (including that of Broken Hill) and by regulating the flow in the lower Murray will give a more assured irrigation supply to South Australia. (O. H. K. S.)

DARLINGTON, a market town and a county and parliamentary borough in Durham county, Eng., 18 mi. S. of Durham by road. Pop. (1961) 84,162. It lies on the Great North road and on the river Skerne, a tributary of the Tees, not far from the main river. Its appearance is almost wholly modern, but there is a fine 12th-century parish church dedicated to St. Cuthbert.

There was a Saxon settlement on the site of the town and in Norman times it was in the Durham palatinate. Before the 19th century Darlington was noted for the manufacture of linen (flax was first spun by machinery there), carpets and worsted; the latter is still carried on, but Darlington owes its modern importance to the opening of the railway between Darlington and Stockton on Sept. 27, 1825. "Locomotive No. 1," the first engine that ever ran on a public railway, stands in Bank Top station. The fairs and markets were in existence as early as the 11th century and were purchased by the local authority in 1854. The town was incorporated in 1867 and became a county borough in 1915. There are an Elizabethan grammar school and a college for further education. The chief industries are spinning, bridge building, heating and ventilating engineering, foundry work, joinery and the manufacture of paint, decorative panels and insulation products. The large locomotive works of the former London and North Eastern railway which were removed to Darlington from Gateshead in 1900 now belong to British railways.

Five miles north of the town is the Aycliffe trading estate near which a New Town (*q.v.*), Aycliffe, with a projected population of 20,000, was initiated in 1947.

DARLINGTONIA, the California pitcher plant, a carnivorous plant belonging to the family Sarraceniaceae. It was named after William Darlington, a U.S. botanist. There is only one species, *D. californica*. It grows in sphagnum swamps and springy hillsides in southwestern Oregon and northwestern California from near sea level to an altitude of 6,000 ft. in the Sierra Nevada mountains. The tall tubular leaves grow in a cluster arising from a stout horizontal stolon and have two forms. The juvenile leaf has the open top overhung by a tapering lidlike appendage. Such leaves are found in seedlings and variously on small shoots. The leaf of maturity may reach a height of three feet, gradually expanding its diameter until at the top it expands suddenly into a bent-over hood ending in a downward hanging appendage of the shape of a fishtail. Beneath the hood is a rounded opening, the entrance, guarded on the inside by a low, inturned flange having many nectar glands, which are common also to the fishtail appendage, and to the interior surface of the hood. The roof of the hood is tessellated by white translucent patches, "windows" mullioned by green, eventually red bands of chlorophyll-bearing tissues.

W. H. HODGE

CALIFORNIA PITCHER PLANT (DARLINGTONIA CALIFORNICA)

To an insect approaching the entrance, attracted by the nectar on the fishtail or elsewhere beneath the hood, the windows doubtless suggest a way of exit. When once inside, the insect feeds on the abundant nectar and gradually, impelled by downward pointing hairs, falls into the hollow tubular leaf. Since digestive glands are absent, the decay of the captured insects take place through the agency of bacteria, the products of this sort of digestion being absorbed by the walls of the tube. So abundant is the dead prey that the odour of decay has often been remarked.

An interesting matter is the invariable presence of often plentiful living insect larvae in the wet mass of decaying insects found in the pitcher; a few of these are obligate commensals, not occurring elsewhere.

See also CARNIVOROUS PLANTS; PITCHER PLANTS.

(F. E. L.)

DARMESTETER, ARSÈNE (1846–1888), elder brother of James Darmesteter (*q.v.*), and a distinguished philologist and man of letters noted for his contributions to the history of the French language, was born at Château-Salins, Moselle, France, on Jan. 5, 1846. He studied under Gaston Paris at the École des Hautes Études, and became professor of old French language and literature at the Sorbonne. He collaborated with Adolphe Hatzfeld in a *Dictionnaire général de la langue française* (2 vol., 1895–1900). Among his most important work was the elucidation of old French by means of the many glosses in the medieval writings of Rashi and other French Jews. Darmesteter died Nov. 16, 1888, at Paris. His scattered papers on romance and Jewish philology were collected by James Darmesteter as *Arsène Darmesteter, reliques scientifiques* (2 vol., 1890). His *Cours de grammaire historique de la langue française* was edited after his death by E. Muret and L. Sudre (1891–95; English ed., 1902).

DARMESTETER, JAMES (1849–1894), French orientalist known for his studies of ancient Iranian, was born of Jewish parents at Château-Salins, Moselle, on March 28, 1849. The family name had originated in their earlier home in Darmstadt, Ger. He studied in Paris under Michel Bréal and Abel Bergaigne. In 1875 he published a thesis on the mythology of the *Zend-Avesta*, and in 1877 became teacher of Zend at the École des Hautes Études. He followed up his researches with his *Études iraniennes* (1883), and ten years later published a complete translation of the *Zend-Avesta*, with historical and philological commentary (3 vol., 1892–93), in the *Annales du musée Guimet*. He also edited the *Zend-Avesta* for Max Müller's *Sacred Books of the East*. Darmesteter regarded the extant texts as far more recent than was commonly believed, placing the earliest in the 1st century B.C., and the bulk in the 3rd century A.D. In 1885 he was appointed professor in the Collège de France, and was sent to India in 1886 on a mission to collect the popular songs of the Afghans, a translation of which, with a valuable essay on the Afghan language and literature, he published on his return. His impressions of English dominion in India were conveyed in *Lettres sur l'Inde* (1888). He married A. Mary F. Robinson. Darmesteter died at Maisons-Lafitte, a suburb of Paris, on Oct. 19, 1894.

DARMSTADT, a city of Germany, former capital of the grand duchy of Hesse-Darmstadt and after the partition of the nation following World War II the administrative centre of Darmstadt *Regierungs-Bezirk* of the *Land* of Hesse in the Federal Republic of Germany. It lies on a plain gently sloping from the Odenwald to the Rhine, 33 km. (20.5 mi.) S.E. of Mainz by road and 28 km. (17.4 mi.) S. of Frankfurt am Main.

Darmstadt is an industrial centre and was heavily damaged by bombing in World War II. It formerly consisted of an old and a new town but after the war it was rebuilt, though many of the old buildings have survived. In the stately Luisenplatz, with its two fountains, stands a statue of Ludwig X, the first grand duke. The ducal castle, to the east, was badly damaged, but most of the library was saved. In the Landesmuseum are collections of art and of natural history, and behind the museum are the castle gardens. There are a technical high school, schools of art and engineering and the *Land* school of music. There is an annual music festival.

To the east of the town lies the Mathildenhöhe, formerly a park and converted into villa residences. There are the artists' colony, created in 1889 by the grand duke Ernst Ludwig, and the Russian church, built (1898–99) by the emperor Nicholas II of Russia in honour of his Hessian wife. Nearby is the Kranichstein hunting lodge, now a hunting museum, and game park. West of Darmstadt is Kuhkopf Island in the Rhine, a large nature reserve with rare waterfowl, especially herons and kites.

The industries are extremely varied and include the manufacture of chemicals, radios and kitchen ranges.

Darmstadt is mentioned in the 11th century, but in the 14th century it was still a village, held by the counts of Katzenelnbogen. It came by marriage into the possession of the house of Hesse in 1479, the male line of the house of Katzenelnbogen having in that year become extinct. The imperial army took it in the Schmalkaldic War and destroyed the old castle. In 1567, after the death of Philip the Magnanimous, his youngest son Georg received Darmstadt and chose it as his residence. He was the founder of the line of Hesse-Darmstadt. Its most brilliant days were those of the reign of Ludwig X (1790–1830), the first grand duke, under whom the new town was built. The chemist Justus von Liebig (*q.v.*) was born in Darmstadt in 1803. The city was captured by the U.S. 3rd army on March 25, 1945.

DARNEL (*Lolium temulentum*), a member of the grass family known also as poison rye grass, tare and ivray. Darnel is an annual noxious weed of grain fields and is poisonous when eaten by livestock. Because the seed is often fungus-infected, its poisonous properties may be due both to the alkaloid, temuline, and to a waste product of the fungus.

Persons have been poisoned by eating bread made from grains contaminated with appreciable quantities of darnel seed. It has been a pest of considerable significance through the centuries, more so in Elizabethan times than in modern times because winnowing processes of earlier eras were unable to separate grains of darnel from those of rye.

The genus *Lolium* includes all rye grasses—a group of about 12 species, distinguished by the spikelets solitary and situated edgewise in altenate concavities along a continuous rachis or stalk. The perennial kinds are important as the principal ingredients of inexpensive lawn-grass mixtures, especially perennial rye grass (*L. perenne*) and Italian rye grass (*L. multiflorum*). They have the merit of germinating quickly and producing a soil-holding sod, but the foliage is coarse and a short-lived turf of poor quality results. (G. H. M. L.)

DARNEL'S CASE (known also as the FIVE KNIGHTS' CASE) is a leading case in the history of the liberty of the subject in England, and contributed to the enactment of the Petition of Right. The case was designed to test the legality of imprisonment for refusing to contribute to forced loans. Sir Thomas Darnel, who had for this reason been committed to the Fleet prison in March 1627, together with four other knights—Sir John Corbet, Sir Walter Earl, Sir Edmund Hampden and Sir John Heveningham—applied for a writ of habeas corpus. Their jailor's return to the writ stated simply that the knights had been committed "by the special command of his majesty." At this stage Darnel withdrew from the action, but the other four defendants decided to challenge the sufficiency of this return before the king's bench judges (Nov. 1627). Counsel for the knights relied on both medieval and modern precedents, including clause 39 of Magna Carta (that no man should lose his liberty without due process of law). They ignored, however, the fact that the Tudors had assumed a large discretionary power of imprisonment, and their argument that public policy demanded the release of the knights was met by pointing out that even more dire consequences would ensue in time of national danger if this prerogative power of arrest was not recognized. The judges ordered that the knights must remain remanded, and refused bail, but they did not decide that the crown could always commit without cause. Whether prisoners should be released or not was a matter of judicial discretion; "upon such a return" the king should be "first consulted with."

The judges showed no partiality, and the precedents were nicely balanced. Nevertheless it was assumed that the decision was in favour of the crown. After the release of the knights in 1628 the debate continued in parliament. Charles I's agreement not to imprison subjects who refused to pay forced loans did not mollify the house of commons which sought to impose on a reluctant monarch its own interpretation of Magna Carta. From this impasse was born the Petition of Right (1628).

See William Cobbett, *State Trials*, vol. iii (1809). (G. H. J.)

DARNLEY, HENRY STEWART (STUART), LORD (1545–1567), second husband of Mary (*q.v.*, Stuart), queen of Scots, was the son of Matthew, earl of Lennox (d. 1571). He was born at Temple Newsam, Yorkshire, on Dec. 7, 1545, and educated in England. His father had pretensions to the Scottish crown, based on the alleged illegitimacy of James Hamilton, earl of Arran (d. 1575), and his mother, formerly Margaret Douglas (d. 1578), had a claim to the throne of England as granddaughter of Henry VII. She planned to strengthen her son's hopes of succession by his marriage with the rival claimant, Mary.

With the permission of Queen Elizabeth I, Darnley went to Scotland in Feb. 1565. Soon after his arrival there, rumours circulated that he would marry Mary, whom he had already met while on a visit to France shortly after the death of her first husband, the French king Francis II. She created him earl of Ross on May 15, and duke of Albany on July 20, 1565. The marriage was celebrated according to Catholic rites at Holyrood on July 29, 1565. Elizabeth had already shown her displeasure by sending the countess of Lennox to the Tower. Her dislike of the marriage was shared by James Stuart, earl of Moray, Mary's half-brother, whose influence was at an end; by the Hamiltons, whose hopes of the Scottish crown were destroyed; and by John Knox and the Protestant ministers, who saw it as a victory for Catholicism. Opposition soon collapsed, however, and Mary's enemies fled to England.

Despite its dynastic advantages and Mary's early infatuation, the marriage soon showed signs of breaking up, for not satisfied with the title of king conferred upon him at time of the wedding, Darnley coveted the crown matrimonial, by which he could reign in his own right after his wife's death. Nevertheless, he was weak, vicious and pleasure-seeking and unwilling to share in the labours of government. Resentful of the confidence which Mary gave to her secretary, David Rizzio, he intrigued with others who desired Rizzio's removal. But after the murder of Rizzio (March 9, 1566) Darnley betrayed his accomplices and enabled Mary to escape. Nevertheless they convinced her that he had been the instigator of the crime and his brief reconciliation with her did not long outlast the birth (June 19, 1566) of their son James, whose baptism at Stirling in Dec. 1566, he refused to attend.

Despised by his wife, hated by those whom he had betrayed and detested by most of the nobility for his pride and arrogance, Darnley became aware of plots against him. He took refuge with his father in Glasgow, where a sudden illness incapacitated him. After visiting him there, Mary, again apparently reconciled, persuaded him to accompany her to Edinburgh, where they lodged in the lonely house of Kirk o'Field, adjoining the city walls. On the night of Feb. 9–10, 1567, while Mary was absent at a servant's wedding festivities, the house was blown up. The body of Darnley, who had apparently been strangled, was found in the garden, some distance away. Soon afterward his widow married James Hepburn, earl of Bothwell, reputed author of the murder plot. Mary's complicity in the murder has never been proved, although Darnley's father collected a mass of evidence against her, some of which was published, in a highly coloured form, by the historian, George Buchanan.

Darnley is the direct ancestor of all British sovereigns since James I (James VI of Scotland).

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DARQUIER DE PELLEPOIX, LOUIS (1897–), French politician notorious as an anti-Semite and collaborator with Nazi Germany, was born at Cahors (Lot) on Dec. 19, 1897; his family was an old one of some distinction. After studying science at Toulouse university, he had a checkered career as a business administrator. As a right-wing demonstrator he was wounded in

the riots of Feb. 6, 1934. He became a member of the Paris municipal council, organized the Anti-Jewish Rally of France and established a virulent journal, *La France enchainée*, which was subsidized by the German-based International Anti-Semitic organization and which was suppressed at the start of World War II. In 1939 he was twice sentenced to imprisonment for anti-Semitic propaganda. He served with distinction in the army and was captured but swiftly released. Appointed commissioner of Jewish questions in the Vichy government in May 1942, he promoted the Nazi policy for the extermination of the Jews; Marshal Philippe Pétain, disgusted, addressed him as "Monsieur le tortionnaire" (Mr. Torturer). In Jan. 1944, however, Darquier was arrested on a charge of misusing confiscated goods and had to resign. At the liberation he was reported to have been captured, tried and executed, but later he was rumoured to be alive in Spain. In Dec. 1947 he was tried *in absentia* and sentenced to death.

(P. W. C.)

DARRANG, a district of Assam, India, lies between the Bhutan and Dafla hills and the Brahmaputra and includes many islands in the river. Area 3,369 sq.mi. Pop. (1961) 1,289,650. The administrative headquarters are at Tezpur (pop. [1951] 18,880), on the right bank of the Brahmaputra, 90 mi. N.E. of Shillong. At Tezpur are Darrang college, connected with the University of Gauhati, and a government industrial and technical school which trains carpenters, smiths, wheelwrights, weavers and other craftsmen. Seven miles from Tezpur is Salani airport, and the town is served by the North Eastern railway via Rangapara. Darrang is for the most part a level plain watered by many tributaries of the Brahmaputra. The district contains the two subdivisions of Tezpur and Mangaldai, tea being the principal crop cultivated in the valley of Tezpur and rice in Mangaldai. Mustard seed and jute are also grown. In Tezpur the population density increased more than sevenfold in the first 30 years of the 20th century because large areas of wasteland were brought under cultivation. There are reserved forests in the district, mostly at the foot of the hills along the northern boundary.

DARROW, CLARENCE SEWARD (1857–1938), U.S. lawyer, famous as defense counsel in notable criminal trials, was born near Kinsman, O., April 18, 1857. He attended law school for only one year before he was called to the bar of Ohio, in 1878. He achieved recognition as a lawyer only when he moved to Chicago, where, through the friendship of John P. Altgeld (*q.v.*), who later became his partner, he was appointed city corporation counsel and then general attorney of the Chicago and North Western railway. He resigned from the latter position to defend Eugene V. Debs, president of the American Railway union, and other union officials in the Pullman strike difficulties of 1895. This case gave him national fame in labour and criminal matters. He became a legend in his lifetime. Among the celebrated cases in which he appeared were the anthracite coal strike arbitration (1903); the William D. Haywood-Charles H. Moyer-George Pettibone and Steve Adams cases, involving the 1905 bomb murder of former Gov. Frank Steunenberg of Idaho (1907); the *Los Angeles Times* dynamite case (1911); the Communist case, involving a 1919 Illinois sedition act (1920); the trial of Richard Loeb and Nathan Leopold for the murder of a 14-year-old boy (1924); the Scopes trial (*q.v.*), in which Darrow defended a Tennessee schoolteacher accused of illegally teaching the Darwinian theory of evolution (1925); the Sweet case, involving violence in a Negro segregation dispute in Detroit, Mich. (1926); and the Thomas H. Massie trial, involving the revenge murder of an alleged rapist (1932). His cases, scattered throughout the nation, were the topics of daily conversation everywhere.

Darrow was at one time the law partner of Edgar Lee Masters, the *Spoon River* poet. His writings included *Crime, Its Cause and Treatment* (1925), *Farmington* (1905), *A Persian Pearl and Other Essays* (1899), *An Eye for an Eye* (1905), *The Prohibition Mania*, with Victor S. Yarros (1927), *The Story of My Life* (1932) and many other books and pamphlets on social, literary and economic questions. His courtroom pleas were filled with allusions based on his wide reading. For many years he was a well-known platform speaker and debater, distinguished for his freedom from dogma and his skepticism about human nature and institutions. He died on March 13, 1938, in Chicago.

His centennial commemoration in 1957 and the parole of Nathan Leopold in 1958 aroused renewed interest in Darrow and he became the subject of plays and books and appeared to have become a part of American folklore.

See an anthology of his speeches, *Attorney for the Damned*, ed. by Arthur Weinberg (1957); Irving Stone, *Clarence Darrow for the Defense* (1941). (E. Gz.)

DARTER, the common name applied to a water-dwelling bird, the anhinga or snakebird, capable of lightning-fast lunges of its head and bill; and to many small, active, bottom-dwelling fishes of the perch family, especially *Etheostoma* species, of North America. *See* SNAKEBIRD.

DARTFORD, a municipal borough (1933) in the Dartford parliamentary division of Kent, Eng., 17 mi. E.S.E. of London by road. It lies near the confluence of the Thames and its tributary, the Darent, which is crossed there by the Roman Watling street from Canterbury to London, thus giving the town its Domesday name of Tarentford. Pop. (1961) 45,643. It is an ancient market town and former coaching station, and also an industrial centre. The parish church has a Norman tower and contains a medieval (*c.* 1450) fresco and several interesting brasses. The Bull is an old coaching inn with a galleried courtyard. The grammar school dates from 1576.

Because of its situation on the main route between London and the continent, Dartford has been associated with many historic events. It was there in 1235 that Isabella, sister of Henry III, was married, by proxy, to the emperor Frederick II. In 1331 a famous tournament was held in the place by Edward III who also established a Dominican nunnery on West hill in 1355, of which, however, little remains. After the Dissolution it was used as a private residence by Henry VIII, Anne of Cleves and Elizabeth I. The town was closely connected with the Wat Tyler revolt in 1381 (*see* TYLER, WAT). One of the first attempts to manufacture paper in England was made there by the German, Sir John Spielman (d. 1607), jeweler to Elizabeth I. Papermaking is still important there as well as chemical manufactures, light engineering and flour milling. In the neighbourhood are large quarries supplying chalk for making lime and cement. There are several big hospitals in and near the town and a museum with Roman and other antiquities.

DARTMOOR, a wild moorland plateau in southwest Devon, Eng., from 1951 a national park. It measures 23 mi. from north to south, 20 mi. from east to west and is 365 sq.mi. in area, with a mean altitude of 1,700 ft. The uplands are unfenced and bleak, with heather moors and peat bogs. Isolated headlands called tors, capped with wind-worn granite rocks, arise in rugged grandeur; the highest of these are Yes Tor and High Willhays (2,028 and 2,039 ft.). Only two good roads, one from Exeter to Plymouth and the other from Ashburton to Tavistock, cross the moor, intersecting at Two Bridges. Most of the moor is uninhabited.

Dartmoor gives rise to eight main rivers but much water is impounded in reservoirs to supply the towns of Devon. Grazing is Dartmoor's other main resource; it supports hardy wild Dartmoor ponies, sheep and some cattle. Granite and china clay are quarried. There are extensive oak and spruce woods on the fringes.

Dartmoor was a royal forest in Saxon times, and from 1337 the central portion has been owned by the royal duchy of Cornwall. The surrounding districts are called venville districts, and their farmers have valuable pasturage rights over Dartmoor. The main centres for local trade and tourists are Okehampton, Chagford, Moreton Hampstead, Ashburton and Tavistock, all lying off the moor itself.

Princetown, near the heart of the moor, 1,400 ft. above sea level, was founded in 1806 to serve Dartmoor prison, which was built to hold French prisoners from the Napoleonic Wars. During 1813–15 it held U.S. sailors captured in the War of 1812, who helped build Princetown parish church. A memorial window and gateway presented by U.S. women commemorate 218 captives who died there. From 1850 Dartmoor has been England's main prison for long-term convicts. (H. L. En.)

DARTMOUTH, BARON AND EARLS OF. The title Baron Dartmouth was bestowed upon GEORGE LEGGE (1647–91) in 1682. His father, William Legge (*c.* 1609–70) was a staunch royalist during the English Civil War and assisted in the Restoration. George served as a volunteer in the navy during the Dutch War of 1665–67. He was a member of the household of the duke of York, afterward James II, was governor of Portsmouth and master general of the army. He commanded as colonel the troop at Nieuport in 1678. In 1683 as "admiral of a fleet" he sailed to Tangier, dismantled the fortifications and brought back the English troops. Under James II Dartmouth was master of the horse and governor of the Tower of London; and in 1688 when William of Orange was expected, James II made him commander in chief of his fleet. Although he was himself loyal to James, the same cannot be said of many of his officers, and an engagement with the Dutch fleet was purposely avoided. Dartmouth, however, refused to assist in getting James Edward, prince of Wales, out of the country, and even reproved the king for attempting this proceeding. He then left the fleet and took the oath of allegiance to William and Mary, but in July 1691 he was arrested for treason, and was charged with offering to hand over Portsmouth to France and to command a French fleet. Dartmouth protested his innocence. He died in the Tower of London on Oct. 25, 1691, before the question was investigated.

The 1st Baron's only son WILLIAM (1672–1750), 1st earl of Dartmouth, succeeded to his father's barony. He became secretary of state for the southern department and joint keeper of the signet for Scotland in 1710. In 1711 he was created Viscount Lewisham and earl of Dartmouth; in 1713 he exchanged his offices for that of lord keeper of the privy seal, which he held until the end of 1714. He retired on the accession of George I and died at Blackheath on Dec. 15, 1750.

WILLIAM (1731–1801), 2nd earl, grandson of the 1st earl, was lord privy seal at the beginning of the American Revolution. He advised the colonies in 1775 to accept the conciliatory proposals put forward by Lord North, but he opposed similar proposals in 1776 and advocated the employment of force. He resigned his office in March 1782 and became lord steward of the household in 1783; he died on July 15, 1801. Dartmouth's piety and his intimacy with the early Methodists won for him the epithet of the "Psalm Singer."

Dartmouth college in New Hampshire was named after him. Among his papers preserved at Patshull house, Wolverhampton, are many letters from America relating to the struggle for independence.

The titles descended directly to GERALD HUMPHRY (1924–), 9th earl, who succeeded his father in 1962.

DARTMOUTH, a city in Halifax County, Nova Scotia, Can., on the eastern side of Halifax Harbour, opposite the city of Halifax, to which it is connected by the mile-long Angus L. Macdonald suspension bridge, opened in 1955. A large oil refinery at Imperoyal, near the mouth of the harbour, employs many residents, and other oil companies maintain docking and distribution facilities. Other industries are shipbuilding, molasses production, and the manufacture of aircraft parts and electric components.

The Royal Canadian Navy has a seaplane base at Shearwater and a research establishment. The Bedford Institute of Oceanography, situated on Bedford Basin, the northern end of the harbour, was established to obtain information about Atlantic and subarctic coasts.

Named after the town in Devonshire, Eng., Dartmouth was founded in 1750 by 353 English settlers who had arrived on the ship "Alderney." It expanded during the building (1826–61) of the Shubenacadie Canal connecting the Bay of Fundy with the Atlantic Ocean, and during World Wars I and II, although partly destroyed by the Halifax explosion of December 6, 1917. Incorporated as a town in 1873, it became a city in 1961 after eight communities had been amalgamated. Pop. (1961) 46,966.

(P. R. BL.)

DARTMOUTH, a seaport and municipal borough of Devon, Eng., lies on the west bank of the River Dart estuary, 30 mi. (48 km.) E of Plymouth by road. Pop. (1961) 5,758. A yachting centre, it attracts tourists and anglers, and an annual regatta is held in August. There are boatbuilding, light engineering, and pottery industries. The castle (begun in 1481), with Kingswear Castle on the opposite bank, guarded the entrance to the estuary. St. Saviour's Church, much restored in the 1630s, has a late medieval rood screen. Dartmouth has many attractive 17th-century buildings, notably a group of houses on the waterfront at Bayard's Cove, and the Butterwalk, an arcade resting on granite pillars, which was damaged by bombing during World War II and restored 1953–54; part of it houses the Borough Museum. Ferry services cross the Dart to the railway station at Kingswear. Dartmouth developed as a harbour early in the Middle Ages, and carried on a wine trade with Bordeaux. In 1190, Richard I's crusaders set sail from the harbour. The town was incorporated in 1341. The "Speedwell" and the "Mayflower" lay off Bayard's Cove in 1620 on their way to America. A steam engine invented by Thomas Newcomen (*q.v.*), who was born in Dartmouth in 1663, is on view in a special building erected in 1963. A memorial commemorates the sailing from Dartmouth in 1944 of United States troops to take part in the invasion of Normandy. The Britannia Royal Naval College is situated above the harbour (*see* MILITARY, NAVAL AND AIR ACADEMIES).

DARTMOUTH COLLEGE, a privately operated nonsectarian institution of higher learning for men, chartered in 1769 and located at Hanover, N.H. *See* HANOVER.

DARTS, a predominantly British game played by throwing darts at a circular numbered board. The board, usually of cork, bristle, or elm, is divided by thin wires into 20 sectors, valued at points ranging from 1 to 20. A narrow outer ring running through all sectors doubles the value of the sector for the dart thrown into that part of the sector and a narrow inner ring trebles it, while the bull's-eye itself has a small outer ring worth 25, the inner circle being worth 50 points (*see* figure). Throwing is free style from 8 to 9 ft. away, with the centre of the board 5 ft. 8 in. from the ground.

Each player has three darts, generally about 6 in. long, weighted and feathered. The usual game is to start with any double score (dart thrown into the double ring) and then subtract this and subsequent scores from 301. The winner must reach exactly zero with a final double. Variations of the game are limited only by the player's imagination.

In the 16th century there were reports of "darts" being thrown at a marked quintain, a tournament practice target, as a game. Darts is recorded as a pastime of the Pilgrim Fathers on board the "Mayflower" in 1620. In its modern form the game is played in the public house (tavern) or club, rather than the home. At the beginning of the 1960s there were estimated to be about 6,000,000 players in the British Isles, of whom 1,000,000 were registered players, organized into 7,000 clubs affiliated with the National Darts Association. Two national Sunday newspapers organize annual championships; the *People* runs a team champion-

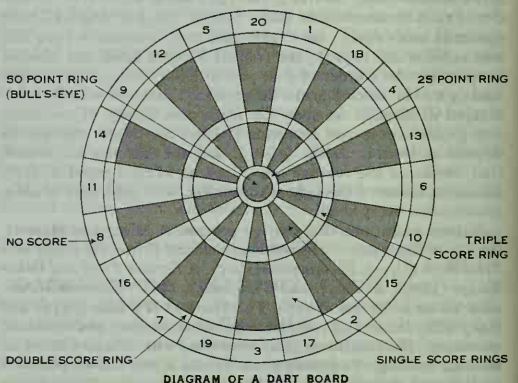

DIAGRAM OF A DART BOARD

ship for the Lonsdale trophy and the *News of the World* runs the individual championship.

See R. Croft-Cooke, *Darts* (1936). (N. D. McW.)

DARU, PIERRE ANTOINE, Comte (1767–1829), French military administrator whose conscientiousness and capability won him Napoleon's complete confidence, was born at Montpellier on Jan. 12, 1767. He entered the military administration in 1784. After serving as chief commissary of Masséna's army in Switzerland (1799), he became secretary-general of the ministry of war (1801) and a member of the tribunate (1802). In July 1805 he became councilor of state and intendant-general of the emperor Napoleon's household. In addition he played the principal role in the administration of the Grande Armée (as intendant-general from October 1806) during the campaigns of 1805, 1806, 1807, and 1809; he supervised the French administration of the Prussian and Austrian territories under military occupation and the execution of the financial side of the treaty of Tilsit by Prussia. Daru was nominated secretary of state on April 17, 1811.

He followed Napoleon with the army in 1812 and 1813, then became minister for the administration of war in November 1813. On the first Restoration he retired in April 1814, but he was nominated intendant-general of the army in December. However, during the Hundred Days (1815) he was minister of state, attached to Napoleon's ministry of war. Under the second Restoration he was admitted to the Chamber of Peers in 1819, where he resisted the ultra-royalist policy. He died at Meulan on Sept. 5, 1829.

Daru was also a man of letters. Among his works are: *Histoire de la république de Venise*, seven volumes (1819); *Histoire de la Bretagne*, three volumes (1826); a poetical translation of Horace, four volumes (1804–05); *Discours en vers sur les facultés de l'homme* (1825); and *Astronomie*, a didactic poem in six cantos (1830).

See C. A. Sainte-Beuve, *Causeries du lundi*, vol. ix (1878); also the composite work *L'Intendant général Comte Daru* (1933), which includes a reprint of the "Notice" on Daru by his younger contemporary M. Viennet (1853). (C. E. Du.)

DARWEN, a municipal borough (1878) in the Darwen parliamentary division of Lancashire, Eng., is situated 4 mi. S. of Blackburn on the Darwen river. Pop. (1961) 29,475. A prehistoric tract and a Roman road run through the borough, which was the site of early settlement where many Bronze Age and Roman remains have been found. Darwen manufactures include cotton goods (since 1820), paper, paint, plastics, textile machinery, pipes, and chemicals. It has three richly flowered and well laid out public parks and the use of 30 mi. of pathways over the surrounding moors.

DARWIN, CHARLES ROBERT (1809–1882), English naturalist, who first soundly established the theory of organic evolution in his monumental work, *Origin of Species*, was born at Shrewsbury, Shropshire, on Feb. 12, 1809, the grandson of Erasmus Darwin (*q.v.*). His mother, a daughter of Josiah Wedgwood (*q.v.*), died in 1817. Darwin was educated at Shrewsbury school under Samuel Butler (1774–1839), and in 1825 went to Edinburgh university to prepare for the medical profession, for which he was unfitted. In 1828 he went to Christ's college, Cambridge, with the idea that he should become a clergyman. He took his degree in 1831, tenth in the list of those who do not seek honours. The chief advantage which he gained at Edinburgh and Cambridge was the friendship of scientific men such as Robert Edmond Grant and William MacGillivray at the former, John Stevens Henslow and Adam Sedgwick at the latter.

Early Observations and Origin of Species.—From Dec. 1831 to Oct. 1836, Darwin sailed in H.M.S. "Beagle" as naturalist for the surveying expedition which visited Cape Verde and other Atlantic islands, the South American coasts and the Galapagos Islands, Tahiti, New Zealand, Australia, Tasmania, Keeling Island, Maldives, Mauritius, St. Helena, Ascension and Brazil. His work on the geology of those lands became the subject of volumes which he published after his return, including his *Journal of Researches* (1839) and *The Structure and Distribution of Coral Reefs* (1842); in the latter he advanced a theory of reef formation that is still generally held.

THE BETTMANN ARCHIVE, INC.

CHARLES DARWIN IN 1869

The voyage was the real preparation for his lifework. His observations on the relationships between geographically separated animals (forms on the islands and the contiguous mainland) and time-separated animals (living and recently extinct forms, related to but not the same as the extant animals) led him to reflect upon the prevailing view of the fixity of species. He had also been much impressed by "the manner in which closely allied animals replace one another in proceeding southwards" in South America. His journal for 1837 contains the words: "In July opened first notebook on Transmutation of Species. Had been greatly struck from about the month of previous March on character of South American fossils, and species on Galápagos Archipelago. These facts (especially latter) origin of all my views." While he was secretary of the Geological society from 1838 to 1841, he saw a great deal of Sir Charles Lyell (*q.v.*), whose principle of uniformity, contained in his *The Principles of Geology* had impressed him greatly. In Jan. 1839 he married his cousin, Emma Wedgwood. They lived in London until 1842, when they moved to Down, near Beckenham, Kent, which was Darwin's home for the rest of his life. From 1846 to 1854 he was chiefly engaged upon monographs on the recent and fossil cirripede Crustacea (*Ray Soc.*, 1851 and 1854; *Palaeontograph. Soc.*, 1851 and 1854).

Soon after beginning his notebook in 1837 he began to collect facts bearing upon the formation of the breeds of domestic animals and plants, and quickly saw "that selection was the keystone of man's success. . . . But how selection could be applied to organisms living in a state of nature remained for some time a mystery to me." Upon reading in Oct. 1838, T. R. Malthus' *Essay on the Principle of Population*, his own observations having long since convinced him of the struggle for existence, it at once struck Darwin "that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here, then, I had . . . a theory by which to work." It was because Darwin provided a scientific explanation of how evolution occurred, free from miraculous intervention or unfounded fancy, that he succeeded where Lamarck had failed in making the fact of evolution acceptable. (*See* Evolution, Organic; Lamarckism.)

In 1856 Darwin started to write a large treatise on his views, and had completed about half of it, when, in June 1858, he received a manuscript from Alfred Russel Wallace (*q.v.*), who was then at Ternate in the Moluccas, in which Darwin was startled to find a complete abstract of his own theory of natural selection. He placed himself in the hands of Lyell and Sir Joseph Dalton Hooker (*q.v.*) who decided to send Wallace's essay to the Linnean society, together with an abstract of Darwin's work which they asked him to prepare, the joint essay being accompanied by an explanatory letter to the secretary. The title of the joint communication was "On the Tendency of Species to Form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection." It was read on July 1, 1858, and published in the *Journal of the Linnean Society* (Zoology) for that year.

On Nov. 24, 1859, Darwin published his great work, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.* The whole edition of 1,250 copies was sold out on the day of issue. The first four chapters explain the operation of artificial selection by man and of natural selection in consequence of the struggle for existence. The fifth chapter deals with the laws of variation and causes of modification other than natural selection. The five

succeeding chapters consider difficulties in the way of a belief in evolution generally as well as in natural selection. The three remaining chapters (omitting the final recapitulation) deal with the evidence for evolution provided by paleontology, geographical distribution, comparative anatomy, embryology and vestigial organs. The theory which suggested a cause of evolution is thus given the foremost place and the evidence for the fact of evolution considered last. Although others before Darwin had conceived the idea of evolution, none had thought out and marshaled the evidence in a manner which bears any comparison with his. A storm of controversy arose over the book, reaching its height at the British association meeting at Oxford in 1860, when the celebrated disputation between T. H. Huxley (*q.v.*) and Bishop Samuel Wilberforce took place. Throughout these struggles Huxley was the foremost champion for evolution.

In Darwin's day nothing was known about heredity. There was a vague belief in blending inheritance and in the inheritance of acquired characters. Darwin's great difficulty was to account for a sufficient supply of variation, which is why he relied more and more on the supposed inheritance of acquired characters. Gregor Johann Mendel's discovery of genes that are particulate, remain uncontaminated, conserve past variance and change occasionally by mutation provided exactly the mechanism required by Darwin and removed his difficulty. The integration of Darwinian selection and Mendelian genetics and the proof that variation in organisms is not directed but fortuitous, demonstrated in 1930 by Sir Ronald Fisher, are now generally accepted as the explanation of evolution. (*See* DARWINISM.)

Reactions to Darwin's Views.—Darwin's character was marked by great tenderness and kindness to his family, friends and fellow scientists. After returning from the voyage of the "Beagle," he was almost continually in poor health; he suffered extreme fatigue and was often disinclined to meet company, with the result that he led the life of a semi-invalid recluse under the constant care of his wife. When he was not well, his daily routine involved no more than four hours' work, the remainder of his time being taken up by walks, rests and reading novels.

About his works he was always modest, although he realized that they inaugurated a new era of thought. His retiring disposition prevented him from ever taking part in the violent controversies over his demonstration of evolution by natural selection, and he was content to let his views be defended by others, in particular Huxley. At the same time, his sensitive nature was deeply pained by unfair criticism. Even when subjected to formidable attacks, as by Fleeming Jenkin on the swamping of new variations, or Lord Kelvin on the reduced estimate of the age of earth, Darwin never lost faith in the validity of his demonstration of natural selection, and modern knowledge has justified him completely.

One of the most important results of Darwin's work has been the demonstration that the evolution of plants and animals, and of the adaptations which they show, provides no evidence of divine or providential guidance or purposive design, because natural selection of fortuitous variations gives a scientifically satisfactory explanation of evolution without any necessity for miraculous interposition or supernatural interference with the ordinary laws of nature. This fact led to a conflict between the upholders of orthodox revealed religion and the scientists. Darwin himself was well aware of the significance of this conflict. "My theology is a simple muddle," he wrote in 1870; "I cannot look at the universe as the result of blind chance, yet I can see no evidence of beneficent design, or indeed of design of any kind, in the details." In 1856 he had written "What a book a devil's chaplain might write on the clumsy, wasteful, blundering, low, and horribly cruel works of nature." Darwin believed that all morality was the result of evolution and that in man it had been produced not by natural selection working on the individual, but by the improvement of social standards conferring survival value on the social units whose members show them. It was therefore not surprising that as he grew older Darwin abandoned the views of an orthodox member of the Church of England and became an agnostic.

Later Works.—*The Variation of Animals and Plants under Domestication* was published by Darwin in 1868, and may be looked upon as a complete account of the material condensed in the first chapter of the *Origin of Species*. It contains his now abandoned theory of "pangenesis" (*see* LAMARCKISM).

The Descent of Man, and Selection in Relation to Sex (1871) was the natural sequel to the *Origin of Species* and amplified his statement there that "light will be thrown on the origin of man and his history." Research has confirmed Darwin's conclusions. The book also contains the evidence in support of his hypothesis of sexual selection which, with modifications, is still accepted. *The Expression of the Emotions in Man and Animals* (1872) offered a natural explanation of phenomena which appeared to be a difficulty in the way of the acceptance of evolution. Of Darwin's numerous other works his *On the Various Contrivances by Which British and Foreign Orchids are Fertilised by Insects* appeared in 1862. *The Effects of Cross and Self-Fertilisation in the Vegetable Kingdom* (1876) proved that the offspring of cross-fertilized individuals are more vigorous and more numerous than those produced by a self-fertilized parent. *The Different Forms of Flowers on Plants of the Same Species* (1877) demonstrates that each different form, although possessing both kinds of sexual organs, is specially adapted to be fertilized by the pollen of another form, and that when artificially fertilized by pollen from a plant of its own form, less vigorous offspring are produced. *On the Movements and Habits of Climbing Plants* and *Insectivorous Plants* were published in 1865 and 1875 respectively. *The Power of Movement in Plants*, assisted by Francis Darwin, appeared in 1880, and *The Formation of Vegetable Mould, Through the Action of Worms*, in 1881.

Darwin died on April 19, 1882, and was buried in Westminster abbey. Four of his sons became prominent scientists: Sir George Howard (1845–1912), professor of astronomy and experimental philosophy at Cambridge; Sir Francis (1848–1925), botanist; Leonard (1850–1943), a major in the royal engineers, and afterward well known as an economist and eugenist; and Sir Horace (1851–1928), civil engineer.

See also references under "Darwin, Charles Robert" in the Index volume.

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DARWIN, ERASMUS (1731–1802), English scientist and poet, was generally considered one of the foremost physicians of his day. The grandfather of the biologists Charles Darwin and Francis Galton, he was born at Elton, Nottinghamshire, of a Lincolnshire family notable for its members' originality of mind and character. He was educated at St. John's college, Cambridge, and received medical training at the universities of Edinburgh and Cambridge. In 1756 he set up medical practice at Nottingham but was unsuccessful and soon moved to Lichfield. In 1781 he moved to Derby where he died on April 18, 1802. He corresponded with such eminent men as Priestley and Rousseau. He was also an accomplished writer of light occasional verse, and the author of several religious poems which were included in popular hymnals.

His more ambitious works include: *The Botanic Garden* (1792) and *The Temple of Nature or the Origin of Society* (1803) in verse; and *Zoonomia* (1794–96), *Female Education in Boarding Schools* (1797) and *Phytologia, or the Philosophy of Agriculture and Gardening* (1799) in prose. Most of Darwin's verse, with its stilted, pedantic heroic couplets and constant use of allegory, is long since forgotten. However, it is not without passages of vigour and even of grandeur. His prose, on the other hand, is clear and readable even by modern standards.

Darwin was a child of the 18th century and a convinced deist. As a young man he wrote to a friend on the occasion of his (Darwin's) father's death: "That there exists a superior *Ens Entium*, which forms these wonderful creatures, is a mathematical demonstration. That He influences things by a particular providence, is not so evident. The probability, according to my notion, is against it, since general laws seem sufficient for that end." In his ideas of aesthetics and psychology he followed in the tradition of

English materialism established by Locke, Hume, Berkeley and David Hartley. *Zoonomia*, particularly, is interesting for its apparent anticipation of the later theories of Lamarck, Charles Darwin, Pavlov and others, and also for its emphasis on the physical basis of thought and emotion.

Briefly, it is as a transitional figure that Erasmus Darwin is chiefly important. He stands at the threshold of a new era, taking most of his basic assumptions from 18th-century materialism, but also prefiguring the more sophisticated approach of scientists like Charles Darwin and T. H. Huxley.

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DARWIN, SIR GEORGE HOWARD (1845–1912), British astronomer and pioneer in applying detailed dynamical analysis to cosmogonical and geological problems, was born at Down, Kent, on July 9, 1845. The second son of Charles Darwin, he was educated at Trinity college, Cambridge (second wrangler and Smith's prizeman), was elected fellow in 1868 and became Plumian professor of astronomy and experimental philosophy in 1883. His work on the harmonic analysis of tidal observations, based on methods developed by P. S. Laplace and Kelvin, is monumental. He discussed the effects of tidal friction on the evolution of binary systems with special reference to the moon, coming to hold that the moon might have originated from the disruption of a parent earth by resonant solar tides. He examined the possibility of geological changes causing large alterations in the inclination of the earth's axis to its orbital plane, but came to a negative conclusion. He also made extensive studies of periodic orbits in the problem of three bodies, and particularly of the figures of equilibrium of rotating masses of fluid, with the difficult problem of their stability; but his conclusion that the pear-shaped figure is stable, contrary to A. M. Liapunov's result and Sir James Jeans's later work, is considered incorrect. He became president of the Royal Astronomical society in 1899 and of the British association in 1905. Darwin received many honours and was made knight commander of the Bath in 1905. He died at Cambridge on Dec. 7, 1912.

Among Darwin's works are *The Tides and Kindred Phenomena in the Solar System* (1898), based on popular lectures at Boston, Mass., in 1897; and *Scientific Papers*, vol. i–v (1907–16), vol. v of which contains a biographical memoir by his brother Sir Francis Darwin.

(R. A. L.)

DARWIN, a town in the centre of the northern coast of Australia, named for Sir Charles Darwin. It lies on the eastern side of a spacious natural harbour and is the administrative centre and chief port of the Northern Territory. Pop. (1954 census) 8,071. Area 27 sq.mi. Founded in 1869 and known as Palmerston until 1911, Darwin was largely rebuilt after World War II. The population consists mainly of public servants; the pastoral, mining and rice-growing industries of the hinterland depend upon the port facilities of Darwin. The town has an international airport and is the terminal of the east and west coast shipping routes, of the railway to Birdum (317 mi. S.E.), of the Stuart highway (1942) to Alice Springs (954 mi. S.S.E.) and of the 1,973-mi. overland telegraph line (1872) to Adelaide, South Australia. (N. S. B.)

DARWIN GLASS: *see* TEKTITE.

DARWINISM. The word Darwinism was originally coined to denote that type of evolutionary mechanism propounded by Charles Robert Darwin (*q.v.*) as an explanation of organic change. Darwinism must not be taken as synonymous with the word evolution itself (*see* EVOLUTION, ORGANIC). Rather, it denotes Darwin's specific view of how the process comes about. Even here the word is open to a certain ambiguity because Darwin actually introduced more than one partial explanation of evolution into his great book, *The Origin of Species*. As the years passed, however, the natural selection hypothesis took on favour with biologists and Darwinism, by degrees, shed some of the minor supporting hypotheses which Darwin originally brought forward to sustain his thesis of natural selection. Modern neo-Darwinism (*see* below) for this reason must not be taken as precisely similar to Darwinism. On the basis of newer knowledge, some ideas have been dropped and new views substituted. If Darwin were living today he would recognize his theory but would be unfamiliar with much that has been incorporated within it. At the core of modern evolutionary theory is still to be found, however, the pure Darwinian conception of a selective death rate, which, on the whole, favours the population most successfully adapted to a given environment.

History of Natural Selection.—The biological theory which we loosely call Darwinism and which was first brought to widespread public attention by the publication in 1859 of Darwin's *Origin*, has a much older history, which was, for a time, obscured by the revolution in biological thought which occurred in the latter part of the 19th century as a consequence of that book.

Accumulation of Facts.—Although fragments of the theory of evolution may be found in the writings of the early Greek philosophers, centuries elapsed before any convincing scientific statements appeared. Like most noteworthy contributions to science the leading idea of Darwin's argument was anticipated by a few writers as the slow accumulation of pertinent facts began to transform the western world's view of life. The truly fruitful harvesting of facts began in the 16th century. Briefly, the events of this period which stimulated thought about evolution can be outlined as follows:

1. The great exploratory voyages of the 16th and 17th centuries had a profound impact upon European scholars. The voyages made Europe aware of a diversity of animals, men and plants of which it had been previously unaware. A new effort, therefore, was required to fit this larger world into the framework of Christian philosophy. Men began to pay more attention to the Deity's second book of revelation: nature. In England, for example, there arose a line of parson naturalists, theologically oriented men who made observations upon local natural history. John Ray (*q.v.*), a model for many later writers, is an exemplar of this class of observers.

2. So long as the notion that the world was only about 6,000 years old obtained, as it did, in orthodox Christian circles, no really strong evolutionary conceptions were possible. Some belief in the ability of plants or animals to alter, existed before the 18th century, but it was certainly different from modern ideas of progressive evolution. Thus before the evolution of life on a grand scale could be taken seriously, two things had to be accomplished: the full depth of geologic time had to be explored, and the nature of past life on earth revealed in all its amazing diversity.

3. Even after the succession of life forms in the rocks had been demonstrated, it would still be necessary to show that the life of one age was genetically related to the life of a later and succeeding age. To do this would demand full recognition of the continuity of geologic ages, an extensive development of comparative anatomy as a science and, finally, a plausible scientific theory as to how organic change in plants and animals might come about. It was this final point which Darwin was to provide in his *Origin*.

Supporting Views in Geology.—By 1785 James Hutton, the Scots geologist, had expressed at considerable length his belief in the great antiquity of the earth and the fact that the face of the planet was still undergoing alteration as it had throughout the great vistas of past time. Although his work suffered temporary eclipse, it was supported ably by his friend and follower, John Playfair.

In the 1830s Charles Lyell (*q.v.*) advocated and readvanced a naturalistic interpretation of geologic processes. His work, *The Principles of Geology*, had a profound effect upon young Darwin. He read the first two volumes during the course of his service as naturalist aboard H.M.S. "Beagle" (*see* below). By the time Darwin began his work upon the species question, the depth of geologic time to the order of millions of years was quite well accepted.

Fossil Record.—The work of Baron Cuvier, Richard Owen, William Smith and others had similarly begun to reveal the richness of the fossil record as well as the basic anatomical relations between extinct forms of life and those of the present.

Idea of Evolution.—A few men, notably P. L. M. de Mauper-

tuis, Buffon, Erasmus Darwin and J. B. Lamarck, had already postulated some kind of evolutionary succession. Darwin, therefore, did not originate the idea of evolution. Instead, he organized the first great body of proofs that showed the process to be a reality and, in addition, supplied the first adequate mechanism to account for it; namely, the theory of natural selection. (*See* SELECTION.)

Struggle for Existence.—The struggle for existence, upon which Darwin's theory was based, was, like so much else in the theory, known long before Darwin. Population pressure (the effect of a surplus of organisms) against food resources had been observed among both men and animals in the 18th century by John Bruckner (1768) and Thomas Malthus (*q.v.;* 1798). It had been remarked that this pressure exercises a pruning effect upon life; *i.e.,* it results in a struggle for existence, an active or passive competition among organisms for the available food and space. Those individuals better equipped for the struggle tend to survive and reproduce themselves; those ill-equipped often perish.

In the 18th and early 19th centuries what today is called natural selection was thought to be simply a kind of divine government maintaining natural forms in their proper proportions. It was thus seen by John Hunter, William Paley and others who repeated these ideas. Hunter termed the process "natural government." Science, in other words, had recognized before Darwin the negative aspects of selection—its role in extinction (Lyell) and its part in keeping species up to par by eliminating the weak or aberrant individuals. What was not glimpsed, except by two or three persons before Darwin, was the fact that selection might be creative—that new forms might be introduced slowly and imperceptibly by degrees.

A strong theological bias on the part of both scientists and the public led to a vague feeling that evolution was atheistic. The fact that it had been propounded by Frenchmen at about the time of the Revolution and directly after made the idea doubly suspect in conservative England. Although antievolutionist sentiment has largely subsided, it is still formally espoused by a few religious groups. (*See* FUNDAMENTALISM; SCOPES TRIAL.)

Darwin's Discovery.—In 1831 Darwin, as a young man of 22, set forth on the famous voyage of the "Beagle" which was to occupy him for five years. In the course of his wanderings he saw and learned much of the geology and animal life of South America and the neighbouring Galapagos Islands. He observed that species vary on opposite sides of mountain barriers and upon the separate islands of archipelagoes. While Darwin was absent on his voyage, two naturalists, Patrick Matthew (1831) and Edward Blyth (1835), had caught shadowy glimpses of the possibilities which lay in natural selection, but their briefly voiced ideas passed unheeded. In 1836 Darwin returned to England and settled down to a quiet life of meditation and study which was to culminate in his great work of 1859. Darwin, in his later years, attributed his inspiration to Malthus, but research suggests that he was also acquainted with the work of Blyth, who, though remaining within the old conservative framework, had hinted (1835–37) that his "localizing principle," as he termed natural selection, might suggest the descent of species from a common parentage.

Beginning in 1837 Darwin proceeded to work on the now well-understood concept that evolution is essentially brought about by the interplay of three principles: (1) variation—a liberalizing factor, which Darwin did not attempt to explain, present in all forms of life; (2) heredity—the conservative force which transmits similar organic form from one generation to another; (3) the struggle for existence—which determines which variations will survive in a given environment, thus altering life through a selective death rate. Add the long course of geologic time, contended Darwin, and life will be as slowly and inexorably altered as the unseen passage of an hour hand around a clock. Men's lives are so fleeting that they are not conscious of organic change until they learn to read the record of past epochs in the rocks of the earth.

This is the bare outline of the philosophy which was independently propounded by Alfred Russel Wallace (*q.v.*) in 1858, and which hastened the publication of Darwin's long-laboured-upon *Origin* in 1859. Darwin still made use of such ancillary hypotheses as the inheritance of acquired habits and, as criticism grew in his declining years, he tended to fall back upon similar Lamarckian arguments which were less prominently utilized in the first edition of the *Origin.* For a discussion of the reaction to Darwin's views *see* DARWIN, CHARLES ROBERT.

Neo-Darwinism.—Darwin and his contemporaries had none of the cytological and genetic information which became available later. Gregor Mendel (*q.v.*)—Darwin's contemporary—the founder of scientific genetics, was unknown, and the significance of his work was not recognized until 1900. As a consequence, Darwin was forced into unnecessary retreats and ambiguities in the later editions of his book.

The neo-Darwinian school—exemplified by, among many others, such outstanding scholars as Sewall Wright, T. Dobzhansky, G. L. Stebbins, Ernst Mayr and Julian Huxley—embraces a great body of experimental data which has removed many of the discrepancies of Darwinism. Modern neo-Darwinism has been purged of Darwin's lingering attachment to the Lamarckian inheritance of acquired characters. Present knowledge of the mechanisms of inheritance are such that modern scholars can distinguish more satisfactorily than Darwin between noninheritable bodily variation and variation of a genuinely inheritable kind.

The specific determiners of heredity (*q.v.;* genes) and the intricate mechanics of the chromosomes during cell division are factors which have been discovered since Darwin's time. Scientists have learned to produce mutations artificially through radiation and chemicals. Studies are being made on the chemical composition of the hereditary substance itself. Mathematical formulas elaborated by such scientists as Ronald Fisher, Wright and others have been introduced to handle the theoretical genetics of entire populations. These increases in perspective have placed scientists in a position to account for variation to a degree unrealized by Darwin.

The modern conception of evolutionary theory would be seen by Darwin as more intricate and complex than he had imagined, a matter of gene pools rather than individuals, but the essence of his theory remains. In this sense Darwin's work has withstood a century of criticism. He will always be hailed along with Wallace as the man who took a new look at an old idea and in doing so rejuvenated what had been regarded as an exploded and fallacious notion of organic descent held by a few solitary philosophers before his time. Darwin's achievement is unique even if not so completely original as is ordinarily assumed. Only a man of persuasive and powerful intellect and an enormous capacity for labour could have so drastically affected the thinking of his time. *See* LAMARCKISM; GENETICS; VARIATION; *see* also references under "Darwinism" in the Index volume.

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DAS, CHITTA RANJAN (1870–1925), Indian politician and leader of the Swaraj ("Independence") party in Bengal, was born at Calcutta on Nov. 5, 1870, of a high-caste Vaidya family of substantial means. After failing the competitive entrance examination for the Indian civil service he was called to the bar. He defended many accused of political offenses and took an active part in nationalistic journalism. Bitterly opposing British rule and rejecting all idea of the political or economic development of India along western lines, he idealized the life of the ancient Indian village and saw a golden age in ancient Indian history. He supported the nonco-operation movement launched by M. K. Gandhi and in 1921 was imprisoned for six months as a political offender. In 1922 he presided over the session of the Indian National Congress at Gaya and subsequently persuaded the members to adopt his policy of standing for election to the provincial legis-

lative councils and obstructing their business from inside instead of entirely boycotting the elections. Later, when the Swarajists were returned as the largest party in Bengal, Das declined the post of chief minister, stating that his aim was to wreck the system of dyarchy under which some provincial departments were headed by ministers responsible to the governor and others by ministers responsible to the legislature. In 1924 he was elected mayor of Calcutta but was criticized for paying more attention to party management than to administrative efficiency. In the following year he began to make hints of a willingness to co-operate with the government, but before anything could come of them he died at Darjeeling on June 16, 1925.

See P. C. Ray, *Life and Times of C. R. Das* (1927). (KE. A. B.)

DASE (DESSIE), the capital of Wallo province of Ethiopia and the third largest town in that country, stands at a height of over 8,000 ft. on the edge of the escarpment between the cool, wet highlands of the western part of the province and the hot, dry lowlands of the Danakil plain to the east. Dase is 250 mi. N. of Addis Ababa, 438 mi. S. of Asmara and 16 mi. N.W. by road from Combulchia, which lies 2,000 ft. below Dase and is the junction of the roads to Asmara, Addis Ababa and Assab. Pop. (1956 est.) 53,500.

The town is the residence of the governor general of Wallo province and has a secondary school, a hospital and flour mills. At the beginning of the 20th century it was the capital of the Galla chieftain Ras Mikael, and it is a long-established and important market for grains, oilseeds and hides and skins and a distributing centre for imported goods. It has a subsidiary market at Batie, 40 mi. to the east on the Assab road and on the edge of the Danakil desert. Combulchia is the airport for Dase. (G. C. L.)

DASHKOVA, EKATERINA ROMANOVNA VORONTSOVA, PRINCESS (1744–1810), Russian literary figure of the Enlightenment, was born in St. Petersburg on March 28 (new style; 17, old style), 1744, the third daughter of Count Roman Illarionovich Vorontsov. (For the family, *see* VORONTSOV.) She became one of the leaders of the party that attached itself to the grand duchess (afterward empress) Catherine. In May 1759 she married Prince Mikhail Ivanovich Dashkov and went to reside with him at Moscow. In 1762 she was in St. Petersburg and took a leading part in the *coup d'état* by which Catherine was raised to the throne. But for this, Princess Dashkova's elder sister Elizaveta, mistress of the emperor Peter III, might have risen to power, as Peter had declared that he would depose Catherine in her favour. Still, the princess' relations with the new empress were not cordial and she set out in Dec. 1769 on an extended tour through Europe, which lasted three years. In Paris she gained the friendship and admiration of Diderot and Voltaire. In 1775 she went again abroad and spent the years 1776–79 in Scotland. In 1782 she returned to the Russian capital, in Jan. 1783 was appointed *directrice* of the Academy of Arts and Sciences and in September first president of the Russian Academy founded at her suggestion. She projected the Russian dictionary of the academy, arranged its plan and executed a part of the work herself. She edited a monthly magazine, the *Sobesednik*, and wrote dramatic works. Shortly before Catherine's death Princess Dashkova retired from court. On the accession of the emperor Paul in 1796 she was deprived of all her offices and ordered to retire to a village in the government of Novgorod, "to meditate on the events of 1762." But she passed the closing years of her life on her estate near Moscow, where she died on Jan. 16 (N.S., 4, O.S.), 1810.

The *Memoirs of the Princess Dashkaw Written by Herself* were composed in French, but first published in English in London, 2 vol. (1840). They were edited by Mrs. W. Bradford.

See A. A. Suvorin, *Knyaginya Katerina Romanovna Dashkova* (1888); G. Schlegelberger, Die *Fürstin Daschkowa* (1935).

DASS, PETTER (1647–1707), Norwegian poet whose place in his country's 17th-century literary revival and in the affections of his compatriots rests mainly on his descriptive poem, *Nordlands Trompet*. The son of a Scottish merchant who had settled in Bergen, he was born on the island of Nord Herö, off the north coast of Norway, studied at Copenhagen and was ordained in 1677. In 1689 he received the living of Alstahaug in northern Norway, where for the rest of his life he exercised jurisdiction over a large and scattered parish, exhorting and comforting his congregation of fishermen, shepherds and farmers and sharing their love for their homeland. His poems were passed in manuscript from hand to hand, and learned by heart by his parishioners: the only work published in his lifetime was *Den norske dalevise* ("The Norwegian Song of the Valley," 1683). His sacred poems, revealing personal faith and piety, were collected after his death as *Aandelig Tidsfordriv* ("Spiritual Pastime"). Many were written with a didactic intention and are easily memorable versions and expansions of biblical texts and parts of the catechism.

Nordlands Trompet (Eng. trans. *The Trumpet of Nordland*, 1955) was first published in 1739. A rhyming description of the province of Nordland, it depicts with loving accuracy, homely humour and quaint learning its natural features, people and occupations. It is written in an easy, swinging metre, as lively and energetic as its writer, and has remained popular with the "men who inhabit the North," "the master who guides and the servant at work," and "all men who wear homespun" to whom it is addressed.

See H. Midbøe, *Petter Dass* (1947).

DASYURE, a name for the marsupial cats or tiger cats of the genus *Dasyurus*, found in New Guinea and Tasmania, as well as on the Australian continent. These are weasellike, carnivorous mammals about the size of a small cat, rusty or olive brown in general coloration, spotted with white. Females have a well-developed pouch in which four to six young may be suckled and supported. However, as many as 24 young may be born at a time, the greater portion of them dying soon after birth. Dasyures hide themselves in the daytime in holes among rocks or in hollow trees, but prowl about at night in search of the small mammals and birds, which constitute their prey. In arboreal species there are transversely striated pads on the feet; these are absent in terrestrial forms such as the common dasyure (*D. viverrimus*). *See* also MARSUPIAL.

DASZYNSKI, IGNACY (1866–1936), Polish Socialist leader and patriot, the most eloquent Polish public speaker of his time, was born at Zbaraz, near Tarnopol, in eastern Galicia, on Oct. 26, 1866, the son of a modest civil servant. He studied at the universities of Cracow and Zürich. In Oct. 1892 he was one of the organizers of the Polish Social Democratic party in Galicia. Elected to the Austrian *Reichsrat* in 1897, he sat in it till 1918. From 1903 he took part in many congresses of the Socialist International, always insisting that the independence and the reunification of all Polish lands were an integral part of the Polish Socialist program. From 1912 he collaborated to this and with Jozef Pilsudski (*q.v.*), whom he then admired. In 1912 also he became editor-in-chief of the Polish Socialist daily newspaper *Naprzod* ("Forward") in Cracow. Daszynski was the head of the first and short-lived provisional government of restored Poland formed at Lublin on Nov. 7, 1918. Elected on Jan. 26, 1919, to the first Polish *sejm*, he was re-elected in 1922, 1928 and 1930. From July 21, 1920, to Jan. 4, 1921, he was deputy premier in the government of national unity presided over by Wincenty Witos. From 1928 to 1930 he was marshal (speaker) of the *sejm* and, as such, firmly defended the parliamentary prerogatives against Pilsudski's authoritarianism. The two leaders were friends no more and in 1930 Daszynski had to surrender his passport. He became ill in 1931 and retired from public life. He died on Oct. 31, 1936, at Wisla, near Cieszyn. His memoirs (two volumes) had appeared in 1925–26.

See A. Próchnik, *Ignacy Daszyński* (1946). (K. SM.)

DATE LINE, a north-south line through the Pacific ocean where, by common usage, the date changes. East of the line it is one day earlier than it is to the west. The line is necessary because the earth is divided into 24 one-hour time zones (of 15° longitude each) which make one full day on the earth. Since the earth rotates toward the east a given clock time progresses westward around the world. Thus noon arrives at London (0° longitude) five hours before it does in Washington (75° west of London), eight hours before it does in San Francisco (120° west of London), and twelve hours before it does at 180° west of London. At that longitude it would be midnight when it was noon in

London. However, if longitude and time were counted east from London's noon, though midnight would be approached again, time would be later in the day, one hour for each 15°, rather than earlier. This situation would place the same day on both sides of 180°. This cannot be, for the new day that starts westward from the 180th meridian must have a date one day later than the day which has just arrived there from the east. The anomaly is solved by arbitrarily designating where a new day begins. On both sides of the line the time of day is the same but the name of the day, and hence its date are changed—forward if going west, backward if going east.

The line which has been arbitrarily designated as the date line (usually international date line) is the 180th meridian, with variations to the east or west for the convenience of certain land areas and islands. The line bulges eastward through Bering strait to accommodate eastern Siberia and then westward to include the Aleutian Islands with Alaska. South of the equator another eastward deviation allows certain island groups to have the same day as New Zealand. (J. W. Rh.)

DATE PALM. The dates of commerce are the fruit of the date palm, *Phoenix dactylifera*, a tree which ranges from the Canary Islands through northern Africa and from the southwest of Asia to Pakistan and India. The tree has been cultivated and much prized, for its fruits have been the staple food and chief source of wealth in the irrigable desert portions of most of these regions from the remotest antiquity. It was carried to the new world by Spanish missionaries in the 18th and early 19th centuries and a few seedling plantings of date palms in the dry districts of Mexico date back to that period.

Plant Characteristics.—The date palm is a beautiful tree, growing to a height of from 60 to 80 ft. and its stem, which is strongly marked with the pruned stubs of old leaf bases, terminates in a crown of graceful, shining, pinnate leaves, 10 to 20 ft. long. The flowers are of separate sexes borne on different palms in branching spadices from the axils of leaves which emerged the previous year. Under cultivation it is necessary to pollinate the female flowers by artificial means. The fruit is a one-seeded berry, usually more or less oblong, but varying much in shape, size, colour, quality and consistency of flesh according to variety and cultural conditions. A single large bunch may carry more than 1,000 fruits weighing 20 lb. or more. The dried fruit so widely exported owes more than half its weight to sugar and about 2% each to protein, fat and mineral matter. Propagation is either from seeds or from suckers or offshoots which arise chiefly near the base of the stem in the early years of the palm's life. Palms grown from seed are a source of new varieties but extremely variable and about equally divided as to number of males and females.

Offshoots reproduce the sex and character of the parent palm and are used for commercial plantings. When offshoots are three to six years old and have formed roots of their own they are removed and planted. Palms are spaced about 30 by 30 ft.; they begin to bear in 4 or 5 years and reach full bearing at 10 to 15 years, yielding 100 to 200 lb. or more each. Although palms are known to live as long as 150 years, fruit production declines, and in commercial culture palms are replaced at a much earlier age.

Varieties.—Early in the 20th century some of the better varieties of the old world were introduced into the southwestern United States and were being cultivated on a commercial scale chiefly in the Coachella valley of southern California, 140 mi. S.E. of Los Angeles. Leading varieties grown in the U.S. are Deglet Noor from Algeria, Medjool from Morocco, and Khadrawy, Zahidi and Halawy from Iraq.

J. HORACE MCFARLAND

YOUNG DATE PALM (PHOENIX DACTYLIFERA)

Economic Value.—All parts of the date palm yield products of economic value to the old-world areas where it is grown. Its trunk furnishes timber for housebuilding; the midribs of the leaves supply material for crates and furniture; the leaflets for basketry; the leaf bases for fuel; the fruit stalks for rope and fuel; the fibre for cordage and packing material; the seeds are sometimes ground and used for stock feed. Sirup, a strong liquor, alcohol and vinegar are derived from the fruit. The sap is used as a beverage, either fresh or fermented, but the method of extraction causes serious injury to the palm so only those of little value for fruit production are used for this purpose. When a palm is cut down the tender terminal bud is eaten as a vegetable or salad.

Date sugar, a commercial product of India, is obtained from the sap of *Phoenix sylvestris*, another species very closely related to the date palm.

Production.—Iraq is the leading date-growing country in the world and supplies most of the fruit exported to other countries. Fruit from Algeria and Tunisia, much of it packaged in Marseilles, France, is also well known in Europe. Although high summer temperatures and low humidity during the ripening season are required for successful fruit production, the palm itself will grow in any tropical or subtropical region where prolonged temperatures below 20° F. are not of frequent occurrence. Along the Mediterranean shores of Europe the date palm is grown as an ornamental and used to supply leaves for the festival of Palm Sunday among Christians, and for the celebration of the Feast of Tabernacles by Jews.

See Palm; Fruit Farming; *see* also references under "Date Palm" in the Index volume.

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(R. W. N.; X.)

DATIA, a town and district in the Gwalior division of Madhya Pradesh, India. The town (pop. [1961] 29,430) is 45 mi. S.S.E. of Gwalior on the Delhi-Bombay main line of the Central railway. It is surrounded by a stone wall enclosing handsome palaces and gardens. The 17th-century palace of Bir Singh Deo is a fine example of Hindu domestic architecture; it is untenanted.

Datia District (area 782 sq.mi.; pop. [1961] 200,467) lies in the level but poor country between the Sind and Pahuj rivers, and is largely covered by scrub jungle and grasses. It comprises the former princely state of Datia which came under British control after the treaty of Bassein in 1802, was settled upon a cadet branch of the Bundela Rajput ruling family of Orchha state by treaties of 1804 and 1818 and was part of the Bundelkhand subagency of Central India. It was merged with Vindhya Pradesh on April 4, 1948, and with it became part of Madhya Pradesh on Nov. 1, 1956. There is an inscription of the emperor Asoka (*q.v.*) at Gujarra, 7 mi. N. of Datia town, and a group of Jain temples are nearby at Sonagir. (S. M. A.)

DATING, METHODS OF. The various methods of dating the earth and its inhabitants are discussed in Geochronology and Archaeology: *The Materials of Archaeology*. Particular methods are treated in the articles Dendrochronology; Radiocarbon Dating; Typology; Varve Analysis.

DATO IRADIER, EDUARDO (1856–1921), Spanish statesman, who was leader of the Conservative party 1913–21, was born at Corunna on Aug. 12, 1856. As undersecretary at the home office in 1892, and minister in 1899, he sponsored workers' compensation acts and bills to regulate female employment. He was minister of justice in 1902, mayor of Madrid in 1907, when he interested himself in municipal health reform, and then president of congress. Like his friend and chief, Francisco Silvela, he belonged to the moderate wing of the Conservative party. When Antonio Maura, the Conservative leader, refused in 1913 to form a government in place of the conde de Romanones, Dato took over the leadership of the party and became head of the government until 1915. As such he established the *mancomunitat* of Catalonia and was instrumental in keeping Spain neutral at the outbreak of World War I. He was in office again from June to Oct. 1917, when he was obliged to suspend constitutional guarantees and freedom of the press in order to put down unrest in Barcelona, strikes in Valencia and near-revolution in other parts of the country. He became prime minister again in 1920 and tried to heal the division in the Conservative party and to calm social upheavals in Catalonia.

He was assassinated by anarchists near his home in Madrid on March 8, 1921. (J. C. J. M.)

DATOLITE, a relatively uncommon mineral consisting of calcium and boron hydrous silicate, $CaBSiO_4(OH)$. It occurs in colourless to white, well-developed monoclinic crystals and in fine-grained granular masses. Some notable localities where it is found are Westfield, Mass.; Bergen Hill, N.J.; and the Lake Superior copper district.

Datolite is commonly difficult to recognize by simple examination and is easily mistaken for quartz. It may be distinguished by its easy fusibility in a Bunsen burner flame and by the characteristic green flame coloration given by the boron contained in it. It occurs most characteristically as cavity linings in igneous rocks such as basalt and diabase. It is commonly associated with quartz, calcite, prehnite, zeolites, apophyllite and pectolite.

(D. M. H.)

DATURA, a genus of shrubby herbaceous plants several species of which, especially *D. stramonium*, the jimson weed or thorn apple, are poisonous. Native to tropical Africa and Asia, these members of the nightshade family (Solanaceae) are naturalized throughout the temperate northern hemisphere chiefly as weeds. *See* Solanaceae; Weed.

DAUBENTON (D'Aubenton), **LOUIS JEAN MARIE** (1716–1800), French naturalist, well known for his studies in comparative anatomy, was born, like Buffon, at Montbard (Côte d'Or). In 1741 he graduated in medicine at Reims, and returned to his native town with the intention of practising. In 1744, however, Bernard de Jussieu's post as keeper of the cabinet of natural history in Paris having become vacant, Daubenton was persuaded by Buffon to accept this position. Buffon also invited him to provide the anatomical descriptions for the *Histoire naturelle;* and Daubenton's details of the dissection of 182 species of quadrupeds in that work brought him great reputation. But the two men were very different in outlook and style. Buffon had a gift for synthesis, while Daubenton's mind was more analytical, and he never used his imagination. Buffon therefore dispensed with Daubenton's services in the remainder of the *Histoire naturelle,* and from 1767 they worked independently of each other, although remaining friends. Daubenton now occupied himself with zoological descriptions and dissections, the comparative anatomy of recent and fossil animals, vegetable physiology, mineralogy, experiments in agriculture and the introduction of the merino sheep into France. From 1775 he lectured on natural history in the college of medicine, and in 1783 on rural economy at the Alfort school. On the enlargement of the Jardin du Roi under the Convention and its change of name to the Muséum, Daubenton was elected its first director (1793–94) from among the 12 professors appointed to it, and enjoyed a second term of office from 1796 to 1797. In Dec. 1799 he was made a member of the senate. He died in Paris on Jan. 1, 1800.

DAUBIGNY, CHARLES FRANÇOIS (1817–1878), French landscape painter and engraver whose discoveries in the values of light influenced the Impressionist movement, was born in Paris on Feb. 15, 1817, of a minor bourgeois family. After visiting Italy in 1835 he returned to Paris in 1836, attempted historical painting and exhibited a "St. Jerome" in the Paris Salon of 1840. He was compelled also in youth to illustrate books, among them E. Sue's *Les Mystères de Paris;* but his true leanings were toward the more tranquil art of landscape as practised by the first painters of the school of Barbizon, themselves largely of the same urban extraction as himself. Like J. B. C. Corot he painted in the Morvan, and in 1852, after the two had met, his work began to depend on a strict observation of tonal values fortified by a concealed but indispensable minimum of composed structure. Such works, though calm and unspectacular, soon gained success, one of them being bought by the emperor in 1853. Later in the 1850s Daubigny's manner, though still restrained, began to express a more personal lyricism, and he increasingly employed the phenomenon of graduated light reflections from surfaces to give effects of space; such methods moreover were directed at conveying a momentary impression of the landscape. Daubigny was never strictly a member of the school of Barbizon, and, painting in the manner described in the region of Auvers-sur-Oise and on the Seine in the boat studio (which he launched in 1857), he is best seen as a link between the more classically organized naturalism of Corot and the undiscriminating visual receptiveness of his young friends Claude Monet and Alfred Sisley—the most striking difference lying between the grays, greens and ochres of Daubigny and the polychromy of the younger men. His glass prints were among the best ever executed. Daubigny died in Paris on Feb. 19, 1878.

See E. Moreau-Nélaton, *Daubigny raconté par lui-même* (1925).

(D. C. T. T.; X.)

DÄUBLER, THEODOR (1876–1934), German writer, was one of the leaders of the Expressionist movement. He was born Aug. 17, 1876, at Trieste, and his birthplace made him free of both German and Romance civilizations. He lived a wandering life in Italy, Germany, France, the Balkans and the middle east, without settled occupation or income. His poetry was slow to win appreciation but he made a deep impression on those who met him, with his huge person, flowing beard and the vast appetite which seemed an aspect of his immense vitality. Däubler published novels (*L'Africana,* 1928; *Die Göttin mit der Fackel,* 1931); writings on art (*Der neue Standpunkt,* 1911); essays and other prose (*Mit silberner Sichel,* 1916; *Griechenland,* 1947); and poetical works (*Der Sternhelle Weg,* 1915; *Das Sternenkind,* 1916; *Die Treppe zum Nordlicht,* 1920; *Attische Sonette,* 1924). His chief work was his long lyrical cycle "Das Nordlicht" (1910), in which, with cosmic imagery, he expresses his visionary ideas. The sun was for Däubler the symbol of the spirit and in seeking to reconcile Christian and pagan conceptions he saw in Apollo the link between the two. He died at St. Blasien, in the Black Forest, June 14, 1934. (M. Kl.)

DAUBRÉE, GABRIEL AUGUSTE (1814–1896), French geochemist and a pioneer in the application of experimental methods to the study of diverse geological phenomena, was born in Metz, on June 25, 1814. He was educated at the École Polytechnique and the École des Mines, following which he toured Germany, England and Scotland for one year and then was sent to Algiers as a member of a commission to undertake studies in mining. In 1838 he became regional mining engineer for the province of Haut-Rhin and professor of the akademie at Strasbourg. In 1861 he became professor of geology at the Musée des Sciences Naturelles, and next year professor at the École Imperiale des Mines. In 1867 he was appointed inspector general of mines, retiring from this position in 1886, after which he remained honorary director of the office until his death in Paris on May 29, 1896. In 1869 he was elected commander of the Legion of Honour.

Daubrée's earliest works dealt with the synthesis of minerals and the study of the formation of minerals in some of the hot springs of France, and the application of these data to the origin of mineral deposits. He also carried on experimental studies on the mechanical formation of pebbles, sands and muds; on the fracturing of rocks with especial regard to the formation of joints and geological faults; and on the metamorphism and the development of schistocity in rocks. Many of his researches were devoted to the subject of meteorites, including their constitution and relations to terrestrial rocks and the modification of their shapes during their flight through the atmosphere. He also proposed a classification of meteorites. These researches were summarized in his principal work entitled *Etudes synthétiques de géologie expérimentale* (1879). His last important work related to the role of underground waters, in which he discussed the changes that water produces within the crust of the earth. These studies were published in his *Les Eaux souterraines* (1887).

The minerals daubréeite (an oxychloride of bismuth) and daubréelite (a meteoric mineral) were named in his honour.

(W. F. Fg.)

DAUDET, ALPHONSE (1840–1897), French novelist, author of short stories and dramatist, usually classed with the "naturalist" school of writers but distinguished from other members of it by his more sensitive approach and by his constant readiness to commit himself in his subject, was born at Nîmes on May 13, 1840, the son of a silk manufacturer. In 1849 his father

was obliged to sell his factory and to move to Lyons, where Alphonse was at first repelled by the damp-laden atmosphere but soon found compensations in escapades and in the life of the Rhône. He wrote his first poems and his first novel at the age of 14. In 1857 his parents lost all their money, and Daudet had to give up his hopes of matriculating. Taking work as an usher at a school at Alais, he led a double life there for six unhappy months which culminated in his dismissal but which later furnished the theme, with embellishments and omissions, for his novel *Le Petit Chose* (1868). At the end of the year he went to join his elder brother Ernest in Paris.

Daudet now threw himself into writing and began to frequent literary circles, both bohemian and fashionable. A handsome young man, he was able to form a liaison with a model, Marie Rieu, to whom he dedicated his only book of poems, *Les Amoureuses* (1858; new ed., 1863). His long and troubled relationship with her was to be reflected, much later, in his novel *Sapho* (1884). He also contributed articles to the newspapers, in particular to *Figaro*. In 1860 he met Frédéric Mistral, who awakened his enthusiasm for the passionate life of the south of France; and in the same year he obtained a secretarial post under the duc de Morny.

His health undermined by poverty and by the venereal disease which eventually cost him his life, Daudet spent the winter of 1861–62 in Algeria. One of the fruits of this visit was *Chapatin le tueur de lions* (1863), the hero of which can be seen as the first sketch of the author's future Tartarin. Daudet's first play, *La Dernière Idole*, made a great impact when it was produced at the Théâtre de l'Odéon in Paris in 1862. His winter in Corsica at the end of 1862 is recalled in passages of his *Lettres de mon moulin* (1869). His full social life over the years 1863–65 (till Morny's death) provided him with the material that he analyzed mercilessly in *Le Nabab* (1877). In Jan. 1867 he married Julia Allard, herself a writer of talent, with whom he was deeply in love and who gave him great help in his subsequent work. They had two sons, Léon and Lucien, and a daughter, Edmée.

In the Franco-German War, which had a profound effect on his writing (as can be judged from *Les Contes du lundi*, 1873), Daudet enlisted in the army; but he fled from Paris during the commune of 1871. His *Tartarin de Tarascon* (1872) was not well received, though its hero is now celebrated as the type of naïveté and boastfulness combined. His play *L'Arlésienne* was also a failure. His next novel, however, *Fromont jeune et Risler aîné* (1874), which won an award from the Académie Française, was a success, and for a few years Daudet enjoyed prosperity and fame—not without some hostile criticism.

In his last years Daudet suffered from agonizing disease of the spinal cord. *La Doulou* (not published till 1931) represents his attempt to alleviate his pain by investigating it. With admirable self-control he continued to write books of all sorts and to entertain Parisian literary and musical society. He was a kindly patron of younger writers, for instance of Marcel Proust. In 1895 he visited London and Venice. He died suddenly on Dec. 16, 1897, while speaking of interplanetary travel.

Psychologically, Daudet represents a synthesis of conflicting elements, and his actual experience of life at every social level and in the course of travels helped to develop his natural gifts. A true southerner, he combined an understanding of passion with a view of the world illuminated by Mediterranean sunlight and could allow himself unfettered flights of the imagination without ever relaxing his attention to the detail of human behaviour. All his life he used to record his observations of other people in little notebooks, which he used as a reservoir of inspiration: a novel, he held, should be "the history of people who will never have any history." Yet there was nothing unfeeling in his approach (he has even been accused of sentimentality), and he was free from preconceived ideas: unlike the naturalists, he believed that the world in its diversity was misrepresented by novelists who concentrated only on its uglier aspects.

At the same time his objective interest in external detail went hand in hand with the expression of an extraordinarily compassionate personality and a reverence for the mystery of things and of individuals. Everything in his world had an inner reality, which he reproduced no less faithfully than the material phenomena. Finally, he saw passion as endowed with something like the force of destiny; and this conception, which bore fruit in many of his writings, tempers his satire with pity and so brings him into kinship with Dickens as well as with Maupassant.

In Daudet's work as a whole we can discern not so much a continuous evolution as an episodic process in which various literary tendencies found expression successively. Even so, the anti-romantic irony of *Tartarin de Tarascon* gave place to a realism akin to that of the pointillist and impressionist painters in *Lettres de mon moulin*, which was followed by the tragic tone of *L'Arlésienne* as a corrective to his earlier mockery of southern characteristics; also there is more sympathy and anxiety than irony in *Le Petit Chose* and *Contes du lundi*. As he grew older Daudet became more and more preoccupied with the great conflicts in human relationship: *Jack* (1876) presents a woman torn between physical and maternal love; *Numa Roumestan* (1881), the antagonism between the northern and the southern character in man and woman; *L'Évangéliste* (1883), filial affection struggling against religious fanaticism; and *La Petite Paroisse* (1895), the contrarieties of jealousy. In *Sapho* (1884), underlying the moral issue, there is Daudet's evaluation of a whole generation of young men, together with a statement of the age-old dilemma of the lover who must choose between freedom and the claims of pity. *Le Trésor d'Arlatan* (1895), *Notes sur la vie* and *Nouvelles notes* show Daudet as a bold psychologist anticipating Freud in his analysis of complexes. Truth and fantasy, merciless delineation and poetry, clear-sighted seriousness and a sense of humour, irony and compassion, all the contrasting elements of which man's dignity is made up are to be found harmonized in Daudet's best work. He could find poetry where no one else would have looked for it, as chemists can extract from coal scents more potent than those of the flowers which they call to mind.

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DAUDET, LÉON (1867–1942), prolific French writer and the most virulent and courageous polemicist of his generation in France, whose literary reputation rests largely upon his memoirs. The son of Alphonse Daudet, he was born in Paris, Nov. 16, 1867, and died in St. Rémy-de-Provence, July 1, 1942. His major journalistic achievement was, from March 1908, in collaboration with Charles Maurras, refashioning *Action Française* into a daily paper of avowedly reactionary, nationalist and royalist opinion and contributing to it in characteristically satirical and Rabelaisian vein. His most important books, *Souvenirs des milieux litéraires, politiques, artistiques et médicaux* (1914–21), are informative, vivid and partisan. Among many novels, *Le Voyage de Shakespeare* (1896) is more successful than most. His books on psychology and medicine, such as *Le Monde des images* (1919), are stubbornly anti-Freudian; his political writings, as in *L'Avant-Guerre* (1913), show prescience as well as conservatism. *Le Stupide XIXe Siècle* (1922) violently condemns the false gods worshiped in France after 1789.

See P. Dresse, *Léon Daudet vivant* (1948).

DAUGAVPILS (Russ. Dvinsk, Ger. Dünaburg), a town of southeast Latvia (now the Latvian Soviet Socialist Republic of the U.S.S.R.), is situated on the Daugava river (Western Dvina) 219 km. (136 mi.) E. of Riga. Pop. (1959) 65,000. The first town, built 1274 by the German Livonian order, was destroyed by Ivan IV called "the Terrible." Daugavpils was rebuilt 1582 by Stephen Báthory, king of Poland, and became an important fortress and administrative centre. It passed to Russia at the first partition

of Poland 1772, and to the French for a short while in 1812. In both World Wars I and II it was the scene of heavy fighting. In Jan. 1920 Latvian and Polish forces expelled the Russians and it became a district town of Latvia. Occupied, with the rest of Latvia, by the Russians in June 1940, it was in German hands from July 1941 until July 24, 1944, when it was recaptured by Soviet forces.

In the 1860s Daugavpils became an important centre of trade and communications when the St. Petersburg-Warsaw and Riga-Orel railways were built. Besides railway workshops there are food, textile, and building works. (J. A. Bo.)

DAUGHTERS OF THE AMERICAN REVOLUTION, a national patriotic society organized Oct. 11, 1890, and chartered by congress Dec. 2, 1895. Membership is limited to direct lineal descendants of soldiers or others of the Revolutionary period who aided the cause of independence; applicants must have reached 18 years of age and must be "personally acceptable" to the society. By the early 1960s the society's membership totaled approximately 187,000. There were more than 2,800 local chapters situated throughout the United States and in several other countries.

The DAR, as the society is generally known, carries on a threefold program through the divisions of its national office. The historical division stresses the study of U.S. history, preservation of Americana, marking of historic sites and maintenance of a museum, library and genealogical record centre. The educational division provides scholarships and loans, helps to support schools for underprivileged youth and for Americanization training, sponsors various prizes and publishes appropriate manuals. The patriotic division alerts the nation to potential dangers through the *Daughters of the American Revolution Magazine*, *The National Defense News*, and a wide range of resolutions adopted at the annual continental congress held at the society's headquarters in Washington, D.C. *See* also PATRIOTIC SOCIETIES. (J. P. N.)

DAULATABAD, formerly a hill fortress and town, now a village in the Aurangabad district of Maharashtra, India. Pop. (1951) 827. Daulatabad owed its position as one of the strongest fortresses in medieval India "to its geological formation, a conical hill of rock rising abruptly from the plain to about 600 feet and situated by the ancient 'ghat' or roadway which runs past Ellora. . . . The fortifications constitute three concentric lines of defence culminating in the citadel with its rock-cut defences. . . . Throughout, the defensive system consists of a wall with bastions standing on the inner edge of a rock-cut ditch and having formidable gateways with elaborated local defences." (Stuart Piggott, *Some Ancient Cities of India*, Oxford University Press, London, 1945.) The citadel is wholly scarped to a vertical rock-cut face, 150–200 ft. high and surrounded by a water-filled moat, dug into solid rock. The only access to it is by a narrow bridge and subterranean galleries culminating in a steep staircase covered by a grating intended to form the hearth of a huge fire maintained by the garrison above.

Daulatabad was probably founded (as Deogiri) about A.D. 1187 by the Yadava Bhillama I. The town was captured by 'Ala ud-din Khalji in 1296 and the Yadavas were forced to pay tribute. It was again occupied by the Delhi forces in 1307 and 1313. The last raja, Harpal, was killed by Sultan Mubarak Shah Khalji of Delhi in 1318.

In 1327, Mohammed Tughluq made Daulatabad his second capital, transferring numbers of the Muslim aristocracy there two years later. The outer defenses probably belong to his reign. In 1346 his military chiefs in the Deccan revolted and Daulatabad was taken by Zafar Khan, governor of Gulbarga. After 1347 it was a headquarters of the Bahmani (*q.v.*) sultanate. Ahmad Nizam Shah captured Daulatabad in 1500 and it remained under Ahmednagar (*q.v.*) until 1633, when it was taken by the Mogul general Mahabat Khan. Its importance declined when Aurangzeb established the Mogul seat of government in the Deccan at Aurangabad. In 1760 Daulatabad passed from the possession of the nizam of Hyderabad to the Marathas.

See Sir W. Hunter, *Imperial Gazetteer of India, s.v.* Daulatabad, vol. xi (1918); S. Toy, *The Strongholds of India* (1957). (P. H.)

DAUMET, PIERRE JÉRÔME HONORÉ (1826–1911), French architect who rebuilt the Palais de Justice, Paris, was born on Oct. 23, 1826, in Paris. He entered the École des Beaux-Arts in 1846, and in 1855 was awarded the Prix de Rome. In 1861 he went on an archaeological expedition to Macedonia, and published, in collaboration with Léon Henzey, an important work on their research in Thessaly, Thrace and Illyria. He was entrusted with the restoration of many monuments of French architecture, including the castle of Chantilly, the Palais de Justice, Paris, and the theatre at Orange. In 1884 Daumet undertook the construction of the Église du Sacré-Cœur on Montmartre, which had already been begun by the architect Abbadie; but the following year he abandoned the task, after a dispute with the ecclesiastical authorities. He died in Paris on Dec. 15, 1911.

DAUMIER, HONORÉ (1808–1879), French caricaturist and painter whose lithographs are an unforgettable record of the ironies of human behaviour and whose paintings are an important link in the development of modern art, was born at Marseilles on Feb. 20 or 26, 1808. The family moved to Paris during Daumier's childhood and thus he grew up in the city with which he is as completely identified as Charles Dickens is with London. He served in such varied capacities as bookseller's assistant and messenger in the law courts. An association with the director of the Musée des Monuments de France gave him an interest in sculpture which was to have a profound effect on his whole career.

After mastering the craft of lithography, Daumier did anonymous work for publishers until, in 1830, his gift for political cartooning caught the attention of Charles Philipon, a liberal journalist who had founded *La Caricature*. Daumier's connection with Philipon and his journals lasted 40 years, though with interruptions. The first of these was caused by the publication of his lithograph of Louis Philippe as "Gargantua" (1832); he was imprisoned for six months and soon afterward *La Caricature* was forced to discontinue. But Philipon provided a new field for Daumier's activity when he founded *Le Charivari* with the intent of holding up to good-natured ridicule the foibles of society.

Daumier's style in lithography underwent a marked change after the 1830s. Drawing by sharp outlines changed to line conceived as a web of sculptural contours, and detailed modeling gave way to ever increasing selectivity of detail. The development may be traced from "Le Ventre Législatif" (1832) and "La Rue Transnonain" (1834), to the Robert Macaire series of the later 1830s (100 lithographs about the adventures of the hero of a then popular melodrama); to the many series of the 1840s and 1850s ridiculing, among other things, decaying classical lore and the evils of the law courts. The total number comes to nearly 4,000 (each in a large edition) and together they form a visual parallel to Balzac's conception of his own work as the *Human Comedy*.

COURTESY OF THE MINNEAPOLIS INSTITUTE OF ARTS

"THE TOO HOT BATH." LITHOGRAPH BY HONORÉ DAUMIER, 1839. FIRST APPEARED IN LE CHARIVARI THE SAME YEAR

Balzac was one of the first to recognize Daumier's genius, as against his mere ability to entertain. He once remarked, "There is something of Michelangelo in that fellow." The point was well taken, for it suggested his dramatic power, his emphatic scale and his concern for the great passions even when the theme chosen might seem trivial. Daumier's interest in sculptural form was another link to Michelangelo, not only in his draftsmanship but in his practice of making small clay reliefs and busts to help him visualize the three-dimensional shape. Cast into bronze after his death, these sculptures became highly prized by collectors.

It is ironic that Balzac did not know Daumier as a painter, for here his reference to Michelangelo would have been especially appropriate. Daumier did not begin to paint until 1848; there were few oils by 1850, when Balzac died, and none of these can be called characteristic. Most of his painting was done between about 1855 and 1870, when his connection with *Le Charivari* was interrupted for long intervals. None of his oil paintings, so far as is known, was done on commission. In 1872 he began to lose his eyesight and by 1878 he was a pauper, totally blind. An exhibition organized in that year by the dealer Durand-Ruel and by such painter friends as Corot and Charles Daubigny had little effect because the public was not prepared to find in a caricaturist the equal of a Molière or of a Cervantes—writers whose themes and characters increasingly absorbed Daumier as a painter. He died in Valmondois on Feb. 10 or 11, 1879.

After his death, however, the demand for Daumier's paintings soon exceeded the limited supply. This stimulated the activity of many forgers, some of them able. The first major one-man exhibition of Daumier's work in America (1937) was accompanied by scientific examination through such techniques as infrared and X-ray photography and a basis was established for identifying paintings and drawings for which he was not responsible.

Among Daumier's masterpieces in oil, "Crispin and Scapin" (Paris), "The Melodrama" (Munich), "Don Quixote and Sancho Panza" (Berlin) and "Third Class Railway Carriage" (New York) may be cited.

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DAUN (DHAUN), **LEOPOLD JOSEPH,** GRAF VON (1705–1766), Austrian field marshal and commander in chief during the Seven Years' War (1756–1763), was born in Vienna on Sept. 24, 1705. He was the son of Wierich Philipp, Graf von Daun, an officer of the Austrian army. As a young and middle-aged man he saw service in many campaigns under a variety of conditions—in Sicily (1718), in Italy during the War of the Polish Succession (1734–35), in the Turkish campaigns of 1737–39 and in the War of the Austrian Succession both against the Prussians in central Europe (1740–42) and against the French in the Netherlands (1746–48). This wide experience of war made him well qualified to reorganize and modernize the imperial army, as he did, before being promoted to field marshal in 1754.

Daun greatly distinguished himself in the Seven Years' War. After the defeat of the Austrians under Graf von Browne near Prague in June 1757, he was instrumental in retrieving the situation by driving Frederick the Great toward Kolin and forcing him to evacuate Bohemia. On Oct. 14, 1758, he won another success over Frederick at Hochkirch. In 1759 he achieved yet another victory, at Maxen, when he compelled the Prussian general Fink and some 11,000 men to capitulate. Daun's run of successes was now at an end. In 1760 he was heavily defeated by the Prussians and severely wounded at the battle of Torgau.

In 1762 he was made president of the Austrian war council and once again used his almost unique experience and talent to carry out various army reforms. At this time he devoted much attention to improving the military academy and to the training of potential officers.

Few men in history have had more battle experience than Daun. From 1734 to 1760 he was almost continuously on active service. He has been described as an adept at making the best of the resources at his disposal and seizing a fleeting opportunity to snatch a victory. He died on Feb. 5, 1766. (C. N. B.)

DAUNOU, PIERRE CLAUDE FRANÇOIS (1761–1840), French statesman, theorist of liberalism and historian, was born at Boulogne on Aug. 18, 1761. Educated at the local school of the Oratorians, he became an Oratorian himself in 1777, taught in Oratorian convents from 1780 and was ordained priest in 1787. In the opening stages of the French Revolution he defended the Civil Constitution of the Clergy, took the oath and was made vicar metropolitan of Paris. Elected to the Convention by Pas-de-Calais, he strongly opposed the king's trial, protested against the proscription of the Girondins, was imprisoned in Oct. 1793 but returned to the Convention in Dec. 1794. He was the chief author of the constitution of 1795 and founder of the Institut National, which replaced the academies suppressed in 1793. Deputy in the chamber of the 500 from 1795 to 1797 and from 1798 to 1799, he was sent in the interval to organize the Roman republic.

The *coup d'état* of 18 Brumaire (Nov. 9, 1799) was prepared chiefly by Emmanuel Siéyès, and it is uncertain whether Daunou had any part in organizing it, though he was certainly a sympathizer. On 19 Brumaire he was elected to the commission of 25, which was to replace the 500. He then became a member of its constitution section, which joined with the corresponding section of the commission of the *anciens* and with the three provisional consuls to produce a draft constitution on the lines envisaged by Siéyès; A. H. Taillandier later published this draft as being Daunou's work entirely, but it was not, though it owed much to him. Subsequently the two commissions and the consuls together produced the constitution of the year VIII (Dec. 1799), to which Daunou subscribed with the rest of the commissioners.

Having entered the *tribunat*, Daunou favoured the administrative reforms of Feb. 18, 1800, but opposed the establishment of special tribunals without juries to deal with crimes of brigandage (armed insurrection) in 1801 and was excluded from the *tribunat* in 1802. His history is that of many discontented *Brumairiens* who became the adversaries of a regime they had unwittingly helped to set up.

Daunou had directed the Panthéon library (now the Bibliothèque Ste. Geneviève) since 1797 and was director of the national archives from 1804 to 1815. During this period he published his *Essai historique sur la puissance temporelle des papes* (1810), in support of Napoleon against Pius VII. Under the Restoration he became director of the *Journal des savants* (1816), professor of history and ethics at the Collège de France (1819), deputy (1819–23 and 1828–34) and director of the archives again (1830–40). He was made a peer of France in 1839. He died in Paris on June 20, 1840. Having no religious beliefs, he was buried at his own wish without any religious ceremony.

Daunou's *Essai sur les garanties individuelles* (1818) deserves to be included among the great books of liberalism. In it he contends that the criterion of a government's goodness or badness is the presence or absence of certain guarantees of individual liberty: namely, security of the person, with juries drawn from a wide range of classes and no secret police; no excessive taxes on property; no corporations to hamper industry; liberty of opinion and of the press; and liberty of conscience in religion. He also wrote numerous articles for the *Histoire littéraire de la France*, vol. xiii–xxi, on 12th- and 13th-century writers. His lectures at the Collège de France were published after his death as *Cours d'études historiques*, 20 vol. (1842–46).

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DAUPHIN, the title of the heir apparent to the French crown from 1350 to 1830, was acquired by the royal house of France through the future Charles V's purchase of Dauphiné (*q.v.*) in 1349. (For the dauphins of Auvergne *see* below.)

The title dauphin was derived from the personal name Dauphin, which occurs in western Europe in various forms (Dalphinus, Delfinus, Dolfin, etc.) from the end of the 4th century A.D. The first ruler of Viennois to bear this name was Guigues IV Dauphin (12th century). An unusual name, it was borne so regularly by his

successors that it came to be taken for a title peculiar to rulers of Viennois: a formula such as *Dalphinus Viennensis et Albonensis comes* could easily be understood as meaning "dauphin of Viennois and count of Albon" instead of "Dauphin, count of Viennois and of Albon." By the end of the 13th century the titular use of the word was established, and the aggregate of fiefs held by the dauphins was called the delphinate or Dauphiné (Dalphinatus). Charles of France, having become dauphin of Viennois in 1349, became heir apparent to the French crown on his father John II's accession to it in 1350. King of France himself in 1364, Charles granted Dauphiné to his son, the future Charles VI, in 1368 and so established the precedent whereby the French king's eldest son became dauphin.

In Auvergne, the count Guilhem VII the Young, son-in-law of Guigues IV Dauphin of Viennois, gave the name Dauphin to his own son. This Dauphin in 1169 secured his succession to the little territory that his father had been able to keep from Guilhem VIII (*see* AUVERGNE). As in the case of Viennois, so here this territory came in the 13th century to be called the delphinate or Dauphiné d'Auvergne. Through the marriage (1428) of the dauphine Jeanne, it passed in 1436 to the house of Bourbon-Montpensier. Seized by Francis I of France in 1523 but restored to the Montpensiers in 1561, it finally passed to the French crown in 1693.

From 1436 to 1693, to distinguish them, the dauphin heir to the French crown was occasionally called *le roi dauphin* (king dauphin) and the dauphin of Auvergne *le prince dauphin,* as the Montpensiers were French princes of the blood.

DAUPHINÉ, an old province of France, bounded on the west by the Rhône, on the extreme northwest by Lyonnais, on the north by Dombes and by Bugey, on the northeast by Savoy, on the east by the Alps and on the south by Provence and by the Comtat-Venaissin; and corresponding to the modern *départements* of Isère, Drôme and Hautes-Alpes.

The nucleus of the province was the countship of Viennois, the country round Vienne on the left bank of the Rhône. In 1029 or 1030 the southern part of this countship was enfiefed to Guigues de Vion, count of Albon, who is reckoned as Guigues I of Viennois. Profiting from the loose control exercised by the Holy Roman emperors over the kingdom of Arles (*q.v.*), Guigues I extended his domain to include first Briançonnais (Briançon and its hinterland) *c.* 1040, then Grésivaudan (the country round Grenoble) by 1050. His great-grandson Guigues IV Dauphin, count from 1133 to 1142, the first to bear the name that was to distinguish his successors (*see* DAUPHIN), was killed early in the first major war between Viennois and Savoy. The last of the male line of Albon, Guigues V, was succeeded in 1162 by his son-in-law Hugh of Burgundy. Hugh's son André Dauphin (d. 1236), otherwise called Guigues VI, acquired Embrunais and Gapençais (round Gap) by marriage in 1202. Guigues VII (d. 1270) likewise acquired Faucigny, but this lay far to the northeast beyond the territories of the counts of Savoy, with whom a series of wars about it naturally ensued. Jean I, last of the Burgundian line, was succeeded in 1282 by his brother-in-law, Humbert I, of the house of La Tour du Pin. By the end of the 13th century the name Dauphin, now traditional in the ruling house of Viennois, had been transformed into a title, dauphin, and the aggregate of fiefs held by them was being called Dauphiné.

The dauphins of the house of La Tour du Pin extended their lordship in the west along the Isère river and in the southwest to Nyons and Le Buis. They also developed governmental and judiciary institutions, but the Savoyard wars and the lavish expenditure of Humbert II, dauphin from 1333, exhausted their financial resources. Finally, in 1349, Humbert II (d. 1355) effected the so-called "transport," in fact the sale, of Dauphiné to the future Charles V of France. In 1355 the treaty of Paris settled the principal dispute with Savoy by the exchange of remote Faucigny for various Savoyard enclaves in Viennois.

Charles of France was the first to convene the provincial estates of Dauphiné (1357). He also began the practice whereby the kings of France ceded Dauphiné to their heir apparent. In 1378, moreover, the Holy Roman emperor Charles IV granted to the dauphin the imperial vicariate over the kingdom of Arles. This act enhanced French authority in the area, but left open the question whether Dauphiné was to be part of the French kingdom or a distinct territory.

The acquisition of Valentinois and Diois from the house of Poitiers-Saint-Vallier by legacy (1419–26) and of certain papal rights over Montélimar by exchange (1447), followed by the exaction of homage for the town of Vienne itself from the archbishop (1450), gave Dauphiné at last a continuous frontier along the Rhône from north to south.

The dauphin Louis II, later Louis XI (*q.v.*) of France, established the *parlement* of Dauphiné (1453) in the place of the delphinal council. He tried, however, to exploit his territory's quasi-independent status in his quarrels with Charles VII of France, who had finally to annex Dauphiné to France in 1457.

In the 16th century Guillaume Farel spread Protestantism in Dauphiné, and the baron des Adrets (François de Beaumont) made himself notorious for his atrocities in the civil wars, first on the Protestant side, then on the Catholic. François de Bonne, duc de Lesdiguières (*q.v.*), a partisan of Henry IV, was governor from 1591 to 1626.

The estates of Dauphiné were suspended by the French government in 1628. A meeting at Grenoble in June 1788, followed by the unauthorized assembly of the estates at Vizille on July 21, was one of the immediate causes of the convocation of the estates-general, which led to the French Revolution of 1789.

See F. Vernay, *Nouvelle histoire du Dauphiné* (1933); G. Le Tonnelier, *Histoire du Dauphiné,* 2nd ed. (1958), with bibliography.

DAVAO, the second largest of the Philippine provinces. Area, 7,529 sq.mi.; pop. (1960) 903,224. The Spanish were never able to pacify the Moro and pagan tribes of the area, and development began after 1914 with the influx of settlers from the central islands. In the late 1950s more than half the population were Cebuano speaking. Japanese development of abacá (Manila hemp) plantations began during World War I, reaching a peak in 1939 when over 15,000 Japanese resided in the province. In 1945 the Japanese plantations were confiscated and distributed to Filipino smallholders who replaced much of the abacá with food crops, but the province remains by far the leading abacá producer of the Philippines. A new highway to the north coast of Mindanao was completed in 1957, opening up the interior for settlement by Visayan islanders.

DAVAO, the provincial capital, is located in S.E. Mindanao Island, near the head of Davao gulf. The city was chartered in 1936, with an area of 748.4 sq.mi., in order to include a population large enough to warrant a charter, and in 1958 comprised one urban and ten rural districts. Pop. (1948) 111,263; (1960) 231,833. Almost completely destroyed during World War II, the rebuilt Davao is an attractive city, an important port for inter-island shipping, and a lesser foreign trade port. It ships abacá both to Manila and abroad, has considerable passenger traffic, and ships copra, maize and rice to Cebu. (J. E. SR.)

DAVENANT (D'AVENANT or D'AVENANT), **SIR WILLIAM** (1606–1668), English poet laureate, playwright and theatre manager who presented the first English opera. He was baptized on March 3, 1606 (new style; 1605, old style), at Oxford. William Shakespeare was apparently his godfather, and gossip suggested that Davenant was actually Shakespeare's son, a story which in 1913 caused Arthur Acheson to identify his vivacious mother, Jane, as the "dark lady" of the Sonnets.

After a smattering of an education under tutors connected with Balliol and Lincoln colleges, in 1622 Davenant became a page in London, first to the widowed duchess of Richmond and then to the famous literary courtier Fulke Greville, Baron Brooke. In Brooke's household he wrote his first plays; tragedies of revenge such as *Albovine* and *The Cruel Brother* and tragicomedies such as *The Colonel* and *The Just Italian.* After experience in the continental wars, his engaging and reckless personality and his plays and occasional verses attracted the attention of Queen Henrietta Maria herself. By 1630 he was signing himself "Servant to Her Majesty." Acquiring other famous patrons, as well as a wife and debts, he became a candidate for the office of poet laureate on the death of Ben Jonson in 1637, but in spite of the success of his

popular comedy, *The Wits* (licensed 1634), of the tragicomedy, *Love and Honour* (1634), of masques such as *The Temple of Love, Britannia Triumphans* and *Luminalia,* and of his little volume of poems, *Madagascar* (1638), the king delayed his appointment until late in 1638. Before that Davenant, as a result of a brawl arising from insults about the disfigurement of his nose (a result of syphilis), had killed a tavern servant and had been briefly exiled to the continent.

His success as a writer and his royal patent to erect a new theatre based on continental models were interrupted by the outbreak of the Bishops Wars, in which he risked his life in the bungled army plot of 1641. When the Civil War broke out in 1642, he was rewarded by being appointed lieutenant general of the ordnance under the duke of Newcastle. In 1643, in recognition of his adventures running supplies and munitions across the channel, he was knighted near Gloucester. After the parliamentary victory Davenant joined the exiled court in Paris. There he began his uncompleted romantic epic, *Gondibert* (1651), with its important critical preface. After the execution of Charles I, the queen resolved to send Davenant to aid the royalist cause in America, as lieutenant governor of Maryland. Davenant's ship was captured, however, and he was imprisoned in the Tower until 1654.

As soon as he was able to settle his affairs in France, Davenant turned to his old love, the theatre. In May 1656 he presented in the hall of his home, Rutland house, Aldersgate, London, *The First Day's Entertainment,* the first real attempt to bring back the drama banned under Cromwell's regime. This successful disguise of the drama as "Declamations and Musick" encouraged him later in the same year to offer publicly the first opera in England, *The Siege of Rhodes. Made a Representation by the Art of Prospective* [sic] *in Scenes and the Story Sung in Recitative Musick.* In it he introduced three important innovations to the English public stage: an opera, painted stage sets and a female actor-singer.

Before the Restoration Davenant presented other operas under similar circumstances; after it, late in 1660, he and his rival, Thomas Killigrew, were granted royal monopolistic patents to establish new acting companies, including women as well as men. Davenant's theatre, finally settling in its new building in Lincoln's Inn Fields, was called the Duke of York's playhouse. As manager, director and playwright, Davenant continued to produce his own plays, his operas, his adaptations of Shakespeare and works by new authors until his death in London, April 7, 1668.

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DAVENPORT, CHARLES BENEDICT (1866–1944), American zoologist, made valuable investigations in the breeding of animals and in the heredity of eye, hair and skin colour and temperament, stature and build in man. He was born at Stamford, Conn., on June 1, 1866. He was educated at Brooklyn Polytechnic institute and at Harvard. After serving as assistant and instructor in zoology at Harvard in 1888–99, he was assistant and associate professor of zoology and embryology at The University of Chicago from 1899 to 1904. He was then made director of the station (at Cold Spring Harbor, L.I., N.Y.) for experimental evolution of the Carnegie Institution of Washington, in which he became the director of the eugenics record office and of the department of genetics (1904–34).

Davenport was the author of a number of works on biology and genetics. He died Feb. 18, 1944, at Huntington, L.I.

DAVENPORT, EDWARD LOOMIS (1815–1877), U.S. actor, born in Boston, Mass., on Nov. 15, 1815, made his first appearance on the stage in 1837 at Providence, R.I., in support of Junius Brutus Booth. Afterward he went to England, where he supported Anna Cora Mowatt (Ritchie) (1819–70), William Macready and others. In 1854 he was again in the United States, appearing in Shakespearean plays and in dramatizations of Dickens' novels. As the thief Bill Sikes in *Oliver Twist* he was especially successful and his Sir Giles Overreach, the villain in Philip Massinger's *A New Way to Pay Old Debts,* and Brutus were also greatly admired. He died at Canton, Pa., on Sept. 1, 1877. In 1849 he had married Fanny Vining (Mrs. Charles Gill) (d. 1891), an English actress also in Mrs. Mowatt's company.

Their daughter FANNY (LILY GYPSY) DAVENPORT (1850–98) appeared in New York city at the age of 12 as the king of Spain in *Faint Heart Never Won Fair Lady.* Later (1869) she was a member of Augustin Daly's company in New York, and afterward, with a company of her own, acted with success in Victorien Sardou's *Fédora* (1883), *Cleopatra* (1890) and similar plays. She died at South Duxbury, Mass., on Sept. 26, 1898.

DAVENPORT, a city of Iowa, U.S., and seat of Scott county, is on the Mississippi river opposite Rock Island and Moline (*qq.v.*), Ill. Situated on the slope of a bluff, it commands an extensive view of the river. The region first attracted white settlers in 1808. Credit Island, now a park, was a battlefield in the War of 1812. Fort Armstrong was established on Rock Island in 1816. Antoine LeClaire, an army interpreter of French-Indian ancestry, acquired the site of Davenport after the Black Hawk treaty of 1832. He in turn sold it to a fur company headed by an Englishman, Col. George Davenport, who had settled in the area. The land was surveyed privately in 1835–36; the town was incorporated in 1839 and was chartered in 1843 and again in 1851. The strategic location of the city, together with the development of both river and rail transportation, assured its economic growth. The first railroad bridge to span the Mississippi river was opened to traffic there in 1856. The Rock Island arsenal, one of the world's largest, was established on the island in 1861. Products manufactured, some in the industrial suburb of Bettendorf, include: agricultural implements, aluminum sheets and plates, cement, gas and diesel engines, lumber and timber products, processed foods, washing machines and pumps.

St. Ambrose college for men (founded 1882) and its co-ordinate, Marycrest college for women (founded 1939), are maintained by the Roman Catholic Church. St. Katherine's, a preparatory school for girls, is supported by the Protestant Episcopal Church. There are 1,155 ac. of parks, including Antoine LeClaire park and Fejervary park, and playgrounds.

Mid-19th century immigration was mainly German, and from 1900 to 1950 the population more than doubled, reaching 74,549. Pop. (1960) 88,981; Davenport-Rock Island-Moline standard metropolitan statistical area (Scott county, Ia., and Rock Island county, Ill.), 270,058. For comparative population figures *see* table in IOWA: *Population.* (P. W. GL.)

DAVENTRY, a market town and municipal borough of Northamptonshire, Eng., lies 12 mi. W. of Northampton by road. Pop. (1961) 5,860. An agricultural centre, Daventry is situated on a sloping site in rich undulating country. Borough hill, adjoining it to the east, is the site of a vast ancient earthwork, and other remains have been found in the vicinity at Burnt Walls. Daventry grammar school was founded in 1576; the parish church of Holy Cross was rebuilt in 1752.

The chief industries of the town are the manufacture of boots and shoes, light engineering and the making of roller bearings. Daventry became an important radio centre after 1925, when the British Broadcasting corporation set up a high-power long-wave station on Borough hill. In 1927 a second, medium-wave station was built for the Midland Regional program. These stations were superseded in 1934 by transmitters at Droitwich. By 1932 the BBC had begun regular services to the commonwealth using short-wave transmitters at Daventry. Overseas broadcasting increased after World War II and by 1956 there were ten transmitters serving all parts of the world.

Nothing is known of Daventry itself until the Domesday survey, when the manor consisting of eight hides was held by the countess Judith, the Conqueror's niece, as the widow of Waltheof, the last native earl of Northumbria, who at the Conquest held the great midland earldom of Huntingdonshire and Northamptonshire. Before the end of the century it had passed to Simon de St. Liz, whose grandson Walter Fitz-Robert held it "of the fee of the king of Scotland," then possessed of the earldom of Huntingdon (*see* HUNTINGDON AND PETERBOROUGH; NORTHAMPTONSHIRE). Daventry was created a borough by King John, who granted to Simon, son of Walter, a market on Wednesday and a fair on St.

Augustine's day, which is still held in October. There is no extant charter before that of Elizabeth I in 1576, by which the town was incorporated under the name of the bailiff, burgesses and commonalty of the borough of Daventry. James I confirmed this charter in 1606, and Charles II in 1674 granted a new charter. During the Civil War Daventry was the headquarters of Charles I immediately before the battle of Naseby. The last remains of the Cluniac priory endowed by Simon de St. Liz were removed during the 19th century.

The pronunciation of Daventry as "Dane-tree," sanctioned by ancient local usage (*cf.* Shakespeare's "Daintry," *Henry VI*, part iii, act v), is referred by tradition to the building of the town by the Danes. Though the written element affords no definite proof of early pronunciation, the spelling "Daventrei" in Domesday is explicit, and in the legend of a seal of the Prior Nicholas (1231–64) "Davintre" is given (*Victoria County History, Northampton*, vol. ii, 1906).

DAVID (Dewi), **SAINT** (d. *c.* 600), the patron saint of Wales. Little is known of his life. According to the genealogists he was the son of Sant, a prince of the line of Cunedda, his mother being St. Non. He seems to have taken a prominent part in the celebrated synod of Llanddewi-Brefi and to have presided at the so-called Synod of Victory held later at Caerleon-on-Usk. Legend asserts that he moved the seat of ecclesiastical government from Caerleon to the remote headland of Mynyw or Menevia, which is still, under the name of St. David's (Ty-Dewi), the cathedral city of the western see. St. David founded numerous churches throughout south Wales (more than 50 still recall his name), but apparently he never penetrated farther north than the region of Powys, although he seems to have visited Cornwall. His shrine at St. David's became a notable place of pilgrimage. His formal canonization by Calixtus II about 1120 is not proved. His feast day is March 1.

See *Butler's Lives of the Saints*, ed. by H. Thurston and D. Attwater, vol. i, pp. 449–451 (1956). (X.; Pl. Gn.)

DAVID, founder and first ruler of the united kingdom of Israel and Judah, was a native of Bethlehem, a town in the territory of Judah. He was the youngest son (I Sam. xvi, 11; xvii, 12–16) of Jesse, who is described as an "Ephrathite," probably referring to the region of Judah bordering on Benjamin, including Bethlehem. During his reign, which began about 1000 B.C. and lasted approximately 40 years, David not only united the land and people of Israel under a single crown but also created an empire extending far beyond its borders. Though the empire was short-lived, David and his lineal heirs ruled in Jerusalem for over 400 years, until Nebuchadrezzar destroyed the city, and his name and throne became symbols of Israel's messianic hope. David's career coincided with a creative period in Israel's cultural development, well illustrated by the beginning of history writing. I Sam. xvi–II Sam. v, which relate the story of David's rise to power, contain many early narratives; and in II Sam. ix–xx and I Kings i–ii is found an account of the family history of David and of Solomon's succession that is nearly contemporary with the events it reports.

In Saul's Service.—The excavations at Mari (Tell el Hariri, on the Euphrates) show that the term *davidum* served as a title for a military marshal. It has been suggested that David's original name was something else, perhaps Elhanan (II Sam. xxi, 19), and that he is known to history only by his title as military leader.

David began his career as an aide at Saul's court. Whether he was brought to Gibeah for his gifts as a musician, as one tradition reports (I Sam. xvi), or whether he won his place, including the promise of marriage to a royal princess, by his victory over Goliath (I Sam. xvii), it was his prowess as a warrior that caused his advancement and also his conflict with Saul. The king was faltering as a leader and the Philistines were soon to overrun all Israel west of the Jordan; the story of David is simultaneously the story of the extinction of the rule of Saul's house and of the decline of the Philistines. Saul's son Jonathan freely abdicated his royal and military prerogatives and facilitated David's appointment as head of the royal guard (I Sam. xviii, 1–5). Saul, like Jonathan, also sensed that David would succeed him, and, despite his genuine affection for David, this prospect and David's popular success provoked in Saul an envy and hatred that caused him to plot the death of the young hero. Forewarned by Jonathan, David fled Saul's court.

Outlaw and Adventurer.—David is a classic example of the public figure who combines adherence to principle and basic aims with flexible and practical political action. The accounts of his slaying of Goliath with a sling and of his doubling the bride price for Michal (I Sam. xviii, 20–27) show that from the very first he was endowed with political shrewdness and with a capacity for public drama. His years as an outlaw in the Judean desert and as a refugee at the court of Achish of Gath stimulated the development and ripening of these gifts. He was without legal protection, and his physical safety often depended on his use of his wits. To become a political and military force David had to win the loyalty of clan heads and towns that owed nominal allegiance to Saul but that were proudly independent and properly concerned with their own interests and welfare.

The arid ranges and steppes of Judah formed a frontier region, a no-man's land where Saul's authority was ineffective. In his flight southward David stopped at the priestly shrine of Nob, probably located northeast of Jerusalem on what is now known as Mt. Scopus. Implying that he was on a mission for Saul, he obtained food and the sword of Goliath from Ahimelech the priest. But the priest's hospitality was reported, and the king commanded the massacre of the entire priestly community; only Abiathar was able to escape and join David in the wilderness, thus beginning a service that endured as long as David lived.

David first sought refuge in the Philistine city of Gath, but since he was not welcome (I Sam. xxi, 10–15) he returned to the Judean wilderness, with his first headquarters in the cave of Adullam. There he launched his own political movement. "And every one who was in distress, and every one who was in debt, and every one who was discontented, gathered to him; and he became captain over them" (I Sam. xxii, 2); that is, he was the chieftain of refugees and outlaws like himself. To keep together this band of adventurers, numbering from 400 to 600 men, David became a sort of Robin Hood, offering help to the injured and protection to the wealthy, hoping thus to provide for his men and win a following. But in this role he was often rebuffed. Having gone to relieve the town of Keilah from the raiding Philistines, and having succeeded, he was nevertheless warned that the town would turn him over to Saul (I Sam. xxiii, 1–14). In the desert of Paran, David sent a deputation to Nabal, a wealthy herdsman, to ask that his men be allowed to share the food and drink of the sheepshearing feast, inasmuch as they had respected the property of Nabal (I Sam. xxv). Nabal interpreted the request as blackmail and rejected it; but his wife Abigail, recognizing that her husband had delivered an insult that would lead to bloodshed, offered hospitality for David's band. David interpreted the sudden death of Nabal as a sign of divine vengeance; and his marriage to Abigail marked a first step in the knitting together of the southern clans under his banner.

His position, however, remained insecure, as is indicated by the fact that he again sought, and this time received, the protection of Achish of Gath, though the Philistine nobles, mindful of his record as their enemy, vetoed their king's plan to use David as his bodyguard in his campaign against Saul (I Sam. xxix, 1–5). Probably much relieved, David returned to his Philistine residence of Ziklag to discover that it had been looted by the Amalekites, against whom he had himself raided periodically. He now pursued and overcame them, restoring all persons and property taken from Ziklag and taking great loot in addition. This he distributed judiciously among "the elders of Judah" in "all the places where David and his men had roamed" (I Sam. xxx, 26–31), thus quietly advancing his plans in the very days of Saul's last, fatal battle.

King and Emperor.—David's success as a builder of political power rested on his political realism and foresight. He could bear temporary hardships, setbacks and even insults for the sake of long-range objectives. He knew how to put all sorts of groups in his debt. Training himself in patience, he attempted at all

costs to avoid shedding the blood of any Israelites, knowing it would hurt his program of unification. He used his sincere convictions to obtain political results, yet without becoming cynical. Thus he dramatized his belief in the sacredness of the royal person to impress the following of Saul (I Sam. xxiv, 6; xxvi, 9 ff.). His deeply moving elegy (II Sam. i, 19–27) not only voiced his grief but also served to conciliate the tribes bound to the house of Saul. And his message of gratitude to Jabesh-gilead for the burial of the royal dead was at the same time an advertisement of his own rule, newly established at Hebron (II Sam. ii, 5–7). He was able to dramatize his hatred of treachery so well that the treacherous slaying of Abner by David's commander Joab did not fatally damage the successful outcome of the long and delicate negotiations leading to the union of north and south (II Sam. iii, 22–39). The character traits and the methods of practical action which years as a fugitive had perfected in David guided him consistently in all his years as a ruler.

When the Philistines slew Saul on Gilboa they almost extinguished the political power of his house. They overran all territory west of the Jordan, and Israel's government, now in the weak hands of Ishbosheth, Saul's son, supported by Abner, was established at Mahanaim. David's first aim was to unite all Israel under his rule. Judah, whose leaders he had so carefully cultivated, proclaimed him king; and Hebron became his capital for about seven years. During this period David bided his time while the dissolution of the house of Saul proceeded. Abner had slain Asahel, brother of Joab, thus creating a feud between the two military leaders. But Abner nevertheless made overtures to David for a "covenant" (II Sam. iii, 12) under which he would deliver the northern tribes to David. Joab's murder of Abner jeopardized the agreement. David publicly condemned Joab's deed, and waited. Sedition in Mahanaim cost Ishbosheth his life, leaving the northern tribes without alternative. They came to Hebron where David was anointed king over all Israel (II Sam. v, 3).

Having been proclaimed king, David had to rid the land of the Philistine menace. The decisive campaigns were fought west of Jerusalem, "from Geba to Gezer" (II Sam. v, 25), in the region that separated Judah from the northern tribes.

These victories over the Philistines apparently followed immediately after his conquest of the citadel of the Jebusites, the walled city of Jerusalem. This constituted a barrier between the south and the north, and it was David's plan to make this neutral location, the "city of David," the capital of the united kingdom he had founded. The citadel occupied an almost impregnable position, but David circumvented this difficulty by having his men enter the city through a water tunnel, which began outside the walls and connected with a vertical shaft inside the city (II Sam. v, 6–10). This stratagem apparently came as a complete surprise to the Jebusites, and the city was surrendered without a battle. David took wives and concubines from the conquered city (II Sam. v, 13), thus confirming his rule over it. With the aid of Hiram of Tyre he built a palace.

David recognized that to make Jerusalem the real centre of loyalty for all Israel it was necessary to make it a symbol of religious significance as well. This presented serious difficulties for, while there were many sacred sites in the land made venerable by Israel's worship of the Lord, the newly conquered site of Jerusalem held no sacred associations of any sort. To meet this problem David brought the ark to Jerusalem.

The ark was a very ancient symbol of the presence of God in the midst of the community of Israel, probably dating back to the nomadic era. Israel believed that by means of it God led her in the wilderness (Num. x, 35 ff.) and fought in her behalf in battle (I Sam. iv, 1–9). It had stood in the shrine at Shiloh, but when the Philistines destroyed Shiloh they took the ark as loot. After its return it had stood in Kiriath-jearim, in a shrine provided by Abinadab (I Sam. vii, 1–2). In bringing it from there to Jerusalem, Uzzah, a son of Abinadab, suffered sudden death, which was interpreted as punishment for his having stretched out unhallowed hands to touch the sacred object. For a time David was overcome with awe and afraid to proceed with his plan. The ark was placed in the house of Obed-edom. After three months David heard that the presence of the ark had brought blessings to Obed-edom, and, with sacrifices and formal acts of reverence, the ark was brought up Mt. Zion and installed in the tent. In these ceremonies David himself offered the sacrifices, led the sacred dance and blessed the people. David was clearly the leading spirit in the establishment of the Jerusalem cultus. As such he naturally served as the patron of psalmists in the centuries that followed. There is, moreover, no reason to doubt that he was himself an author of psalms used in worship (*see* PSALMS, BOOK OF).

David made very practical political use of the ark and of the worship connected with it. But this is not to impugn either his deep reverence for it or the sincerity of his personal faith in the God of Israel. The episode simply illustrates that the characteristic qualities of his personality, already noted in connection with his political activity, are also reflected in his religious life. David believed that God had made a "covenant" with him; that is, that in the person of David, as king, God acted to mediate his power and blessing to fulfill the destiny of Israel, and that this covenant included all David's royal heirs to come until God's promise to Israel was realized. At the same time, as the conclusion of the story of his affair with Bathsheba illustrates (II Sam. xii), he was keenly aware that he was responsible for his own deeds and that these were subject to the judgment of God.

Having unified Israel, overcome the Philistines and established a political and religious capital, David proceeded to build an empire. He conquered and occupied the kingdoms of Edom and Moab, east of the Jordan. Farther north in Syria, he installed garrisons at strategic points, notably in Damascus, and created a series of tributary states. It has been estimated that his non-Israelite subjects were more numerous than the Israelites and that his territory extended from the upper Euphrates to the Gulf of Aqaba. David's was the only empire ever to rise in Palestine, a geographical region not intended as a centre of empire but rather as a bridge between empires. The fact that it did not long outlast David offers additional tribute to the skill of its builder.

Domestic Problems.—David's great success as warrior and empire builder was marred by family dissensions and political revolts. The two were interrelated in many ways and both were in large measure the result of the social and cultural transition exhibited and furthered by the establishment of a central political monarchy in Israel.

To tie together the heterogeneous elements of his kingdom, David took wives from them and created a harem. David's family represents an extreme departure from the family in the consanguineal context of a clan structure. In such a society the rights and status of the members of a given family were determined by the unchanging traditions of the clan life and by the place of a given family in the hierarchy of the clan. Moreover, even if a man had several wives, these normally came out of a common context in clan or tribe. David's wives, on the other hand, were mostly completely alien to one another, and his children were without the directing support of established social patterns that provided precedents for the resolution of conflict. The point is often made that in family quarrels, such as that between Ammon and Absalom, David was indecisive or "indulgent." But considering the policy of watchful waiting that governed his political program, it may be suggested that David lived by the same qualities and principles in relation to his family, although the results were not so salutary as they were in the arena of statecraft. For example, the problem of the succession did not take care of itself as helpfully as had the problem of the throne of Saul.

The revolts, first of Absalom and then of Sheba, also imply a rapid social and cultural transition that was beginning to meet resistance. To further his conspiracy, Absalom sought direct personal contact with the heads of clans (II Sam. xv, 1–6), reviving a royal practice of David's earlier years that had fallen into disuse with the establishment of a state bureaucracy. The revolt of Sheba (II Sam. xx) contained elements of northern, especially Benjaminite, resistance to the rule of David; it anticipated the breakup that was to come at the end of the reign of Solomon, David's son and successor.

Messianic Symbol.—Under David, Israel enjoyed military and

political achievement greater than in any subsequent era. As king, David was "Messiah" ("anointed"), the vicegerent of God through whom God mediated his salvation and blessing to Israel. Israel lived by the "promise" of God to Abraham. This promise was variously defined in detail but was always summed up by the word "peace"; and this included the most complete material and spiritual well-being for Israel. The full realization of the promise would be the arrival of the Kingdom of God on earth. Israel's prophets used the great era of David as an illustration of the time of fulfillment for which they waited and prayed. Often their expectation included the coming of a Messiah (*q.v.*), a lineal "son of David" by means of whom God would bring in his kingdom; for they took seriously the promise to David (II Sam. vii. 16) that his house would "be established for ever." In the New Testament Jesus is called "son of David" and "Messiah," showing that the Christians believed that in him the promises to Abraham and David had been fulfilled and that the rule of God had come, though the form of these promises was sharply redefined.

See also references under "David" in the Index volume.

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DAVID I (*c.* 1082–1153), king of the Scots from 1124 to 1153, brought Scotland to a zenith in its power. The sixth and youngest son of Malcolm III and St. Margaret, he spent much of his early life at the court of Henry I of England, who married his sister. He is said to have been left southern Scotland by his brother King Edgar when the latter died in 1107, but it was probably a few years later that David, with Anglo-Norman help, secured from another brother, King Alexander I, the right to rule Cumbria, Strathclyde and Lothian south of Lammermuir. Through his marriage with Matilda, daughter of Waltheof, earl of Northumbria, he was already earl of Huntingdon and held extensive lands in that county and in Northamptonshire. When Alexander I died in April 1124, David succeeded as king of Scots.

His relations with England were governed by the oath he took in 1126 or 1127 recognizing the empress Matilda as heir to Henry I. David seized Cumberland and Northumberland in 1136 and his subsequent warfare on behalf of Matilda was an attempt both to secure the English throne for her and Northumberland for the king of Scots. He was prepared to sacrifice the former to the latter aim; a short-lived peace with King Stephen in 1136 gave him Cumberland and the earldom of Huntingdon for his son Earl Henry. He again invaded in 1137, and was defeated at the battle of the Standard at Northallerton (Aug. 22, 1138), but in the following year Northumberland was also conceded to Earl Henry by King Stephen. David again entered the war on Matilda's side in 1141, and her son Henry Plantagenet (afterward Henry II) was knighted by him at Carlisle in 1149, acknowledging David's right to Northumberland. The claims of Earl Ranulf of Chester to Cumberland were bought off when King David conceded to him the honour of Lancaster, acquired by unknown means in 1141.

In Scotland David I effected a revolution. Probably at his enthronement he granted to Robert de Bruce, a Yorkshire baron, the territory of Annandale. Already many men of Anglo-Norman extraction had come to serve David as ruler of Cumbria, and their numbers grew after he became king. Not all stayed, and of those who did, not all founded Scottish families. But although the native aristocracy was not apparently dispossessed, by marriage to them and by grant from the royal demesne a new Anglo-French aristocracy was established in Scotland. Bruce, Stewart, Melville, Corbet, Riddel, Gifford, Oliphant, Comyn are family names whose earliest bearers came to Scotland from England in the time of David I; they had come to England a generation or so earlier from northern France. Most received lands, usually scattered rather than consolidated, south of the Forth, and some at any rate held them in return for military service. None was made earl, but so pervasive was French culture as a result of this peaceful invasion that by the end of the 12th century the Celtic and Anglian were indistinguishable from the French aristocracy in speech, manners and life. Royal castles were built and in them appeared the first sheriffs, around them grew the first burghs. A rudimentary central administration was created and, perhaps the most significant feature of Scotland's emergence from the dark ages, a Scottish royal coinage made its first appearance.

In the ecclesiastical field, David restored the bishopric of Glasgow and probably several others including Dunkeld and Aberdeen. He cannot be shown to have founded any new sees, but most were void of pastors on his accession and held by clerics of non-Scottish origin on his death. The priory of Dunfermline existed but was perhaps deserted at his accession; the priories of Scone and Inchcolm had been founded by Alexander I, and the abbey of Selkirk was founded by David as earl. There were no other non-Celtic religious foundations in Scotland in 1124. King David founded the priories or abbeys of Coldingham (on earlier endowments), Melrose, Holyrood, Newbattle, Cambuskenneth, Dundrennan, Kinloss, St. Andrews and several others, mainly cells of lesser importance.

His only surviving son, Earl Henry, called "designated king" from 1144, died in 1152, leaving three sons. Of these the oldest became king of Scots as Malcolm IV, and the second, William (also later king), was earl of Northumberland when King David died at Carlisle on May 24, 1153. (A. A. M. D.)

DAVID II (1324–1371), king of Scots, son of Robert I the Bruce by his second wife, Elizabeth de Burgh, was born at Dunfermline on March 5, 1324, and on July 17, 1328, in accordance with the treaty of Northampton he married Joanna, sister of Edward III, at Berwick-on-Tweed. He succeeded his father on June 7, 1329, and was crowned at Scone in Nov. 1331, the first Scottish king to receive unction. The success of Edward Balliol and the disinherited barons at the battle of Dupplin (Aug. 1332), followed by Edward's coronation and the English victory at Halidon Hill (July 1333) led to his spending seven years in France, where Philip VI lodged him at Château Gaillard, contributing large sums for his maintenance. He joined Philip's fruitless campaigns of 1339 and 1340 against Edward III. By 1341 Scotland was liberated sufficiently for his return, but he showed little capacity for government, preferring to make futile raids into England. During the siege of Calais he responded to Philip's appeal for a diversion by leading a large army to disaster at the battle of Neville's Cross (Oct. 1346). Wounded and captured, he remained a prisoner, chiefly in the Tower of London, at Newcastle and at Odiham (Hampshire) until released in 1357 for a ransom of 100,000 marks to be paid in 10 years. This proved beyond the resources of Scotland, and David, now on cordial terms with Edward III, made several visits to London, partly for pleasure, partly in successful attempts to postpone payment. In 1363 he proposed the cancellation of the ransom in return for a son of Edward being declared successor to the Scottish throne, but this was repudiated by the Scottish parliament. Ultimately 76,000 marks were paid altogether. At home David had trouble with the nobles, especially with Robert Stewart, his nephew and heir, and the royal officials provoked complaints. His extravagance led in 1368 to some appropriation of supply by parliament, which in 1370 cancelled a proportion of his debts. In his reign parliament developed the use of judicial and legislative committees and burghal representation became regular. He built David's tower in Edinburgh castle and St. Monan's church in Fife. Having married, secondly, Margaret Drummond, widow of John Logy, in 1363, he divorced her six years later. Her appeal to the pope was pending when he died in Edinburgh castle on Feb. 22, 1371. (E. W.-M. B.-M.)

DAVID, the name of three Welsh princes, near descendants of Prince Owen Gwynedd, all of whom ruled in Gwynedd, the principal Welsh lordship which covered the greater part of North Wales.

DAVID I (d. 1203) was a son of Owen Gwynedd. When Owen died in 1170, David seized Gwynedd, entered into alliance with England, and in 1174 married Emma, half-sister to Henry II. This, however, did not shield him from the enmity of kinsmen who by Welsh custom had claims to portions of Gwynedd. He died *c.* May 1203, in England where he had been exiled since 1194 after the triumph of his nephew Llewelyn ap Iorwerth the Great.

DAVID II (*c.* 1208–1246) was a son of Llewelyn ap Iorwerth, and

through his mother Joan a grandson of King John. Although Gruffydd, a son by an earlier marriage, had a claim to at least a portion of Gwynedd, Llewelyn designated David as his sole heir in the hope of perpetuating the paramount position of his dynasty. Soon after his accession in 1240, however, David saw the achievements of his father's lifetime destroyed when his uncle, Henry III, forced him to submit on terms which included the transfer of Gruffydd from a Welsh prison to royal custody. But when Gruffydd broke his neck trying to escape from the Tower of London in 1244, David declared war on Henry, claimed to hold his lands in fee of the papacy, and assumed the title prince of Wales—the first recorded use of this style. David died on Feb. 25, 1246, at Aber, while hostilities were in progress, leaving no issue by his wife Isabella de Braose.

DAVID III (d. 1283) was a son of Gruffydd ap Llewelyn. David steadfastly opposed his brother Llewelyn who had assumed the mantle of Llewelyn ap Iorwerth. Rewarded by Edward I at the close of the Welsh war of 1277 with lands in northeast Wales, David was so angered by the oppressive administration of English officials in adjoining territories that on Palm Sunday 1282 he attacked the English at Hawarden, thus precipitating the final struggle for independence. After Llewelyn's death (Dec. 1282) David continued to resist in Snowdonia until in the summer of 1283 he was betrayed and taken to Shrewsbury where he was executed on Oct. 3, 1283. All his children by Elizabeth Ferrers died in captivity. David was the last of three native Welsh princes, all successive rulers of the house of Gwynedd, to claim the title prince of Wales.

See WALES: *History.*

See J. E. Lloyd and R. T. Jenkins (ed.), *Dictionary of Welsh Biography* (1959). (T. J. P.)

DAVID, FÉLICIEN CÉSAR (1810–1876), French composer who introduced oriental elements into French music. Born at Cadenet, Vaucluse, on April 13, 1810, he received his early musical education at the Jesuit college at Aix-en-Provence where, in 1829, he was appointed chapelmaster at the cathedral of St. Sauveur. In 1830 he studied at the Paris Conservatoire under Henri Réber and F. J. Fétis. In 1831 he joined the socialist brotherhood of the Saint-Simonians where he was associated with Père Barthélemy Enfantin (*q.v.*). David became their main artistic figure and in 1830 published a series of religious chants, *Menilmontant*, which were sung at their ceremonies. When the sect was dispersed David spent two years (1833–35) preaching their doctrines in the middle east. Recollections of music heard in Jerusalem, Cairo and Syria were incorporated in the works he wrote on his return. In 1844 he produced *Le Désert*, a descriptive choral and orchestral work in three sections on words by Auguste Colin and embodying Arabian melodies. Described as a symphonic ode, *Le Désert* was more properly an oratorio bordering on the style of opera and resembling the *opéra de concert* of Berlioz. David's later works in this style, *Moïse au Sinaï* (1846), *Christophe Colomb* (1847) and *Éden* (1848), were less well received. Of his five operas, *Lalla Roukh* (1862), based on the tales of Thomas Moore, was the most original. He died at St. Germain-en-Laye on Aug. 29, 1876. Neglected in the 20th century, David's work was admired by Berlioz and Saint-Saëns and it also foreshadowed oriental influences in later romantic opera, notably in Bizet's *Djamileh*, Delibes' *Lakmé* and Verdi's *Aïda*.

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DAVID, GERARD (d. 1523), Netherlandish painter, born at Oudewater, in Holland, was the last great master of the Bruges school. He was rescued from complete oblivion in 1860 by W. H. J. Weale, whose researches in the archives of Bruges brought to light the main facts of the master's life. David went to Bruges, presumably from Haarlem, where he is supposed to have formed his early style under the tuition of A. van Ouwater; he joined the guild of St. Luke at Bruges in 1484, and became dean in 1501. He married, in 1496, Cornelia Cnoop, daughter of the dean of the goldsmiths' guild, and became one of the leading citizens of the town, being admitted in 1515 to the Antwerp guild. He died on Aug. 13, 1523, and was buried in the Church of Our Lady at Bruges.

In his early work he had followed the Haarlem tradition as represented by Ouwater and Geertgen tot Sint Jans, but already gave evidence of his superior power as colourist. To his early period belong the "Christ Nailed to the Cross" (National gallery, London; wings at the Antwerp museum) and the "Nativity" at Budapest. In Bruges he studied and copied masterpieces by the Van Eycks, R. van der Weyden and H. van der Goes, and came under the influence of Hans Memling. To this period belong the Madonna triptych in the Louvre, Paris, the "Enthroned Madonna With Angels" at Darmstadt (Ger.), the "Deploration" at Philadelphia (wings in the Lehman collection) and the Munich "Epiphany." But the works on which David's fame rests most securely are his great altarpieces—the "Judgment of Cambyses" (two panels, 1498) and the triptych of the "Baptism of Christ" at Bruges; the "Virgin and Child With Saints and Donor" at the National gallery, London; the triptych of the "Madonna Enthroned and Saints" in the Palazzo Bianco at Genoa; the St. Anna altarpiece in Washington, D.C. (predella in the C. Loyd collection); the "Annunciation" on two panels in the Metropolitan museum, New York; and, above all, the documented altarpiece of the "Madonna With Angels and Saints" at Rouen (1509). In Antwerp, he became impressed by the life and movement in the work of Quentin Massys, who had introduced a more intimate and more human conception of sacred themes. David's "Pietà" in the National gallery, London, and the "Crucifixion" at Genoa were painted under this influence and are remarkable for their dramatic movement.

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DAVID, JACQUES LOUIS (1748–1825), chief French painter of the period of the French Revolution, consulate and first empire, was born in Paris on Aug. 30, 1748, of a prosperous bourgeois family. He entered the Académie Royale in 1766, studying under J. M. Vien, and remained there until 1774, when, at his third attempt, he won the Prix de Rome with the rather rococo "Antiochus Dying for the Love of Stratonice" (École des Beaux-Arts, Paris). Once in Italy David fell under the spell of High Renaissance and, especially, of antique art; he was also interested in the ideas of neoclassicism that had been developed in Rome by Johann Winckelmann, Anton Mengs and Gavin Hamilton. Shaped by these influences, and more directly by Poussin, David quickly evolved a markedly individual style. This was first apparent in "Belisarius Asking for Alms" (Lille) which was exhibited in Paris in 1781. David had returned home in 1780, but was in Rome again 1784–85 to paint "The Oath of the Horatii" (Louvre, Paris). "Belisarius" and "The Horatii" belong to a group of large historical paintings with Greek and Roman subjects; it includes "Andromache Grieving Over the Dead Hector" (1783; École des Beaux-Arts, Paris), "The Death of Socrates" (1787; Metropolitan museum, New York), and "The Lictors Bringing Home to Brutus the Bodies of His Sons" (1789; Louvre, Paris). These pictures firmly established the neoclassical style in France and made David's reputation. They were intended not for the court circle, but for an expanding educated middle class to whom the classical allusions were perfectly familiar. David was not concerned to entertain, but deliberately sought to preach a moral.

David's paintings had been an incitement to revolutionary activity and when in 1789 the revolution broke out he put his art at the service of the new regime. The unfinished "Oath of the Tennis Court" (1791; Versailles) was intended to celebrate the parliamentarians' first defiance of royal authority, and in 1793 and 1794 David began a trilogy dedicated to the martyrs of the revolution: "Marat" (Brussels), "Lepeletier de Saint-Fargeau" (destroyed) and "Joseph Barra" (sketch at Avignon). These pictures are more realist than neoclassical in style. An intimate and associate of all the revolutionary leaders, many of whom he painted or sketched,

MUSÉES ROYAUX DES BEAUX-ARTS DE BELGIQUE, BRUXELLES

"DEATH OF MARAT" BY JACQUES LOUIS DAVID, 1793. IN THE MUSÉES ROYAUX DES BEAUX-ARTS DE BELGIQUE, BRUSSELS

David was elected to the national convention in 1792, and soon found himself directing the new republic's artistic affairs. His career was however sharply interrupted in 1794 with the downfall of his friend Robespierre and for some weeks David was threatened with trial and imprisoned in the Luxembourg palace. The painting of the Luxembourg garden (1794, Louvre) is one of his rare landscapes. For several years David's fame was in eclipse, and during this time he painted "The Rape of the Sabine Women" (1799; Louvre), a neoclassical composition, dominated by the figure of Hersilia begging her husband and her father to stop fighting, that is clearly a plea for an end to internecine strife. With the rise to power of Napoleon in 1799, David won popularity once again and became first painter to the consul and (after 1804) emperor. In a number of pictures, among them "Bonaparte Crossing Mont Saint Bernard" (1800; Versailles), "The *Sacre:* Napoleon Crowning Josephine" (1805–07; Louvre) and "The Distribution of the Eagles" (1810; Versailles), he recorded Napoleon's public life. The problem of depicting contemporary events and figures in contemporary dress had led David to a new tableaulike manner of composition, very different from the earlier neoclassical works, and lacking something of their conviction.

With the fall of Napoleon and the restoration of the monarchy David was exiled to Brussels, where he lived from 1816 until his death on Dec. 29, 1825. In his old age he returned to the mythological subject matter of his youth, painting "Amor and Psyche" in 1817 and "Mars Disarmed by Venus" (Brussels) in 1824. Throughout his career David had painted portraits remarkable for their honesty and penetration. Among the most important are the portraits of Leroy (1783; Montpellier); of M. and Mme. Pécoul (1784; both Louvre); of the chemist Lavoisier with his wife (1788; Rockefeller institute, New York); of himself (1794; Louvre); of M. and Mme. Sériziat (1795; both Louvre); of Mme. Récamier (1800; Louvre); and of Pope Pius VII (1805; Louvre). The portraits reflect, albeit less directly than the history paintings, the evolution that his style underwent. The attribution to David of a number of well-known works—the "Maraichère" (Lyon), the so-called "Gerard and his Family" (Mons), and the "Three Women of Ghent" (Louvre)—has been questioned: the last two may have been painted by or in collaboration with David's Belgian pupil, François Joseph Navez.

David bridges the gap between the rococo art of the 18th century and the realism of the 19th century. His bourgeois origins led him in early career to avoid the declining aristocratic circles and to seek instead to create a new art for the rising middle classes. This he did with remarkable success, and the development of his personal style closely echoes the rapidly changing revolutionary situation at the turn of the century. The neoclassicism of the early period is itself imbued with romanticism and gives way to a realism that is entirely 19th century in spirit. David's influence on his younger contemporaries was enormous and the roots of the art of painters as different as Th. Géricault, Eugène Delacroix, J. D. Ingres and A. J. Gros can often be found in his work. He seems to have been an excellent teacher, anxious that his pupils should develop naturally, but his precepts were subsequently made the excuse for much of the worst academic teaching of the 19th century. *See* also PAINTING: *France: 17th and 18th Centuries.*

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DAVID D'ANGERS, PIERRE JEAN (1789–1856), French sculptor, who revolted against the prevailing neoclassic style of early 19th-century French sculpture, was born at Angers on March 12, 1789. The son of a carver, he went to Paris at 17 with 11 francs in his pocket to study under Philippe Laurent Roland. After a year and a half's struggle he received a small annuity from the municipality of Angers. In 1811 he won the Prix de Rome and was sent to Italy, where he worked for some time in Antonio Canova's studio. Returning to Paris in 1816, after a short visit to London, he received many important commissions. One of his first works in Paris, the "Condé" at Versailles, showed the new tendency toward a more realistic method. In 1827 he visited England, and in 1828 and 1834 Germany. Always a Radical in politics, he had to leave France for a short period after the *coup d'état* of Dec. 1851. Many of the most famous men and women of his time sat to David for busts or medallions. A nearly complete collection, originals or copies, is to be seen in the Musée David at Angers. Among David's most important works are: the sculptures on the pediment of the Panthéon, showing the principal personages in France since the Revolution grouped round a figure of "La Patrie"; the Gutenberg monument at Strasbourg; the monument to General Gobert in Père Lachaise, the "Philopoemen" in the Louvre, and the bust of Goethe, presented by him to the poet in 1831, in the public library at Weimar. David died at Paris on Jan. 4, 1856.

DAVIDOVIC, LJUBOMIR (1863–1940), Yugoslav statesman who was twice prime minister, was born at Vlasko Polje, Serbia, on Dec. 24 (new style; 12, old style), 1863. He entered parliament in 1901, was one of the founders of the Independent Radical party in 1902 and became minister of education in 1904, speaker of the *skupstina* in 1905 and lord mayor of Belgrade in 1909. Elected leader of his party in 1912, he served as minister of education (1914–17) in Nikola Pasic's coalition cabinet and in the first Yugoslav government (1918). As leader of the newly formed Democratic party (1919), he presided over the Democratic-Socialist coalition government (1919–20). In July 1924 he again became prime minister at the head of a short-lived coalition of Democrats, Slovene Clericals and Bosnian Moslems, supported by the Croatian Peasant party. He led the Democratic party until his death, in Belgrade, on Feb. 19, 1940. He actively opposed the régime introduced by King Alexander in 1929. Brought up in Serbia's liberal and democratic traditions, he believed that a thorough democratic government within a centralist constitution would gradually weld Serbs, Croats and Slovenes into one unified nation. After experiencing the complex Yugoslav realities, Davidovic revised his constitutional ideas and promoted a popular movement advocating a federalist state organization

based on Serbian-Croation-Slovene agreement and parliamentary constitution. (K. St. P.)

DAVIDSON, ANDREW BRUCE (1831–1902), Scottish Old Testament scholar, one of the first to introduce historical methods of Old Testament study in Scotland, was born in 1831 at Kirkhill, Aberdeenshire. He graduated from Aberdeen university in 1849 and in 1852, after three years as a schoolmaster, entered New college, Edinburgh. He was licensed to preach (Free Church of Scotland) in 1856. In 1858 he became assistant professor of Hebrew and in 1863 professor of Hebrew and oriental languages at New college. Davidson also served as a member of the Old Testament revision committee. He died on Jan. 26, 1902.

Among Davidson's published works were commentaries on Job, Ezekiel and Nahum, Habakkuk and Zephaniah; an *Introductory Hebrew Grammar,* widely used as a textbook; a Bible-class primer on *The Exile and Restoration;* and lectures on *Old Testament Prophecy,* published after his death. He also contributed a mass of articles to the *Imperial Bible Dictionary,* the *Encyclopædia Britannica, Hastings' Bible Dictionary* and the chief religious reviews.

See J. Strahan, *Andrew Bruce Davidson* (1917).

DAVIDSON, JOHN (1857–1909), British poet whose vigorously written verse expresses a *fin de siècle* despair, was born at Barrhead, Renfrewshire, on April 11, 1857. As a boy he worked in a chemical laboratory and later attended Edinburgh university for one session. He taught at various Scottish schools for six years, during which period he published the plays *Bruce* (1886), *Smith* (1888) and *Scaramouch in Naxos* (1889). Although these showed his ability as a writer of blank verse, they failed to gain him a reputation, and in 1890 he went to London to devote himself wholly to writing. He contributed to several papers and wrote novels and short stories for a living, but it was his *Fleet Street Eclogues* (1893) that established him. This was followed by *Ballads and Songs* (1894), a second series of eclogues (1896) and other volumes of verse which revealed Davidson's mastery of the narrative lyrical ballad. He continued to write novels and plays, and toward the end of his life published a series of *Testaments,* expressing his philosophical belief in man as the measure of the universe, created to express himself to the utmost. He planned a trilogy of plays with this theme, to be called *God and Mammon,* of which only *The Triumph of Mammon* (1907) and *Mammon and His Message* (1908) appeared. In 1908 he went to live at Penzance, Cornwall. Although he received a small civil list pension he was troubled by poverty, and also by ill-health. On March 23, 1909, he drowned himself in the sea at Penzance.

DAVIDSON, THOMAS (1817–1885), British paleontologist noted for his exhaustive *Monograph of British Fossil Brachiopoda,* was born in Edinburgh on May 17, 1817, and educated partly in the Edinburgh university and partly in France, Italy and Switzerland. Besides his *Monograph*—published (1850–70) by the Palaeontographical society (6 vol., containing 250 plates done by Davidson himself)—he also prepared an exhaustive memoir on *Recent Brachiopoda,* published by the Linnean society. Davidson was elected fellow of the Royal society in 1857. He died at Brighton on Oct. 14, 1885.

See biography with portrait and list of papers in *Geological Magazine,* p. 145 (1871).

DAVIDSON OF LAMBETH, RANDALL THOMAS DAVIDSON, 1st Baron (1848–1930), for 25 years (1903–28) archbishop of Canterbury and an ecclesiastical statesman who was prominent in debate in the house of lords on moral and national questions at home and on the welfare of the underprivileged and persecuted abroad. He was born in Edinburgh on April 7, 1848, and educated at Harrow school and Trinity college, Oxford. He studied for holy orders with C. J. Vaughan and was ordained in 1875. In 1877 he was appointed resident chaplain to the archbishop of Canterbury, A. C. Tait, whose daughter he married. Davidson won the confidence of Queen Victoria and her influence secured his appointment to the deanery of Windsor in 1883 and successively to the sees of Rochester (1891) and Winchester (1895). Both in the ritualist controversy and in the disputes over religious instruction in schools between 1902 and 1906 he attempted to reconcile the extremists. In Feb. 1903 he succeeded Frederick Temple as archbishop of Canterbury.

Davidson's strength as archbishop lay not in brilliance of intellect but in sound common sense. He was often consulted on questions quite outside normal ecclesiastical interests, and his speech in the house of lords was decisive in persuading the bishops to accept Asquith's Parliament bill in 1911. In foreign affairs, he supported the League of Nations and led public protests against religious persecution in Russia in 1922.

Davidson was responsible for promoting efforts to forward Christian unity. He succeeded in winning the confidence of English Free churchmen, and as president of the Lambeth conference in 1920 he helped to frame the "Appeal to All Christian People" to make greater efforts for church unity. He personally expounded the Appeal to the Church of Scotland and to the United Free Church of Scotland and he was kept informed of the Malines conversations (1921–25) between Anglicans and Roman Catholics. He encouraged closer relations with the Eastern Orthodox churches, some of which recognized Anglican ordinations, and he pressed successfully for the retention of the ecumenical patriarchate in Constantinople. Davidson's influence was also often extended on behalf of native peoples, and his advice was always considered particularly valuable by workers in the missionary field. His archiepiscopate was marked by doctrinal disputes and in 1922 a commission was set up to consider the existing differences. More important was the setting up in 1919 of the Church assembly (*see* Convocations of Canterbury and York), and Davidson as chairman guided the new assembly through its early years. The rejection by the house of commons of proposals for the revision of the Book of Common Prayer (*see* Common Prayer, Book of) was a severe blow to Davidson.

Davidson's activities led to an increase of the Church of England's influence abroad, and his sincere piety, open mind and loyalty to truth won him recognition at home. He was created a baron on his retirement in Nov. 1928; he died in London, May 25, 1930.

His published writings include *Life of Archbishop Tait,* 2 vol. (1891), and *The Character and Call of the Church of England* (1912).

See G. K. A. Bell, *Randall Davidson,* 2 vol. (1935). (H. M. W.)

DAVIES, ARTHUR BOWEN (1862–1928), U.S. painter, one of the "Ash Can" school and a leader in the modern movement, was born at Utica, N.Y., on Sept. 26, 1862. He was a pupil of Dwight Williams at Utica, afterward studying in New York and Chicago. He became an adherent of the romantic school of painting and made notable contributions in the fields of etching and colour lithography. His later work showed influences of Cubism, though it never lost its idyllic quality.

In 1908 Davies organized an exhibit of artists who came to be known as The Eight, also called the Ash Can school. (*See* Painting: *Modern Painting* [*Late 19th and 20th Centuries*]: *National Development*). As president of the Society of Independent Artists, Davies was a major figure in the organization of the famous Armory show of 1913, which brought the works of European and American modernists to the attention of the U.S. public. He died in Italy on Oct. 24, 1928.

See Phillips Memorial Gallery, *Arthur B. Davies: Essays on the Man and His Art* (1924); R. Cortissoz, *Arthur B. Davies* (1931).

DAVIES, DAVID (1818–1890), Welsh industrialist, was born at Llandinam, Montgomeryshire, on Dec. 18, 1818, the eldest of nine children of a tenant farmer. From farming and sawing timber on commission he turned to contracting and built eight lengths of railway in Wales. In 1864 he sank for coal in the upper Rhondda valley, and his success led to the formation of the Ocean Coal company. Because of the inadequacy of Cardiff docks for the growing coal trade he took the lead in a parliamentary struggle for a new dock at Barry, begun in 1884. He was a Liberal member of parliament for Cardiganshire from 1874 to 1886. He died at Llandinam on July 20, 1890. Davies was characteristic of the British Industrial Revolution, hard working but fair minded, a Calvinistic Methodist of puritan habits, with a rugged sense of humour.

See Ivor Thomas, *Top Sawyer: a Biography of David Davies of Llandinam* (1938). (I. B.-T.)

DAVIES, DAVID DAVIES, 1ST BARON, OF LLANDINAM (1880–1944), who pleaded the cause of internationalism between World Wars I and II, was the only son of Edward Davies of Plas Dinam, Llandinam, Montgomery, where he was born on May 11, 1880. He was educated at Merchiston Castle school, Edinburgh, and at King's college, Cambridge. In 1906 he entered the house of commons from Montgomeryshire. He fought in World War I and at its conclusion became parliamentary private secretary to David Lloyd George, obtaining his peerage in 1932. He was actively interested in university education in Wales and was also closely associated with the work of the League of Nations union. After the failure of the Disarmament conference in 1933, he founded and acted as treasurer of the New Commonwealth society, which aimed to produce a more effective League of Nations, with a police force and an impartial tribunal with a wide jurisdiction to settle international disputes. He wrote many books and pamphlets on this theme, including *The Problem of the Twentieth Century* (3rd ed., 1938). Lord Davies died on June 16, 1944. (G. W. K.)

DAVIES, (SARAH) EMILY (1830–1921), pioneer in the movement to secure university education for women and chief founder of Girton college, Cambridge, was born at Southampton, Eng., on April 22, 1830. Educated at home, she joined the campaign for the emancipation of women with Mme Bodichon (Barbara Leigh Smith) and Elizabeth Garrett (Mrs. Garrett Anderson). With Dorothea Beale and Frances Mary Buss she gave evidence before the schools inquiry commission (1864–68). Her aim was to secure the admission of women to university examinations, but, unlike her friends, she insisted that women should be admitted on the same terms as men. As a consequence of her advocacy, University college, London, admitted women to classes in 1870. In 1869 Miss Davies and her friends opened a women's college at Hitchin; this moved to Cambridge in 1873 as Girton college. During 1870–73 she served on the London school board till she went to Girton as mistress (1873–75). From 1867 to 1904, except for an interval as treasurer, she was honorary secretary of the college. Her chief publications were *The Higher Education of Women* (1866) and *Thoughts on Some Questions Relating to Women, 1860–1908* (1910). She died at Hampstead, London, July 13, 1921.

See Barbara Stephen, *Emily Davies and Girton College* (1927). (S. J. C.)

DAVIES, SIR HENRY WALFORD (1869–1941), English organist and composer, who exerted a wide influence on musical education was born at Oswestry, Shropshire, on Sept. 6, 1869, and was educated privately. In 1882 he became a chorister at St. George's chapel, Windsor, and in 1885 assistant organist to Sir Walter Parratt there. During 1890–94 he was pupil and scholar at the Royal College of Music, where, in 1895, he became a teacher of counterpoint. In 1898 he was appointed organist to the Temple church, London, a post which he held until 1923. He was conductor of the London Bach choir from 1903 to 1907 and professor of music in the University college of Wales at Aberystwith from 1919 to 1926. During World War I, with the rank of major, he worked for the organization of music among the troops, and in 1917 was made director of music to the R.A.F. He was appointed director of music and chairman of the National Council of Music, University of Wales, in 1919 and Gresham professor of music in 1924. He was organist of St. George's chapel, Windsor, from 1927 to 1932.

His compositions include a Symphony (1911); "Solemn Melody" for strings and organ; and in the way of choral works, *Everyman*, a felicitous setting for chorus and orchestra of the old morality play, which enjoyed wide favour; "Ode on Time" (1908); *Five Sayings of Jesus* (1911); "Fantasy" on a text of Dante (1914); and *Heaven's Gate* (1917); in addition to a quantity of church music, chamber music and songs. Over and above his creative work Walford Davies was for many years one of the most potent and stimulating forces (not least by means of his immensely popular radio talks) in musical education in England. He wrote *Music and Worship* (1935), with Harvey Grace, and *The Pursuit of Music* (1935), and edited several song books. He was knighted in 1922. He died at Wrington, Somerset, on March 11, 1941.

See H. C. Colles, *Walford Davies* (1942). (F. S. H.)

DAVIES, SIR JOHN (1569–1626), English poet and lawyer whose *Orchestra, a Poem of Dancing* reveals a typically Elizabethan pleasure in the contemplation of the correspondence between the natural order and man's activity. Born in 1569, he was baptized at Tisbury, Wiltshire, on April 16. Educated at Winchester college and Queen's college, Oxford, he entered the Middle Temple, London, in 1588 and was called to the bar in 1595. He was disbarred in 1598 for having hit his "very friend, Master Richard Martin," with a cudgel during a quarrel in the hall of the Middle Temple, but was restored in 1601 after apologizing to Martin. In the same year he sat for Corfe Castle in parliament, and on Queen Elizabeth I's death he was one of the messengers who carried the news to James VI of Scotland.

James received him with great favour, sent him to Ireland as solicitor-general and conferred a knighthood on him. In 1606 Davies was made attorney-general for Ireland and created serjeant-at-law. He took an active part in the Protestant plantation of Ulster and wrote several tracts on Irish affairs, including *A Discoverie of the True Causes why Ireland was never entirely subdued . . . untill the beginning of his Maiesties happie raigne* (1612) and *Le Primer report des cases & matters en ley resolues & adjudges en les courts del roy en Ireland* (1615). He entered the Irish parliament and was elected speaker, in which capacity he delivered an address reviewing the history of Irish parliaments, and on his resignation in 1619 he returned to England and sat in the English parliament of 1621 for Newcastle-under-Lyme. He was appointed lord chief justice in 1626, but before he could take up office he died suddenly on Dec. 8, 1626. With Sir Robert Cotton he was one of the founders of the Society of Antiquaries.

Much of Davies' early poetry consisted of epigrams published in various collections. *Epigrammes and Elegies by J. D. and C. M.* (1590?) contained posthumous work of Christopher Marlowe and was one of the books which the archbishop of Canterbury ordered to be burned in 1599. *Orchestra* (1596) is a poem in praise of dancing set against the background of Elizabethan cosmology and its theory of the harmony of the spheres. *Nosce teipsum* (1599) was written during the year after his disbarment, and is a lucid account of his philosophy on the nature and immortality of the soul. In the same year he published *Hymnes of Astraea in Acrosticke Verse*, a series of poems in which the initials of the first lines form the words "Elisabetha Regina." His last poetic works were two dialogues contributed to Francis Davison's *Poetical Rhapsody* (1602). He published a collected edition of his poetry in 1622.

Davies' *Works* were edited by A. B. Grosart, 2 vol. (1869–76) and by H. Morley (1889) and his *Poems* by C. Howard (1941). *Orchestra* was edited with a useful introduction by E. M. W. Tillyard (1945). For Davies' work in and tracts on Ireland, *see* G. Chalmers (ed.), *Historical Tracts* (1786).

See M. Seemann, *Sir John Davies, sein Leben und seine Werke* (1913); E. H. Sneath, *Philosophy in Poetry* (1903).

DAVIES, JOHN, OF HEREFORD (*c.* 1565–1618), English poet and writing master whose chief work was *Microcosmos* (1603), a didactic treatise modeled on Joshua Sylvester's translation of Du Bartas' *Le Sepmaine*. He was born at Hereford *c.* 1565. He settled in Oxford and became known as the best penman of his day. As well as other religious verse treatises, he wrote *Wittes Pilgrimage* (*c.* 1605), a collection containing some good love sonnets; *Humours Heav'n on Earth; With the Civile Warres of Death and Fortune*, a description of the plague (1609); and *The Scourge of Folly* (*c.* 1611), containing epigrams to literary contemporaries, including Shakespeare. Davies was also the author of a popular writing manual, *The Writing Schoole-Master* (16th ed., 1636). He died in London in 1618.

DAVIES, JOHN LLEWELYN (1826–1916), English clergyman, educator and promoter of education for women, was born at Chichester on Feb. 26, 1826. He was educated at Repton and Trinity college, Cambridge, where he was made a fellow in 1851. He was ordained in the same year, and held successively

several London livings, including the crown living of Christ church, Marylebone, and in 1889 became vicar of Kirkby Lonsdale, Westmorland, where he remained until 1908. Davies was closely associated with John Frederick Denison Maurice in the foundation of the Working Men's college (1854), where he taught for many years. He was elected to the first London school board in succession to Huxley, and from 1873 to 1874 and 1878 to 1886 was principal of Queen's college, Harley street, founded by Maurice in 1848 for the advancement of women's education. Davies was an advocate of the higher education of women, a cause in which his sister, Emily Davies (*q.v.*), was also prominent, and favoured the granting to women of university degrees and the parliamentary franchise. He died at Hampstead on May 17, 1916. With David James Vaughan he produced in 1852 a well-known translation of Plato's *Republic*.

DAVIES, SIR LOUIS HENRY (1845–1924), Canadian politician and jurist, chief justice of Canada's supreme court from 1918 to 1924, was born in Charlottetown, P.E.I., on May 4, 1845. He studied law at the Inner Temple, London, and was called to the English bar in 1866 and the provincial bar in 1867. In 1872 he was elected a member of the legislative assembly of Prince Edward Island, and from 1876 to 1879 was prime minister of the province. He was elected to the Canadian house of commons as a Liberal in 1882; and from 1896 to 1901 he was minister of marine and fisheries in the Laurier administration. In 1897 he was a joint delegate to Washington with Laurier on the Bering sea seal question, and in 1898–99 a member of the Anglo-American joint commission at Quebec. In 1901 he was appointed a judge of the supreme court of Canada, and in 1918 he became its chief justice. He was knighted in 1897 and appointed to the imperial privy council in 1919. He died at Ottawa on May 1, 1924.
(W. S. Wa.)

DAVIES, SAMUEL (1723–1761), American religious and educational leader, preacher, champion of religious dissenters and hymn writer, was born in New Castle county, Del., on Nov. 3, 1723. He was educated at Samuel Blair's "log college" and ordained minister of the Presbyterian Church in 1747. Davies became a leader of the southern phase of the religious revival known as the Great Awakening, his work centring at Hanover, Va. The Virginia struggle between established church leaders and nonconformists found in Davies one of the dissenters' chief defenders; he argued their cause before the Virginia general court and enlisted the support of prominent English and Scottish dissenters. On the outbreak of the French and Indian War the government became too preoccupied to concern itself with checking Davies' activities, especially since his war sermons helped rouse the populace of tidewater Virginia to the defense of the frontier, and his influence in favour of religious rights and freedoms became decisive. When the state constitution was being formed, at the time of the Revolutionary War, the lobbying of Presbyterian leaders helped defeat a provision for an established church.

Davies was one of colonial America's greatest preachers, if not the greatest. This was evidenced not only by the extent of his following and the praises of his contemporaries but also by the popularity of his printed sermons, about 20 editions of which were published. He was also the first American hymn writer.

In 1753 the synod of New York sent Davies and Gilbert Tennent to England to win support for American dissenters and to raise funds for the College of New Jersey (now Princeton university). They were highly successful in both missions. Davies in 1755 became the first moderator of the first presbytery of the south, Hanover presbytery. In 1759 he became the fourth president of the College of New Jersey, instituting during his short regime a number of important changes. He died on Feb. 4, 1761.

See George H. Bost, "Samuel Davies, the South's Awakener," *Journal of the Presbyterian Historical Society*, 33:135–156, and sources listed in the footnotes. (G. H. Bt.)

DAVIES, WILLIAM HENRY (1871–1940), British poet born at Newport, Monmouthshire, on July 3, 1871. The truth and simplicity of his lyrics distinguishes his work from that of his Georgian contemporaries. After serving as apprentice to a picture-frame maker he tramped through the United States, crossed the Atlantic many times on cattle boats, became a peddler and street singer in England, and, after several years of this life, published his first volume of poems, *The Soul's Destroyer, and Other Poems* (1905), from a common lodginghouse in London. *The Autobiography of a Super-Tramp* (1908)—the best known of his prose works—appeared with a preface by Bernard Shaw, followed by *Nature Poems and Others* (1908). His poetry includes *Forty New Poems* (1918), *Poems 1930–31* (1932) and *The Loneliest Mountain* (1939); the first of the collected editions appeared in 1916. He also published a novel, *A Weak Woman* (1911), and volumes of nature studies, including *Later Days* (1925) and *The Adventures of Johnny Walker, Tramp* (1926). Davies was something of a recluse and the man was never as well known to the general public as his work, which achieved great popularity. He died at Nailsworth, Gloucestershire, on Sept. 26, 1940. His *Collected Poems*, with an introduction by Sir Osbert Sitwell, appeared in 1943. (J. Sp.)

DAVILA, ENRICO CATERINO (1576–1631), Italian historian who was the author of a widely read history of the civil wars in France. His ancestors had been constables of the kingdom of Cyprus. In 1570 the island was taken by the Turks, and Antonio Davila, his father, had to leave, despoiled of all he possessed. He traveled into Spain and France, and finally returned to Padua, and at Sacco, Oct. 30, 1576, Enrico Caterino was born. About 1583 Antonio took him to France, where he became a page in the service of Catherine de Medicis, wife of King Henry II. He subsequently became a soldier, and fought through the civil wars until the peace in 1598. He then returned to Padua, and there and later at Parma, he led a studious life until, when war broke out, he entered the service of the republic of Venice. He never lost sight of his early design of writing the history of those civil wars in France in which he had borne a part. The success of the *Historia delle guerre civili di Francia* (1630) was immediate and enormous. Over 200 editions followed, of which perhaps the best is the one published in Paris in 1644. Davila was murdered, while on his way to take over Cremona for Venice, at San Michele in Campagna, near Verona, May 26, 1631.

The *Historia* was translated into English by Sir Charles Cotterell and William Aylesbury (1647–48), and by Ellis Farnesworth (1758). The best French translation was by G. Baudouin (1642).

See E. Allodoli, "E. C. Davilo," in *Pegaso* (Sept. 1929).

DAVIS, ALEXANDER JACKSON (1803–1892), U.S. architect, a pioneer figure in U.S. architecture during the 19th century, was born in New York on July 24, 1803. He studied in New York and in Boston, and in 1827, with Ithiel Town of New Haven, Conn., founded the firm of Town and Davis. He was unusually inventive in the many revival styles of the time, but particularly favoured the Gothic. His illustrations for the publications of the horticulturist A. J. Downing helped establish the familiar types of American rural "carpenter Gothic" of the mid-19th century. (C. J. W.)

DAVIS, CHARLES HAROLD (1857–1933), U.S. painter, whose romantic interpretations of the landscape excelled in their cloud effects, was born at East Cambridge, Mass., Feb. 2, 1857. A pupil of the schools of the Boston Museum of Fine Arts, he was sent to Paris in 1880. Having studied at the Academy Julian under Lefebvre and Boulanger, he went to Barbizon and painted much in the forest of Fontainebleau. He became a full member of the National Academy of Design in 1906, and received many awards, including a silver medal at the Paris exhibition of 1889. He is represented by important works in leading museums throughout the U.S. He died in Mystic, Conn., on Aug. 5, 1933.

DAVIS, CHARLES HENRY (1807–1877), U.S. naval officer and scientist, was born in Boston, Mass., Jan. 16, 1807. He had spent two years at Harvard before becoming a midshipman, and he returned there for the study of mathematics between sea cruises. He made the first comprehensive survey of the coasts of Massachusetts, Rhode Island and Maine, including the intricate Nantucket shoals area, and was a prime mover in establishing the *American Nautical Almanac* (1849), supervising its preparation for several years. A tireless worker for scientific progress, Davis was one of the founders of the National Academy of Sciences in

1863. He was one of the board which recommended building the "Monitor," and was with Adm. Samuel F. du Pont (*q.v.*) at Port Royal. Then he commanded the Union gunboat flotilla on the upper Mississippi for several months after Commodore Andrew Hull Foote was injured in Feb. 1862. He became a rear admiral in 1863. Davis was a practical officer as well as a lover of literature, a man of science and author of scientific books, and was the father-in-law of Sen. Henry Cabot Lodge and of Brooks Adams the historian. He died Feb. 18, 1877, at Washington, D.C. (J. B. Hn.)

DAVIS, ELMER HOLMES (1890–1958), U.S. radio commentator and author, was born in Aurora, Ind., Jan. 13, 1890. He was a Rhodes scholar at Queen's college, Oxford, where in 1912 he received a B.A. degree. Prior to 1924 he worked as a reporter and editorial writer for the *New York Times*. For 15 years thereafter he devoted his time chiefly to writing fiction, plays and essays. He became a radio news analyst for the Columbia Broadcasting system in 1939 and won a wide following for his dry humour and incisive comments on the news. In 1942 he became director of the United States Office of War Information and served in this capacity during World War II, after which he returned to radio broadcasting with the American Broadcasting company until 1953. He died in Washington, D.C., May 18, 1958. (H. J. Sc.)

DAVIS, HENRY WINTER (1817–1865), U.S. congressman and a leader of the opposition to President Lincoln's policies during the American Civil War, was born at Annapolis, Md., Aug. 16, 1817. He graduated from Kenyon college, O., in 1837, and from the University of Virginia in 1841 with a degree in law. In 1854 he was elected from Baltimore to the national house of representatives, where except for the years 1861–63 he served until 1865.

Davis was important chiefly in terms of Lincoln and the Civil War. An ardent and forceful antislavery spokesman, although from a slave state, he strongly supported the president until 1864. Then, as chairman of a committee on reconstruction, he helped to write and pass the Wade-Davis bill curbing Lincoln's conciliatory policies by placing reconstruction in the hands of congress. The president's refusal to sign the bill led Davis to make a bitter attack on him in the *New York Tribune*, Aug. 5, 1864. Known as the "Wade-Davis manifesto," it charged Lincoln with exceeding his executive powers and with political opportunism. But after Lincoln's re-election three months later, Davis turned again to his support. Although Davis had inherited slaves he fought hard both for abolition and for universal suffrage. He died at Baltimore, Dec. 30, 1865.

See *Speeches and Addresses by Henry Winter Davis* (1867); B. C. Steiner, *Life of Henry Winter Davis* (1916). (E. J. N.)

DAVIS, JEFFERSON (1808–1889), U.S. statesman and only president of the Confederate States of America (*q.v.*), was born June 3, 1808, in southwestern Kentucky on the present site of Fairview. He was the fifth son and last of ten children of Samuel Emory Davis, a Georgia-born planter and horse breeder who had fought in the American Revolution. On his father's side the family was Welsh. His grandfather, Evan Davis, who moved to Georgia, had been a man of property in Philadelphia. His mother, Jane Cook, from South Carolina, was of Scottish stock and reputedly related to the Revolutionary War officer, Gen. Nathanael Greene.

When Jefferson Davis, who was named for Thomas Jefferson, was still a baby the family moved again to the deep south. His memories began in Woodville, Wilkinson county, Miss., where Samuel Davis settled on a farm that came to be known as "Rosemont." Realizing the boy's potential abilities, his Baptist father sent him to an excellent school, St. Thomas's, near Springfield, Ky., run by Dominican monks. At the age of seven, he made the long journey on pony back in the company of family friends. When he was nine he returned home by one of the recently invented steamboats. Four years later he entered Transylvania university in Lexington, Ky., and made a high record. At 16 he accepted an appointment to the U.S. military academy.

Both at Transylvania and at West Point his best friend was Albert Sidney Johnston, five years his senior. In the class behind him at West Point were two others who were to serve the Confederacy in battle, Robert E. Lee and Joseph E. Johnston, each a year and some months older than he. Davis was a fun-loving youth who got many demerits and who read widely in world literature instead of studying for examinations. In the class of 1828 he finished 23rd in a class of 33. His army service lasted seven years, the major part being spent as a lieutenant in the wilds of Wisconsin. Here during a winter of unprecedented cold an attack of pneumonia left him with facial neuralgia, which sometimes almost blinded him with pain. His life was saved by the devoted nursing of a faithful Negro body servant named James Pemberton.

While in Prairie du Chien, Wis., Davis fell in love with Sarah Knox, second daughter of Col. Zachary Taylor, the commanding officer. In 1835, after two years in Arkansas, he resigned his commission to marry her. He then settled as a cotton planter in Mississippi south of Vicksburg on delta land given him by his eldest brother, Joseph, 20 years his senior. Three months after the marriage his bride died of malarial fever and the young man's world collapsed about him. The shock of his wife's death changed his disposition. According to a contemporary record, Davis at 25 was "a witty, sportful, humorous and captivating gentleman." Now learning to bear an insufferable grief brought a stoicism which was later interpreted as coolness. For seven years he stayed largely in seclusion, creating a cotton plantation out of a wilderness and reading the classics and constitutional law in his brother's excellent library. The Davises were noted for model plantations, where the slaves themselves held the trials, and by their own testimony, were "hardly aware of slavery."

In 1845 Jefferson Davis, a stanch Jeffersonian Democrat, entered politics. Earlier that same year he married 19-year-old Varina Howell (1826–1906) of Natchez whose paternal grandfather had been governor of New Jersey. In December, Davis went to Washington as a member of the house of representatives. With his good looks, forceful dignity and oratorical gifts he made an immediate impression. When war with Mexico broke out in 1846 he resigned his seat to become colonel in command of the First Mississippi volunteers. At Monterrey (Sept. 1846) he proved a hero, and at Buena Vista (Feb. 22, 1847) he saved the day for Gen. Zachary Taylor with an inspired V-formation, which won him military notice even in Europe. Severely wounded, he returned to Mississippi and was shortly named U.S. senator. In the senate he became chairman of the committee on military affairs. In 1851 the Democrats of Mississippi misguidedly persuaded him to resign as senator and run for governor. Here, by a narrow margin, he met his only defeat in politics.

When Franklin Pierce was inaugurated president in 1853, Davis was made secretary of war, and in this office he functioned brilliantly. He expanded the army, introduced improvements at West Point and at army posts, raised soldier's pay, boosted morale generally, built up coastal defenses, and directed three valuable surveys for future railroads to the Pacific. He engineered the Gadsden Purchase (*q.v.*). He also urged buying a strip of land in Panama and building a railroad for transshipment of freight from merchant ships.

When Pierce went out of office in March, 1857, Jefferson Davis again entered the senate, and there exerted more influence on legislation than any senator of his time. While recuperating from an illness in Maine in the summer of 1858, Davis was feted and pressed to make speeches. Bowdoin college conferred upon him an honorary degree. Everywhere he went Davis proved a winning ambassador of good will for the South. He spoke in Faneuil hall, Boston, advocating a strict construction of the federal constitution. In New York he warned the electorate of the danger of pushing the South too far, and was resoundingly cheered. When he returned to Mississippi he tried to "harmonize the views" of his constituents, and spoke for union. When the antagonism between the sections grew more acrimonious, Davis insisted that disunion should not come except as a last alternative. Repudiating Stephen A. Douglas's doctrine of "squatter sovereignty," he asserted that congress had no right to deny admission to the Union of any territory because of slavery. In 1860 he opposed Douglas's nomination as the Democratic presidential candidate and supported John C. Breckinridge. Though Davis did not attend the conven-

tion in Charleston and declined to be a candidate. Benjamin F. Butler, head of the Massachusetts delegation, voted for him in 57 successive ballots. Butler contended that if Davis had been the nominee he might well have defeated the Republican candidate, Abraham Lincoln, and avoided a war between the states.

Jefferson Davis was a reluctant secessionist even after the withdrawal of South Carolina on Dec. 20, 1860. He was among the few who believed that the North might coerce the cotton states. In South Carolina's behalf he intervened unsuccessfully to persuade President Buchanan to remove the Federal garrison from Charleston harbour. On Jan. 21, 1861, twelve days after Mississippi seceded, Davis made a moving farewell speech in the senate and pleaded eloquently for peace. Before he reached "Brierfield," his plantation, he was commissioned major general to head Mississippi's armed forces and prepare for its defense. But within two weeks the Confederate convention at Montgomery, Ala., unanimously chose him provisional president of the Confederacy. Davis was both surprised and saddened; he would have preferred to head the army of defense. But there was no other candidate whose record and qualities for leadership, political and military, equaled his.

On Feb. 18, 1861, Davis was inaugurated in Montgomery and again, under the permanent constitution, in Richmond, Va., on Feb. 22, 1862. As president of the Confederate States his first act was to send a commission to Washington, D.C., to negotiate amicably with the Federal government and prevent armed conflict. Though President Lincoln refused to receive the commissioners, Davis still had hope of peace because the secretary of state, William H. Seward, the head of the army, Gen. Winfield Scott, and the foremost northern Democrat, Stephen A. Douglas, all advocated peace, as did most private citizens in the North. Even leading abolitionists urged the administration to let the southern states go. The South warned Washington that sending armed ships into Charleston harbour could not be tolerated. But President Lincoln decided to send supplies to the Federal garrison of Ft. Sumter and so notified the governor of South Carolina. Only when the ships were off the bar did President Davis give Gen. P. G. T. Beauregard discretionary orders to reduce the fort rather than let in the enemy flotilla. On April 13, after a terrific bombardment, Ft. Sumter surrendered with the loss of but a single life, that of a Federal gunner killed in an accident. Davis was relieved that no Federal troops had been killed by Confederate fire. Two days later President Lincoln called for 75,000 volunteers. This move brought about the secession of four more states: Virginia, Tennessee, North Carolina and Arkansas. (*See* AMERICAN CIVIL WAR.)

Jefferson Davis was a president without precedent: he molded a new nation within the caldron of a war. With only one-fourth the white population of the northern states, with a small fraction of the North's manufacturing capacity, with no navy, no powder mill, and an appalling lack of arms and equipment, the South was in poor condition to withstand invasion. Its only resources seemed to be cotton and courage. But at Bull Run (Manassas), Va., on July 21, 1861, the Confederates routed the invading Union forces, and sent them back to the Potomac. In the meantime, with makeshift materials, Davis created factories for producing powder, cannon, side arms and quartermaster stores. In restored naval yards gunboats were fashioned. Davis sent agents abroad to secure arms and ammunition. Purchases from Europe began slipping through a tightening Federal blockade. The inadequate southern railroads and rolling stock were patched up repeatedly. In the first months of 1862, after a series of Union victories in the west and the death of the irreplaceable Gen. Albert Sidney Johnston at Shiloh, a tremendous Federal drive was launched by Gen. George B. McClellan against the forces defending Richmond. When Gen. Joseph E. Johnston was wounded at Seven Pines, Davis named Robert E. Lee commander of the army of northern Virginia, June 1, 1862. It was an inspired decision, though few in the South believed in Lee at the time. In the Seven Days' Battle, which ended July 2, 1862, the Federals were beaten back to the James river. Lee became the South's hero.

After a second Confederate victory at Manassas in Aug. 1862, with Gen. Thomas J. ("Stonewall") Jackson conspicuously brilliant, Davis backed the audacious Lee in an invasion of Maryland. General McClellan, who had been removed, was recalled by Lincoln to save Washington. By accident Lee's entire battle plans fell into McClellan's hands; Lee's outnumbered forces fought a drawn battle at Sharpsburg near Antietam creek and returned to Virginia. England, which was nearly ready to recognize the Confederacy, became cautious. Lincoln, without constitutional authority, issued a proclamation freeing the slaves in those states over which he had no jurisdiction, and thus changed the battle cry of "War for Union" to "War for Emancipation."

When Davis at last persuaded a squabbling congress to pass an act of conscription, it aroused the extreme states' rights men, including the vice-president, Alexander H. Stephens, and two state governors, J. E. Brown of Georgia and Zebulon Vance of North Carolina. The conscript law raised an opposition to Davis which continued to war's end. Davis made trips about the South encouraging his people and counteracting the bad influence of self-seeking politicians and disgruntled generals. The year 1862 ended with a Union defeat at Fredericksburg by Lee and Jackson. In early May of 1863 a powerful invading Federal army under Gen. Joseph Hooker was defeated at Chancellorsville, Va., by Confederate forces half its size. But the engagement cost the life of the invaluable "Stonewall" Jackson. Meanwhile affairs looked dark in the west. Davis had reluctantly made Gen. Joseph E. Johnston commander of the western department, and Johnston now stood still arguing with the administration while Gen. Ulysses S. Grant vigorously assailed Vicksburg, commanded by Gen. John C. Pemberton. To draw Union forces out of Virginia, Lee persuaded Davis to let him invade Pennsylvania, though Davis thought it better strategy to crush Grant at Vicksburg. Disaster came to Lee at Gettysburg on July 3. The next day Vicksburg fell; the Federals controlled the Mississippi river and the Confederacy was cut in two.

Despite these crushing defeats, unrelieved tensions, distressing lack of manpower and armaments, skyrocketing inflation, profiteering, and malicious newspaper criticism from friends of Gen. J. E. Johnston and Gen. P. G. T. Beauregard, Davis stood resolute, with Lee in agreement by his side. Even after Braxton Bragg's failure at Chattanooga in late November, Davis counted strongly on the organized armies still in the field, supply ships running the blockade, and a growing peace party in the war-weary North. In December, Davis sent an emissary, Dudley Mann, to Pope Pius IX to beg His Holiness to try to halt the vast emigration of impoverished Irish and German Catholics, whom Federal agents were luring by land grants and cash bounties to fight against the Confederates.

In 1864 Lee's depleted army of northern Virginia successfully withstood the onslaughts of the most powerful Federal army yet assembled. Grant, who had been made general-in-chief of all the Union forces, lost more in casualties than Lee possessed in total armed forces. Davis was continually on the Virginia battlefields, conferring with Lee and giving counsel. Lee declared Davis was "the best military adviser that he had ever consulted."

While Lee was making a brilliant defensive, J. E. Johnston was retreating before W. T. Sherman in Georgia. Davis had been persuaded to put Johnston in command of the army of Tennessee after Bragg's resignation. Now when Johnston seemed determined to give up strategic Atlanta, the frightened Georgia authorities, along with Secretary of War J. A. Seddon and the entire cabinet, clamoured for his dismissal. Under pressure, Davis removed Johnston on July 17 and put the daring young Gen. John Bell Hood in command. Hood made three vigorous, if unsuccessful, attacks on Sherman, and held Atlanta until Sept. 1, 1864. When Sherman occupied the city, Lincoln's re-election in November, which had been doubtful, was assured. Now Davis was denounced for having removed Johnston. The governors of North Carolina and Georgia became increasingly antagonistic and threatened to return their states to the Union. But Davis urged the southern people to hold to their principles and fight on for the rights of sovereign states under the constitution. In Sept. 1864, in *The Atlantic Monthly*, appeared a candid interview with Davis by a northern writer named Edmund Kirke, who declared Davis "a man of peculiar ability."

"Our interview . . . explained why with no money and no commerce, with nearly every one of their important cities in our hands, and with an army greatly inferior in numbers and equipment to ours, the Rebels have held out so long. It is because of the sagacity, energy, and indomitable will of Jefferson Davis. Without him the rebellion would crumble to pieces in a day."

On Nov. 8, heading a Union party with a Democrat, Andrew Johnson, for vice-president, Lincoln was re-elected over McClellan by a popular majority of less than 500,000. This result was regarded as a mandate to continue the war. At the end of 1864 the Federals won a decisive victory over Hood at Nashville, and Sherman made his burning march through Georgia to the sea. On Feb. 6, 1865, at the instigation of the Confederate congress, Davis formally appointed Lee commander-in-chief of all the southern armies. Meanwhile, on Jan. 28, with Grant still besieging Petersburg, Davis sent three commissioners headed by Vice-President Stephens to hold informal peace talks with Lincoln, who had hitherto refused to talk with any Confederate emissary. The Hampton Roads conference, held on Feb. 3, came to naught because Lincoln demanded union as a basis for peace while Davis would accept only southern independence. Finally in April, with his army crumbling at Petersburg, Lee wired the president to evacuate Richmond. Davis moved the executive offices to Danville, Va., on April 3. Lee surrendered at Appomattox on April 9. Davis and his cabinet moved to Greensboro, N.C., and then farther south. Davis planned to reach the trans-Mississippi area and continue the struggle until better terms could be secured from the North. He never gave up because he foresaw the kind of Reconstruction the Radical Republicans might inflict on a South helpless without arms. But at dawn on May 10, 1865, Davis was captured near Irwinville, Ga.

Taken to Ft. Monroe, Va., he was put in a casement cell with one small barred window facing the moat. The commandant, Maj. Gen. Nelson A. Miles, had heavy shackles placed on his ankles and kept a lamp burning by his bedside all night. Shocked public opinion in the North caused the chains to be removed. But under the prison rigours and the ceaseless tramping of two guards in his cell, Davis's health was severely impaired. He was later assigned better quarters and was joined by his wife. In May of 1867, after two years imprisonment, he was released on bail bond; among the signers of the bond was the famous abolitionist editor, Horace Greeley. To Davis's regret, he was never brought to trial. The treason case was dropped on Dec. 25, 1868. In shattered health Davis went to Canada and later to England, where he was warmly received and entertained by many of the nobility who had favoured the southern cause. Altogether he made five trips to Europe in his remaining two decades. Because of the North's hostility he was thwarted in several attempts to become the American agent of various British business concerns.

Davis was offered the presidency of the University of the South at Sewanee, Tenn., but, because the salary was too small to support his large family, he had to decline. For a few years he served as president of an insurance company in Memphis. In 1877 he retired to "Beauvoir," the Gulf coast estate of a friend (Mrs. Sarah A. Dorsey) near Biloxi, Miss., and Mrs. Dorsey ultimately bequeathed the property to him. In 1881, he published his two-volume work *The Rise and Fall of the Confederate Government.* Though pressed by the Mississippi electorate to re-enter the U.S. senate, he eschewed politics and refused to ask for amnesty. He never regained U.S. citizenship. As the elected leader of his people he felt he must uphold the principle that under the original constitution sovereign states had the right to secede, although secession had proved impracticable. This attitude increased resentment toward him in the North, and many northern historians dealt unkindly with him. Some southerners made him the scapegoat for their defeat and for the humiliations of Reconstruction. But Sen. John Daniel of Virginia put the matter simply in 1890: "Had a man less sober-minded and less strong than Davis been in his place the Confederacy would not only have gone down in material ruin—it would have been buried in disgrace."

Dedicated to the principles of democracy, Davis by temperament was an aristocrat of the benevolent kind; he believed in the strong protecting the weak. The official records and holograph letters absolve him from the charge that he interfered with his generals. Too often he took the blame for others' errors and kept silent for the sake of unity. He was perhaps too loyal to friends when they were out of favour. He stood by Judah P. Benjamin, the first Jewish cabinet member in America, when powerful interests opposed him. Though diplomatic to a degree, Davis did not possess the pliancy of the professional politician, and he could not conceal his silent reproach of self-seeking men. His pervading compassion had its counterpart of over-sensitivity. While sometimes austere in his dignity, he was really the warmest of men. Few public figures have won the devotion of so many associates, and he kept his friends in the North. He was idolized by his family and greatly loved by his in-laws and his one-time slaves. He had the power to stir soldiers and citizens to their noblest behaviour. His integrity and probity were impeccable, as persistent enemies discovered. Though he did not join a church (Episcopal) until he was 52, throughout his life his simple faith in God's grace sustained him in his trials.

Davis's personality was exceedingly attractive. "Erect as a spear," he stood 5 ft. 11 in. tall and became ascetically thin. His features were sculptured and handsome. His eyes were blue-gray, and in youth his hair was gold. His well-modulated speaking voice was said to be "of peculiar sweetness and resonance." Though when suffering excessive pain from facial neuralgia he was often irritable, he was noted for his courteous manner.

At "Beauvoir" in his last decade he continually received visitors from the North, the South, and abroad, and was generally acknowledged the leader of the South. On Dec. 6, 1889, at 81, Davis died in New Orleans of a complicated bronchial ailment. He was given the greatest funeral the South had ever seen when he was temporarily entombed in that city. On May 31, 1893, he was buried permanently in Hollywood cemetery in Richmond, Va.

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(HU. ST.)

DAVIS (DAVYS), **JOHN** (1550?–1605), English navigator who was, apart from Martin Frobisher, the first to make a serious attempt to find a northwest passage through the Canadian arctic to the Pacific. During the course of several voyages he explored much of the coasts of the strait that bears his name between Greenland and Baffin Island. He was born at Sandridge near Dartmouth about 1550 and made several voyages with Adrian Gilbert. In Jan. 1583 he appears to have broached his design of a northwest passage to Sir Francis Walsingham (*q.v.*) and the mathematician John Dee, and in 1585 he started on his first northwestern expedition. He began by striking the icebound east shore of Greenland, which he followed south to Cape Farewell; thence he turned north, and coasted the west Greenland littoral, and shaped a "course for China" by the northwest. In 66° N., however, he fell in with Baffin Island, and though he pushed some way up Cumberland sound, he turned back at the end of August. He tried again in 1586 and 1587; in the last voyage he pushed through the straits still named after him into Baffin bay, coasting west Greenland to 73° N. Many points in arctic latitudes (Cumberland sound, Cape Walsingham, Exeter sound, etc.) retain names given them by Davis, who ranks with Baffin and Hudson as the greatest of early arctic explorers.

In 1588 he seems to have commanded the "Black Dog" against the Spanish Armada, and in 1591 he accompanied Thomas Cavendish on his last voyage, with the object of searching "that northwest discovery upon the back parts of America." The rest of Cavendish's expedition returned unsuccessful, and Davis continued to attempt on his own the passage of the Strait of Magellan, and discovered the Falkland Islands. After his return in 1593 he published a valuable treatise on practical navigation in *The Seaman's Secrets* (1594), and *The World's Hydrographical Descrip-*

tion (1595) dealing with the problem of the northwest passage. His inventions of backstaff and double quadrant (called a "Davis Quadrant") remained in use long after John Hadley's reflecting quadrant had been introduced in the 18th century. In 1596–97 Davis sailed with Raleigh probably as master of Sir Walter's own ship to Cadiz and the Azores; and in 1598–1600 he accompanied a Dutch expedition to the East Indies as pilot. In 1601–03 he accompanied Sir James Lancaster as first pilot on his voyage in the service of the East India company; and in Dec. 1604 he sailed again for the same destination as pilot to Sir Edward Michelborne (or Michelbourn). On this journey he was killed by Japanese pirates off Bintang near Sumatra, on Dec. 29 or 30, 1605.

See Sir Albert Markham (ed.), *The Voyages and Works of John Davis the Navigator* (1880) and Sir Clements Markham, *A Life of John Davis* (1889).

DAVIS, JOHN WILLIAM (1873–1955), U.S. lawyer, diplomat and Democratic presidential candidate in 1924, was born at Clarksburg, W.Va., April 13, 1873, where he received his early education. He graduated from Washington and Lee university, Lexington, Va., in 1892, and from the law school there in 1895, being admitted to the bar in the same year. After a year as assistant professor of law at his alma mater, he returned in 1897 to Clarksburg, where he entered into an informal partnership with his father, also a lawyer, which continued until 1913. In 1899 he was elected a member of the West Virginia house of delegates and in 1910 to the U.S. house of representatives.

In Aug. 1913, Davis was appointed solicitor general of the United States, an office he held until 1918. During these years he also served as counsel for the American Red Cross. In 1918 he was appointed U.S. delegate to a conference with Germany at Bern, Switz., on the treatment and exchange of prisoners of war, and in the same year succeeded Walter Hines Page as U.S. ambassador to Great Britain, retaining this post until 1921.

During the peace conference at the end of World War I, Davis was one of Pres. Woodrow Wilson's advisers and helped draft the form of allied control and government in the occupied Rhineland territory. In 1921 he returned from England and accepted a partnership in a New York law firm. Davis was nominated on the 103rd ballot as Democratic candidate for the presidency at the Democratic national convention held in New York city, July 1924. The ensuing election resulted in an overwhelming victory for Calvin Coolidge, the Republican candidate.

Returning to private law practice, Davis appeared in a great many cases before the U.S. supreme court. The capstone of his career was his victory in 1952 when the supreme court ruled that Pres. Harry S. Truman had exceeded his powers in seizing control of the nation's steel mills. Davis took many cases without fee and closed his legal career by defending physicist J. Robert Oppenheimer against the charge that he was a security risk. He died in Charleston, S.C., March 24, 1955.

DAVIS, RICHARD HARDING (1864–1916), U.S. journalist and author whose romantic novels and short stories had notable success in his lifetime, was born in Philadelphia, Pa., April 18, 1864. He studied at Lehigh and Johns Hopkins universities, and in 1886 became a reporter on the *Philadelphia Record*. He then worked on various newspapers in Philadelphia and New York, wrote short stories, and, in 1890, became managing editor of *Harper's Weekly*. On *Harper's* assignments he toured various parts of the globe, recording his impressions in *The West from a Car Window* (1892), *The Rulers of the Mediterranean* (1894), *Our English Cousins* (1894), *About Paris* (1895) and *Three Gringos in Venezuela and Central America* (1896). He was a war correspondent, reporting every war from the Greco-Turkish to World War I, and the best known reporter of his generation. His tendencies toward sentimentality and the sensational made his writings immensely popular. His early fiction achieved immediate success, particularly *Gallegher and Other Stories* (1891), a collection of newspaper stories, and *Van Bibber and Others* (1892). Other short story collections were *The Lion and the Unicorn* (1899), *Ranson's Folly* (1902) and *The Scarlet Car* (1907). He wrote seven popular novels including *Soldiers of Fortune* (1897), *The King's Jackal* (1898), *Captain Macklin* (1902), *The Bar Sinister* (1903), *Vera the Medium* (1908) and *The White Mice* (1909). Several of his 25 plays were also very successful, notably *Ranson's Folly* (1904), *The Dictator* (1904), and *Miss Civilization* (1906). Harding was essentially the journalist in all his writings, treating subjects superficially while emphasizing the colourful and dramatic. He died near Mount Kisco, N.Y., April 11, 1916.

BIBLIOGRAPHY.—There have been several collected editions of Davis, the principal one being *The Novels and Stories of Richard Harding Davis* (12 vol., 1916). A collection of his best short stories, *From Gallegher to The Deserter*, was edited by Roger Burlingame in 1927. *See* also *The Adventures and Letters of Richard Harding Davis* (1917), edited by Charles B. Davis; H. C. Quinby, *Richard Harding Davis: A Bibliography* (1924); and F. D. Downey, *Richard Harding Davis: His Day* (1933).

DAVIS, THOMAS OSBORNE (1814–1845), Irish writer and politician, the chief organizer and poet of the Young Ireland movement, was born at Mallow, County Cork, Oct. 14, 1814. At Trinity college, Dublin, he evolved his ideal of uniting all creeds and classes in a vigorous Irish nationalism. In 1842, with Charles Gavan Duffy and John Dillon, he founded the weekly *Nation*, which, while giving momentum to Daniel O'Connell's agitation for restoring an Irish parliament, also became the organ of many gifted writers, soon known as the Young Irelanders. He also formed study groups on Ireland's economic and social problems and wrote patriotic verses, including "A Nation Once Again" and "The Battle of Fontenoy." An Irish Protestant, he resented the tendency to identify Irish nationalism with Roman Catholic interests, and a rift arose between O'Connell and the Young Irelanders, before Davis died from overwork in Dublin, Sept. 16, 1845. His writings became almost the gospel of the subsequent Sinn Fein movement.

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DAVIS, WILLIAM MORRIS (1850–1934), U.S. geographer, geologist and founder and acknowledged world leader of modern geomorphology, was born at Philadelphia, Pa., of Quaker stock on Feb. 12, 1850. After education at Harvard, he spent three years with the Argentine Meteorological observatory, Córdoba. Appointed to Harvard in 1876, he taught there until retirement (1912). To meteorology he contributed 42 papers, and *Elementary Meteorology* (1894). Turning to study of land forms, in the 1870's, he synthesized existing knowledge and illumined the entire field with his own penetrating analyses. He emphasized deductive reasoning, made rigorous field observations, and used drawings of unique clarity. Especially well known is his concept of the "cycle of erosion." His voluminous writings include *The Rivers and Valleys of Pennsylvania* (1889), *Physical Geography* (1898), *Geographical Essays* (1909), *Die Erklärende Beschriebung der Landformen* (1912), *The Coral Reef Problem* (1928) and *Origin of Limestone Caverns* (1930–1931). He died on February 5, 1934. (F. M. FL.)

DAVISON, WILLIAM (*c.* 1541–1608), secretary to Queen Elizabeth I, is chiefly remembered in connection with the execution of Mary Stuart. Of Scottish descent, he went to Scotland as secretary to the English ambassador, Henry Killigrew, in 1566. He remained there for about ten years. He was then employed as agent in the Netherlands (1576–79), on missions to Scotland (1583, 1584) and again to the Netherlands in 1585, returning to England in 1586. That year he became member of parliament for Knaresborough, a privy councilor and on Sept. 30 Sir Francis Walsingham's colleague as principal secretary. As a privy councilor, he was a member of the commission appointed to try Mary Stuart but he took no part in its proceedings. It was Davison who obtained Elizabeth's signature to the warrant for Mary's execution. On this occasion and also in subsequent interviews with her secretary, Elizabeth suggested that she would be glad to avoid the responsibility of the execution, but Mary's jailors, Sir Amias Paulet and Sir Drue Drury, refused to take the hints thrown out to them. Meanwhile, the privy council, summoned by Lord Burghley, decided to carry out the sentence at once, and Mary was beheaded on Feb. 8, 1587. When the news of the execution reached

Elizabeth she was extremely indignant, and her wrath was chiefly directed against Davison, who, she asserted, had disobeyed her instructions not to part with the warrant. The secretary was arrested and sent to the Tower of London. Charged before the Star Chamber (March 28, 1587) with misprision and contempt, he was acquitted by many of the commissioners of evil intention but was sentenced to pay a fine of 10,000 marks, and to imprisonment during the queen's pleasure.

However, Davison was released in Sept. 1589; he seems never to have paid the fine; his annuity as secretary, granted to him for life, was paid him until his death; and he continued to receive a secretary's share of the profits of the signet until Walsingham's death in 1590. Attempts were then made to secure his restoration to favour, but they failed, and he retired to Stepney, where he died. He was buried on Dec. 24, 1608. (R. B. Wm.)

DAVISSON, CLINTON JOSEPH (1881–1958), U.S. experimental physicist and Nobel laureate, was born at Bloomington, Ill., on Oct. 22, 1881, received his doctorate at Princeton university and spent most of his career at the Bell Telephone laboratories in New York city. He did distinguished work in several fields of physics, notably in the thermionic emission of metals both clean and oxide-coated, and pioneering work in electron microscopy. His fame, however, is based chiefly on his relationship to Louis de Broglie's principle that electrons are of a dual character, having the qualities both of corpuscles and of waves. While studying the reflection of slow electrons from metals, he noticed singular phenomena which eventually he interpreted as signs of the diffraction of electron waves by the periodic arrangement of the atoms in the crystals of the metal. These phenomena consisted in the appearance of beams of diffracted electrons proceeding in specific directions calculable by De Broglie's theory, allowance being made for the refraction of the electrons in the metal. In this work he had as his associate L. H. Germer, and for the discovery of the diffraction of electrons he shared the Nobel prize in physics in 1937 with G. P. (later Sir George) Thomson of England. He died in Charlottesville, Va., on Feb. 1, 1958. *See* also Electron: *Electron Wave Length;* Electron Diffraction. (K. K. D.)

DAVIS STRAIT separates Greenland from North America and connects Baffin bay with the Labrador sea. At its narrowest point, which coincides with the Arctic circle, it is 200 mi. wide. The strait is the site of a submarine threshold, showing maximum soundings of 330 fathoms, which separates the depths of Baffin bay from those of the Labrador sea. Along the eastern shore the west Greenland current carries relatively warm water northward. Along the western shore the Canadian current carries very cold water and masses of sea ice southward, joining the Labrador current beyond the strait. From the vast interior Greenland icecap, great numbers of icebergs are discharged into these waters. The largest icebergs eventually may be carried far south into shipping lanes by the Labrador current. The navigation season for the principal west Greenland settlements, which dot the coast from Cape Farewell to Disko Island, extends from midsummer to late fall, with great annual variations. The Baffin Island coast has few permanent settlements, and navigation is hazardous even in the best season. Shipping routes through the strait traverse the east side, near the Greenland coast. The strait takes its name from its discoverer, the explorer John Davis. *See* Arctic, The: *Exploration: Northwest Passage.* (T. M. G.)

DAVITT, MICHAEL (1846–1906), Irish nationalist, the founder of the Land league, was born at Straide, County Mayo, on March 25, 1846. His father, a small tenant farmer, was evicted in 1852 and migrated to Lancashire, where Michael started work in a cotton mill in 1856. A year later he lost his right arm in a machinery accident. After a few years at school he became a newsboy and "printer's devil." He joined the new Fenian brotherhood in 1865, and was appointed organizing secretary of the Irish Republican brotherhood (I.R.B.) for England and Scotland in 1868. He was arrested at Paddington, London, on May 14, 1870, for sending firearms to Ireland, and was sentenced to 15 years penal servitude, but after serving 7 years he was released on ticket-of-leave.

Davitt at once rejoined the I.R.B. and went to the U.S. where his American mother had settled with her family. In prison, Davitt had conceived the plan of linking the revolutionary Fenian movement with the constitutional agitation which C. S. Parnell was actively promoting in parliament, and combining agrarian and political agitation. On his return to Ireland from the U.S. he secured Parnell's cooperation in organizing the Land league in 1879. His policy of the "new departure" in associating Fenian forces with Parnell's parliamentary campaign led to his expulsion from the supreme council of the I.R.B. in 1880. For his vehement speeches he was imprisoned in 1881–82, and again for four months in 1883. He had been elected member of parliament for Meath in 1882, but as a convict was disqualified from taking his seat.

During his stay in the U.S. Davitt had been deeply influenced by Henry George and his program of land nationalization. He campaigned on those principles in Ireland, but was repudiated by Parnell, and the final settlement of the land question on a basis of peasant ownership went against Davitt's convictions. In 1887–89 Davitt took a leading part in the defense of the nationalists before the Parnell commission. His five-day speech to the commission was published in 1890 as *The Defence of the Land League.* However, the commission's charge that Davitt brought the Irish parliamentary party in touch with the American Fenians was unanswerable. In 1890, when the Irish party split over Parnell's involvement in Capt. W. H. O'Shea's divorce case, Davitt was among the first to oppose his continuance as leader, mainly because Parnell had deceived his colleagues with assurances that O'Shea had no case against him.

Davitt was elected to parliament in 1892 and 1893 but was unseated on petition the first time, and for bankruptcy the second. He was elected member for West Mayo in 1895, but he was not at home in Westminster and resigned his seat in 1900 in protest against the South African War. He worked with William O'Brien in founding the United Irish league (1898) to reconcile the conflicting sections of the Irish party, but he strongly disapproved of the Irish Land Purchase act (1903), introduced by George Wyndham in co-operation with O'Brien, on the ground that the landlords were receiving compensation for property which belonged to the state.

Davitt died in Dublin on May 31, 1906. He had been a symbolic figure, representing the multitude of depressed tenants and labourers who had endured famine during his early childhood. He was a devout Roman Catholic, but, as a Fenian, opposed ecclesiastical authority in the state. His demand for land nationalization met with almost no support in Ireland; his political connections were rather with the radical elements of the rising Labour movement in Great Britain. His book, *The Fall of Feudalism in Ireland* (1904), is a valuable record of the period.

See F. Sheehy Skeffington, *Michael Davitt* (1908). (D. G.)

DAVOS (Romansch Tavau), one of the chief winter sports centres in Switzerland, canton of Graubunden (the Grisons), comprises the villages of Davos-Dorf and Davos-Platz which take their names from the Davos valley, 5,015 ft. above sea level. Pop. (1960) 9,588. The facilities for winter sports are excellent, the Parsenn run from 8,700 to 5,100 ft. being one of the world's most perfect ski runs. There are ski schools, sanatoria (Davos is a great centre for the treatment of tuberculosis) and beautiful walks in winter and summer. The Davoser See is to the north of the villages. Davos is connected to Chur and the Engadine by narrow-gauge railway. Formerly the valley contained many iron mines. Tavaus or Tavauns is mentioned in 1160 and 1213 as a mountain "alp." At that time it was populated by Romansch-speaking people, but between 1260 and 1282 it was settled by German speakers from the upper Valais. In 1436 it became capital of the League of Ten Jurisdictions (*see* Graubünden) and from 1477 to 1649 it belonged to Austria. In 1860 the population was only 1,705; the town's growth as a holiday and health resort took place thereafter.

DAVOUT, LOUIS NICOLAS, Duc d'Auerstädt and Prince d'Eckmühl (1770–1823), French marshal of the Napoleonic era, was born at Annoux in Burgundy on May 10, 1770. Though a cavalry officer and a noble, he opposed the *ancien régime,* headed a riot at his depot in 1790, went home and was elected to

command the local volunteers (2nd Yonne battalion). With them he fought in Belgium and on April 4, 1793, encountered the traitor general C. F. Dumouriez and fired on him. This act of "citizenship" made him a general at 23, but he obtained leave to retire to study for future service. In 1795–97, however, he had a brigade on the Rhine. Then, with his friend L. C. A. Desaix, he went to Italy to see Napoleon and so to Egypt with a cavalry brigade. He returned in time to command Guillaume Brune's cavalry in Italy (Dec. 1800). Davout expressly took a line of absolute devotion to Napoleon and by marrying Louise Aimée Leclerc, Pauline Bonaparte's sister-in-law, became a member of his family and so a marshal in 1804.

At the Bruges camp he trained the III corps of the *Grande Armée* for the invasion of England, handling his 14 regiments (all but one of which he kept to 1812) with constant care and the strictest method. In central Europe in 1805 he had only one division at the battle of Austerlitz, but it held the vital point at the critical time. On the Saale river in 1806 the III corps was sent out with poor information and met the main Prussian army, twice its strength: the divisions of L. Friant, C. Gudin and C. Morand reached good positions in villages, and the Prussians were broken on them with such loss that the battle of Auerstädt (*q.v.*) was a greater victory than Jena. The III corps was now the corps *d'élite* and Davout the chief lieutenant of the emperor. They saved the day at Eylau in 1807; and in 1809 they brought the army out of danger on the Danube, fighting as only picked troops could the long battle of their flank at Eckmühl, which gave Davout his title of prince (1809; he received his ducal title in 1808). At Wagram (1809) and again on the Moskva during the campaign of 1812 in Russia their task was an obstinate frontal struggle which ended in success for the better troops. At last, however, at Vyazma (Nov. 3, 1812) the III corps broke, and at Krasnoe (Nov. 17) was held to have deserted Michel Ney and lost his renown as a leader in battle.

Napoleon meanwhile had also given Davout political posts: the control of Poland and Germany in 1807–09 and the governorship of the Hanseatic towns in 1810. In 1813 Davout was sent to recover Hamburg and to terrorize northern Germany. In the latter task he failed, though Europe long remembered his seizure of the bank of Hamburg as a war crime. Yet he held Hamburg till the peace of Paris by good organization, using his own resources.

It was as an organizer that Davout was employed by Napoleon in 1815, as minister of war during the Hundred Days. He collected the army for Waterloo, making mistakes, especially in the choice of generals, for his difficult character had isolated him and he did not know them. From June 21 to July 27 he was commander in chief in Paris and on the Loire, in five painful weeks of undecided resistance. On the second Restoration he was interned until 1817. He died of tuberculosis in Paris on June 1, 1823. (I. D. E.)

DAVY, SIR HUMPHRY, BART. (1778–1829), brilliant English chemist and exponent of the scientific method, inventor of the miner's safety lamp and discoverer of sodium and potassium, was born in Penzance, Cornwall, on Dec. 17, 1778, the elder son of middle-class parents with an estate nearby. He was educated at a preparatory school, the grammar school in Penzance and, in 1793, at Truro. In 1795, a year after the death of his father, Robert, he was apprenticed to J. B. Borlase, surgeon and apothecary (later physician), hoping eventually to qualify in medicine. An exuberant, affectionate and popular lad, of quick wit and lively imagination, he was fond of composing verses, sketching, making fireworks, fishing, shooting and collecting minerals. He loved to wander, one pocket filled with fishing tackle and the other with rock specimens; he never lost his intense love of nature and particularly of mountain and water scenery.

While still a youth, ingenuous and somewhat impetuous, Davy had plans for a volume of poems, but he began the serious study of science in 1797 and these visions "fled before the voice of truth." He was befriended by Davies Giddy (later Gilbert), who offered him the use of his library and took him to the Copper House at Hayle, Cornwall, where, with tumultuous delight, Davy first saw a well-equipped chemical laboratory. Though inexperienced, he held strongly independent views on topics of the moment, such as the nature of heat, light and electricity and the doctrines of A. L. Lavoisier. In his small private laboratory he prepared and inhaled nitrous oxide (laughing gas), in order to test a claim that it was the "principle of contagion." On Gilbert's recommendation he was appointed (1798) chemical superintendent of the Medical Pneumatic institution, founded at Clifton by Thomas Beddoes to inquire into the possible therapeutic uses of various gases. Davy attacked this problem with characteristic enthusiasm, evincing an outstanding talent for experimental inquiry. He investigated the composition of the oxides and acids of nitrogen, as well as ammonia, and persuaded his scientific and literary friends, including S. T. Coleridge, Robert Southey and P. M. Roget, to report the effects of inhaling nitrous oxide. He nearly lost his own life inhaling water gas. The account of this work, published as *Researches, Chemical and Philosophical* . . . (1800), immediately established his reputation and he was invited to lecture at the newly founded Royal institution in London, where he moved in 1801, with the promise of help from Count Rumford, Sir Joseph Banks and Henry Cavendish in furthering his researches; *e.g.*, on voltaic cells. His carefully prepared and rehearsed lectures rapidly became important social functions and added greatly to the prestige of science and the institution. In 1802 he was styled professor. His duties included a special study of tanning: he found catechu as effective and cheaper than the usual oak extracts and his published account was long used as a tanner's guide. In 1803 he was admitted a fellow of the Royal society and an honorary member of the Dublin society and delivered the first of an annual series of lectures before the board of agriculture. This led to his *Elements of Agricultural Chemistry* (1813), the only systematic work available for many years. For his researches on voltaic cells, tanning and mineral analysis, he received the Copley medal in 1805. He was elected secretary of the Royal society in 1807.

Davy early concluded that the phenomena of simple cells resulted from chemical action and that combination occurred between substances of opposite charge. He therefore reasoned that electrolysis offered the most likely means of decomposing all substances to their elements. These views were explained in his Bakerian lecture of 1806 "On some Chemical Agencies of Electricity," for which he received Bonaparte's prize from the Institut de France, despite the fact that England and France were at war. This work led directly to the isolation of sodium and potassium from the alkalis (Bakerian lecture, 1807) and of the alkaline-earth metals (1808). He also discovered boron (by heating borax with potassium), hydrogen telluride and hydrogen phosphide (phosphine). He showed the correct relation of chlorine to hydrochloric acid and the untenability of the earlier name (oxymuriatic acid) for chlorine and of the oxygen theory of acids. He explained the bleaching action of chlorine (through its liberation of oxygen from water) and discovered two of its oxides (1811 and 1815). His views on the nature of chlorine were disputed, but experiments designed to reveal oxygen in the substance failed.

In 1810 and 1811 he lectured to large audiences at Dublin (on agricultural chemistry; the elements of chemical philosophy; geology) and received £1,275 in fees, as well as the honorary degree of LL.D. from Trinity college. In 1812 he was knighted by the prince regent (April 8), delivered a farewell lecture to members of the Royal institution (April 9) and married Jane Apreece, a wealthy widow well known in social anad literary circles in England and Scotland (April 11). He also published the first part of the *Elements of Chemical Philosophy*, which contained much of his own work; his plan was too ambitious, however, and no more appeared. Its completion, according to J. J. Berzelius, would have "advanced the science of chemistry a full century."

His last important act at the institution, of which he remained honorary professor, was to interview the young Michael Faraday, who became laboratory assistant there in 1813 and accompanied the Davys on an European tour (1813–15). By permission of Napoleon he traveled through France, meeting many prominent scientists, and was presented to the empress Marie Louise. With the aid of a small portable laboratory and of various institutions

in France and Italy, he investigated the substance "X" (later called iodine), whose properties and similarity to chlorine he quickly discovered; further work on various compounds of iodine and chlorine was done before he reached Rome. He also analyzed many specimens of classical pigments and proved that diamond was a form of carbon.

Shortly after his return he studied, for the Society for Preventing Accidents in Coal Mines, the conditions under which mixtures of fire-damp and air explode. This led to the invention of the safety lamp and to subsequent researches on flame, for which he received the Rumford medals (gold and silver) from the Royal society and, from the northern mine owners, a service of plate (eventually sold to found the Davy medal). After being created a baronet in 1818, he again went to Italy, inquiring into volcanic action and trying unsuccessfully to find a way of unrolling the papyri found at Herculaneum. In 1820 he succeeded Banks as president of the Royal society, a position he held until 1827. In 1823–25 he was associated with J. W. Croker in founding the Athenaeum club, of which he was an original trustee, and with Sir Stamford Raffles in founding the Zoological society and in furthering the scheme for zoological gardens in Regent's park, London (opened in 1828). During this period he examined magnetic phenomena caused by electricity and electrochemical methods for preserving copper sheathing on ships by means of iron and zinc plates. Though the protective principles were made clear, considerable fouling occurred and the method's failure greatly vexed him. But he was, as he said, "burned out." His Bakerian lecture for 1826 "On the Relation of Electrical and Chemical Changes" contained his last thoughts on electrochemistry and earned him the Royal society's royal medal.

Davy's health was now failing rapidly; in 1827 he departed for Europe and, in the summer, was forced to resign the presidency of the Royal society, being succeeded by Davies Gilbert. Having to forego business and field sports, Davy wrote *Salmonia* (1828), a book on fishing (after the manner of Izaak Walton) that contained engravings from his own drawings. After a last short visit to England he returned to Italy, settling at Rome in Feb. 1829—"a ruin amongst ruins." Though partly paralyzed, he spent his last months writing a series of dialogues published posthumously as *Consolations in Travel, or the Last Days of a Philosopher* (1830). He suffered a further stroke and soon afterward was joined by Lady Davy from London and his brother, John Davy, then stationed at Malta. He made a slow recovery and insisted on moving to Geneva, where he died during the night after his arrival, on May 29, 1829. *See* also references under "Davy, Sir Humphry" in the Index volume.

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DAWES, CHARLES GATES (1865–1951), U.S. vice-president, ambassador and author of the "Dawes plan" for managing Germany's reparations payments. He was a colourful and outspoken public figure and devoted a long career to finance and public service. Born in Marietta, O., on Aug. 27, 1865, he graduated from Marietta college in 1884. He entered the legal profession from the Cincinnati law school and practised in Lincoln, Neb., from 1887 to 1894. Becoming interested in midwestern public utilities, he made his permanent home in Evanston, Ill. Dawes worked prominently in the successful 1896 campaign of William McKinley for president and was rewarded with appointment as U.S. comptroller of the currency, an office he held from 1898 to 1902. In 1902 he returned to private business and organized the Central Trust Co. of Illinois, which became a powerful bank serving the middle west.

During World War I, Dawes became head of supply procurement for the American Expeditionary Force in France, where he remained to direct the disposal of surplus materials. He resigned as brigadier general in 1919 after gaining wide notice as a bluntly effective administrator. This reputation was expanded with Dawes' appointment in 1921 as the first U.S. director of the budget.

In 1923 the Allied Reparations commission, with unofficial encouragement from the U.S. department of state, appointed Dawes chairman of a board of financial experts to plan a solution for the problem of Germany's inability to pay reparations to the Allies. Dangerous European financial instability was revealed when Germany ceased payment of reparations and threatened a failure of Allied war debt payments to the United States. The Dawes plan, submitted in 1924, provided for a reorganization of German finances with the assistance of loans from U.S. investors. This plan saved Europe from economic collapse but it was only a partial and temporary solution for the dilemma of world economic disorganization. (*See* REPARATIONS.) In 1925 Dawes was awarded the Nobel peace prize jointly with Sir Austen Chamberlain.

As a popular public figure Dawes was nominated for the vice-presidency by the 1924 Republican convention after the nomination had been declined by F. O. Lowden. Dawes was more active than President Coolidge in the campaign and they were elected by a large majority. While vice-president and therefore president of the U.S. senate, Dawes urged reforms in the senate rules, making them a public issue, but without result. After completing his term as vice-president, Dawes provided technical assistance in reorganization of the Dominican Republic's financial system and then represented the U.S. as ambassador to Great Britain from 1929 to 1932. While in this post he also served as delegate to the London Naval conference in 1930. In 1932, when the economic depression was severe, he returned to the United States to direct the Reconstruction Finance corporation, which made loans to banks and other key enterprises. He resigned the same year and re-entered the banking business. He died in Evanston, Ill., on April 23, 1951.

Dawes contributed to several philanthropies, including the foundation of charitable lodging houses. He was the author of works on banking and several books of memoirs.

See Bascom N. Timmons, *Portrait of an American: Charles G. Dawes,* (1953). (J. H. Sh.)

DAWES PLAN: *see* REPARATIONS.

DAWLISH, an urban district and seaside town of Devon, Eng., lies on a bay of the English channel sheltered by two headlands, 13 mi. S.S.E. of Exeter by road. Pop. (1961) 7,807. The Lawn and Manor pleasure grounds are enhanced by an ornamental stream running through the centre of the town. The earliest recorded history is given in a document of 1044 signed by Edward the Confessor granting the royal manor of Dawlish to his favourite chaplain, Leofric. Because of the equable climate and the sandy beaches, flower growing and the tourist trade are the main industries.

DAWN, the time when light appears in the sky. The dawn colours appear in the reverse order from those of the sunset. When the sun is lowest in both cases the colour is deep red; this gradually changes through orange to gold and yellow as the sun leaves the horizon. This is their order of refrangibility in the spectrum; the blue rays usually are scattered in the sky. The colours of the dawn are purer and colder than the sunset colours as the reduced dust content of the atmosphere causes less sifting of the light rays. *See* also TWILIGHT.

DAWN REDWOOD (*Metasequoia*), the most abundant fossil conifer of the northern hemisphere, first appeared during the Age of Dinosaurs and became extinct in North America and Europe during the Miocene epoch, about 15,000,000 years ago. It lingered on into the Pliocene epoch in Japan, and in the 1940s was found living in remote valleys in Szechuan and Hupeh provinces, China. Growing with it are descendants of its forest associates of past ages, birch, oak, chestnut, maple and katsura. Only 1,000 dawn redwoods are known to have survived in central China, but since it was discovered its seeds and cuttings have been planted widely over most of the world. It requires moist soil with good drainage in a sunny environment; under favourable conditions, early growth is quite rapid.

Fossil dawn redwoods were long confused with the living California coast redwood, *Sequoia sempervirens*. Although dawn redwood is placed in the bald cypress family (Taxodiaceae) with modern redwoods, recent comparisons of fossil and modern foliage

and cones show marked differences: dawn redwood needles are borne in opposite pairs (decussate phyllotaxy) instead of alternately; its branches and cone scales are also opposite; its long-stalked cone is distinctive. Perhaps the most significant difference is the shedding of dawn redwood leaves in the autumn, a habit apparently necessary during the long winters of its original home in Alaska, Greenland and Spitsbergen. (R. W. Cy.)

DAWSON, GEORGE GEOFFREY (1874–1944), English journalist, editor of the *Times* from 1912 to 1919 and from 1923 until his retirement in 1941, was born at Skipton-in-Craven, Yorkshire, Oct. 25, 1874. His name was originally Robinson, but he changed it by deed poll in 1917, following an inheritance. Educated at Eton and at Magdalen college, Oxford, and elected a fellow of All Souls college, Oxford, in 1898, he entered the civil service and went to South Africa (1901) as private secretary to Lord Milner, then high commissioner. He became a journalist almost by accident, when Milner persuaded the owners of the *Johannesburg Star* to appoint him editor, to ensure continued support for the Milner policy after Milner's return to England. Dawson became Johannesburg correspondent of the *Times*, and by his dispatches attracted the personal interest of Lord Northcliffe, its new director, who invited him to extend its "Imperial side." In 1912 Dawson succeeded G. E. Buckle, whom Northcliffe had never liked, as editor and provided a valuable counterpoise to Northcliffe's erratic genius during World War I. By 1919, however, Northcliffe's increasing determination to run the paper as an instrument of his personal policy led to a break, and Dawson agreed to go. He was succeeded by Henry Wickham Steed (*q.v.*), but in 1923, after Northcliffe's death (1922), when John Jacob Astor (later Lord Astor) became chief proprietor, Dawson was invited to return, on terms which gave him authority over editorial policy.

As editor of the *Times* Dawson exercised great influence on affairs for more than a quarter of a century, yet in an important sense this influence was not primarily journalistic and certainly not one that his predecessors Thomas Barnes and J. T. Delane, who believed that the paper must not commit itself to any government or person, would have approved. For, although he had quarreled with Northcliffe for doing the same thing, he made the *Times* the instrument of his personal policy, rather than himself becoming the instrument of a journalistic policy based upon impartiality. A close intimate in turn of Stanley Baldwin, Neville Chamberlain and, to a lesser extent, Ramsay MacDonald, he was a leader in the group connected with the quarterly magazine, the *Round Table*, which sought, from the highest sense of duty, to influence national policies by intimate and private exchanges with leading statesmen; he saw himself as the "secretary-general of the Establishment." A firm believer in appeasement, he became, both through the *Times* and in personal relations with ministers, one of the chief instruments of the policy that reached its climax at Munich, and, in pursuit of ends which he honourably espoused, did not hesitate to censor the dispatches of his foreign correspondents when they disclosed facts which might, in his view, turn public opinion against that policy. He was too committed a man to be an editor of the highest rank, but according to his lights he served the *Times* well. He died in London, Nov. 7, 1944. (E. F.-Ws.)

DAWSON or Dawson City, a town of Yukon territory, Can., is best remembered for the fabulous tales about it as a boom town during the Klondike gold rush at the turn of the century. At the height of the rush, in 1899, the city had a population of 10,000. By 1911, however, there were only 3,000 in the settlement and after 1921 the population was less than 1,000.

Dawson occupies a narrow beach less than one mile wide on the east bank of the Yukon river just north of its confluence with the Klondike river. Owing to its latitude of about 64° N., Dawson has almost continuous daylight in late June. Garden vegetables grow well, and during the gold rush there were farms on nearby river benches. Although the average monthly temperature for July is 60° F., temperatures of 80° F. may be experienced. January average monthly temperatures are about −20° F., with extremes of −50° F. and below. The average annual precipitation is about 12 in. and there is comparatively little snowfall.

Dawson was the capital of Yukon territory from 1898 until 1951, when the administration was moved to Whitehorse. Dredges still operate in the Klondike river, extracting gold from the river gravels; this is the main occupation in the region. The town has a Royal Canadian Mounted Police detachment, schools, a hospital and a small false-fronted commercial section. The tourist trade, once important, faded with the decline of river traffic. *See* also Yukon Territory: *History*. (J. L. R.)

DAX, a town of southwestern France in the Landes *département*, lies on the left bank of the Adour river, 142 km. (94 mi.) S.W. of Bordeaux by road and 80 km. (50 mi.) from Spain. Pop. (1962) 16,016. It is a well-known spa with thermal waters and mud baths for the cure of rheumatism. The Fontaine Chaude, a hot-water spring in the town centre, gives 454,600 gal. an hour at 147° F. Dax, on the southern edge of the forest of Landes (*see* Landes, Les), is also a centre for tourists. The cathedral, rebuilt in the 17th century, has a magnificent 13th-century doorway. In the church of St. Paul les Dax (11th–12th century) is a Romanesque apse with curious bas-reliefs. The ancient Gallo-Roman fortifications are a promenade. There are a bull ring in a fine park, an archaeological and folklore museum and a military airfield. Pouy, 5 km. (3 mi.) away, is the birthplace of St. Vincent de Paul, and 9 km. off is Buglose, a sanctuary with a miraculous statue of the Virgin Mary. Around Dax are salt mines, coniferous plantations and farming land. Pinewood, resin, turpentine and cork are traded, and agricultural and poultry produce includes maize, geese, ducks and *foie gras*.

Dax, the ancient Aquae Tarbellicae and then Aquae Augustae, was the capital of the Tarbelli tribe in classical times, when its waters were already famous. In the 11th century its viscounty passed to the viscounts of Béarn and in 1177 it was annexed to Gascony by Richard I of England. In World War II Dax was in German hands from June 1940 to Aug. 1944. (M. J. B.)

DAY, CLARENCE SHEPARD (1874–1935), U.S. writer, whose greatest popular success was his autobiographical *Life With Father*, was born in New York city, Nov. 18, 1874. He was educated at St. Paul's school, Concord, N.H., and at Yale, from which he graduated in 1896. Following in the footsteps of his father, a prominent Wall street broker, he became a member of the New York Stock exchange in 1897 and joined his father's firm as a partner. He enlisted in the navy the following year, but was soon stricken by arthritis, a disease that invalided him for the rest of his life. He died in New York city on Dec. 28, 1935.

In 1920 his first book, *This Simian World*, a collection of humorous essays and illustrations, appeared. This was followed by *The Crow's Nest* (1921) and *Thoughts Without Words* (1928). He achieved great success with *God and My Father* (1932), *Life With Father* (1935) and *Life With Mother* (1937). Drawn from his own family experiences, these were pleasant and gently satirical portraits of a late Victorian household dominated by a gruff, opinionated father and a warm, charming mother. *Life With Father* was dramatized by Howard Lindsay and Russel Crouse in 1939 and had a decade of almost phenomenal success on the American stage.

See H. S. Canby, "Clarence Day, Jr." in the *Saturday Review of Literature* (Aug. 24, 1935).

DAY, JOHN (1574–1640?), English dramatist of a peculiar delicacy of fancy and a dainty inventiveness, as shown by his six surviving dramas, was born at Cawston, Norfolk, in 1574, and educated at Ely. He became a sizar of Gonville and Caius college, Cambridge, in 1592 but was expelled in the next year for stealing a book. As early as 1598 he became one of Philip Henslowe's playwrights, collaborating with Henry Chettle, William Haughton, Thomas Dekker, Richard Hathway and Wentworth Smith, but his almost incessant activity seems to have left him poor enough, to judge by the small loans, of five shillings and even two shillings, that he obtained from Henslowe. The first play in which Day appears as part author is *The Conquest of Brute, with the Finding of the Bath* (1598), which, with most of his journeyman's work, is lost. *The Ile of Guls* (printed 1606), a prose comedy founded upon Sir Philip Sidney's *Arcadia*, contains much

satire in its light dialogue, but the meaning of it is no longer understood. In 1607 Day produced, with William Rowley and George Wilkins, *The Travailes of the Three English Brothers*, which detailed the adventures of Sir Thomas, Sir Anthony and Robert Shirley. Day's reputation chiefly rests on the *Parliament of Bees*. This exquisite masque, or rather series of pastoral eclogues, is occupied with "the doings, the births, the wars, the wooings" of bees. The bees hold a parliament under Prorex, the Master Bee, and complaints are preferred against the humblebee, the wasp, the drone and other offenders. This satirical allegory ends with a royal progress of Oberon, who distributes justice to all. Its beauty and ingenuity were praised by Charles Lamb. There is no earlier edition than that of 1641, but a persistent tradition has assigned the piece to 1607. In 1608 Day published two comedies, *Law Trickes or, Who Would Have Thought it?* and *Humour out of breath*. His death date is unknown, but an elegy on him by John Tatham, the city poet, was published in 1640.

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DAY (Daye), **STEPHEN** (*c.* 1594–1668), credited with being the first printer in the English American colonies, was born in London and worked as a locksmith in Cambridge. It does not appear that he himself was a printer, but his two sons were probably apprentices in a Cambridge printing office. In July or August of 1638, he contracted with the Rev. José Glover of Sutton, England, a dissenting clergyman of some wealth, to set up the first printing plant in the English colonies. Although Glover died on the sea voyage, Day, with the help of Glover's widow, set up the plant at Cambridge, Mass., in the autumn of 1638, but it was not until March of 1639 that the shop was in full operation. The first piece of printing from the press was *The Freeman's Oath* (Jan. 1639); the second was an *Almanack* by William Pierce, a mariner (1639); the third was *The Whole Booke of Psalms*, now known as the *Bay Psalm Book* (1640). Stephen Day's name does not appear in connection with the imprint on any of his publications. The name of his son Matthew, who was next in charge and apparently did the typesetting, appears on the title page of the *Almanack* (1647). When Glover's widow married Henry Dunster, president of Harvard college, the press of Stephen Day became the forerunner of the Harvard University Press, considered the oldest in the United States. Day died at Cambridge, Mass., on Dec. 22, 1668. (W. V. Ha.)

DAY, THOMAS (1748–1789), English philanthropist, follower of Rousseau and author of *Sandford and Merton* (1783–89), a moral story for children showing Day's belief in the power of reason and the practical wisdom of doing right. Born in London, June 22, 1748, Day was educated at Corpus Christi college, Oxford, and became a friend of Richard Lovell Edgeworth (*q.v.*). Having independent means he devoted himself to study and philanthropy. He brought up two foundlings, one of whom he hoped to marry, but neither acquired the quality of stoicism he looked for, and he married an heiress who agreed with his asceticism. He settled in 1781 at Ottershaw, Surrey, farming on philanthropic principles. His poem *The Dying Negro* (1773) struck the keynote of the antislavery movement. He died at Wargrave, Berkshire, on Sept. 28, 1789.

DAY, in astronomy, the interval of time that transpires during one revolution of the earth on its axis. Days are distinguished as solar, sidereal or lunar, depending on whether the revolution is taken relative to the sun, the stars or the moon. The solar day is the fundamental unit of time in civil life and in astronomical practice. In the latter case, where it is determined by observations of the sun, the day is taken to begin with the passage of the mean sun over the meridian of the location in question, or at mean noon, while the civil day begins at midnight.

The question of a possible variability in the length of the day is one of fundamental importance. One effect of the tidal retardation of the earth's rotation is gradually to increase this length. It is remarkable that the discussion of ancient eclipses of the moon, and their comparison with modern observations, show only a small and rather doubtful change, amounting perhaps to less than one-hundredth of a second per century. As this amount seems to be less than that which would be expected from the tides, it is probable that some other cause tends to accelerate the earth's rotation and thus shorten the day. (*See* Calendar; Time Measurement.) (X.)

Legal Aspects.—In law the word day, unless qualified, means the natural day consisting of the 24 hours between midnight and midnight, rather than, *e.g.*, the daylight hours between sunrise and sunset. Most problems are concerned with the computation of time, as when a number of days or some other period is prescribed for the doing of an act. In general, when an act is to be done within a specified number of days from or after the occurrence of some event, the day on which the event occurs is excluded and the day on which the act is to be done is included. Thus, if an agreement is executed on Aug. 1 giving one of the parties the right to buy property from the other at a certain price, provided he signifies his acceptance within 30 days from the execution of the agreement, an acceptance or exercise of the option is timely if it is communicated on Aug. 31. If that date falls on a Sunday, the time will be extended to the following day. Parts of a day are not considered for such purposes; *e.g.*, if the option agreement is executed at noon on Aug. 1, the holder nevertheless has until midnight of Aug. 31 in which to exercise it. Thus, also, a person comes of age in the first minute of the 21st anniversary of his birth, regardless of the hour of his birth. These general rules are not universally accepted, and are subject to modification by contract or by statute.

Lay days are the time given the charterer of a vessel to load or unload cargo without paying demurrage. (B. Ce.)

DAYAK (Dyak). The population of Borneo falls into two categories: the coastal peoples consisting predominantly of Malays, together with settlers (such as the Bugis, Javanese, etc.) from other parts of Indonesia and immigrant Chinese; and the indigenous peoples of the interior. Dayak is a general term (derived from the Malays) which is applied to any of these indigenous peoples. The Dutch variant Dajak has the same wide connotation, being used to refer to any non-Malay native inhabitant of Borneo. Dayak is thus a generic term with no precise ethnic or tribal significance.

All the native inhabitants of Borneo belong to the Mongoloid stock of the human race. Within Borneo two main strains have been distinguished: the first, less specifically Mongoloid, being termed Indonesian or Nesiot, *e.g.*, the Land Dayaks; and the second, more specifically Mongoloid, called Pareocan or proto-Malay; *e.g.*, the Iban or Sea Dayaks. Although all may be classified as Mongoloid, they are divided culturally into many different peoples and, in terms of social and political organization, into numerous separate tribes. Among the most important of the major groupings are the Bahau tribes (including the Kayan and Kenyah) of central and eastern Borneo, the Ngadju tribes of southern Borneo, the Land Dayaks of southwestern Borneo and the Iban or Sea Dayaks of Sarawak. The total Dayak population of Borneo is probably between 1,000,000 and 1,250,000.

With the exception of the Punans and other forest nomads of the deep interior (who live by hunting and by gathering wild produce), most Dayak tribes have a number of characteristics in common. They are riverine peoples, living in long-house communities (of seldom more than a few hundred members) based on bilateral kinship. In general, their subsistence economies rest on the shifting cultivation of hill rice, with fishing and hunting as subsidiary activities. Their tools are of iron and their principal weapons the sword, the spear and the blowpipe. Their languages all belong to the Indonesian section of the Austronesian group. Their religions, animistic, polytheistic and with shamanistic cults, are highly developed and complex. Formerly intertribal warfare was rife, with head-hunting as one of its major aspects. Many Dayaks are still preliterate and pagan; however, with the establishment of education and other services, economic, social and political change has become widespread and rapid. *See* also Borneo: *The People: The Dayak Peoples;* Iban; Kayan; Punan. (J. D. Fn.)

DAYLIGHT, ARTIFICIAL. The wide use of artificial

light in civilization created a demand for lamps which show coloured objects truthfully; *i.e.*, which do not change colours from their hues as seen by daylight. The problem is thus one of producing an artificial light whose spectrum closely resembles that of sunlight. Artificial light always contains too high a proportion of red, orange and yellow rays.

A gas-filled electric lamp is employed, as its filament temperature is high and its form economical. The spectrum obtained from a black body, heated to 5,000° C., is approximately that of average diffused daylight. According to the temperature at which the filament of an incandescent electric lamp is heated, the amount of red and orange contained in the spectrum of its light varies, becoming relatively greater as the temperature is lower. (*See* BLACK BODY.) If the metal filament in an evacuated bulb is heated to 2,200° it radiates more red and orange than a gas-filled bulb, in which it may be heated to approximately 3,000°. Therefore, the gas-filled bulb is used in artificial daylight devices, but its light has still to be subjected to special treatment to correct its undue yellowness and redness.

Various means are employed for this purpose, such as filtering the light through a coloured transparent medium (*i.e.*, glass, talc, or varnish) or using coloured reflectors. The use of reflectors, however, absorbs a larger amount of the initial illumination than when transparent filters are used; hence filters are preferred.

The later development of fluorescent lamps from which the radiation is not due to heated filaments but from the ultra-violet excitation of phosphors on the interior of the glass tubes resulted in the possibility of obtaining light of almost any practically desirable spectral distribution. Such lamps can be made to approximate daylight for all practical purposes and also are of great luminous efficiency. (*See* also LUMINESCENCE; LIGHTING.)

Artificial daylight was at first mainly used for the purpose of matching colours. It came into use for general illumination, however, as the value of artificial daylight for ease on the eyes became appreciated. Hospital staffs, dentists, physicians and surgeons find artificial daylight of great value. The method is also employed in dye and colour works. (H. B. LM.)

DAYLIGHT SAVING, a means of providing for the utilization of more daylight, especially in summer, by setting clocks ahead. It was suggested in 1784 in a whimsical essay by Benjamin Franklin, but was not put into practice until the 20th century.

Great Britain.—In 1907 an Englishman, William Willett, published a pamphlet entitled *Waste of Daylight*. He financed a campaign for putting the clock ahead by 80 min. in four moves of 20 min. each in the spring and summer months. In 1908, Robert (later Sir Robert) Pearce introduced a bill in the house of commons to put the clock ahead by law. The plan, as simplified, called for advancing the clock one hour in spring and returning to Greenwich mean time in autumn. The bill failed.

Conservation of fuel became doubly important during World War I, and Germany adopted daylight saving in 1915. In Great Britain a one-hour change became law on May 17, 1916, effective the following Sunday, May 21. In honour of its proponent, who had died a year earlier, the system was at first called Willet time; later the name adopted was British summer time. After World War I, summer time was renewed by acts of parliament; that of 1922 provided that summer time should begin on the Sunday following the third Saturday in April, or if that is Easter day the Sunday following the second Saturday in April, and end on the Sunday following the third Saturday in September. The act of 1925 altered the closing date to the Sunday following the first Saturday in October. The official time for altering the clock is always 2 A.M. Greenwich mean time.

After World War II began, it was found necessary to change the dates in order to aid war production, and emergency powers were granted under defense (summer-time) regulations. Later changes involved the adoption of double summer time; *i.e.*, two hours in advance of Greenwich mean time. In some years the customary period of about 5 months was lengthened to 7, 10 or even 12 months. The 12-month period was maintained for four years, 1941–44.

Objections to daylight-saving time took several forms. Complaint was made that cows were unable to adjust to a new milking time and that dew in the earlier hour was heavy enough to hinder farm work. Small children were said to lose an hour's sleep because, rising at the same time as their parents, they were reluctant to go to bed before sundown. By some the reform was called contrary to nature, by others contrary to tradition, and by still others contrary to the interest of distributors of lighting power and equipment. For better or worse, the new system was accepted as a war measure, and in many places it was retained in times of peace.

United States.—In 1916, largely as a result of World War I, a campaign for daylight saving was launched in the United States. In 1917 congress passed an act whereby the standard time would be advanced one hour on the last Sunday of March and set back on the last Sunday of October. The act was effective in 1918 and 1919. Opposition developed from farmers, and the law was repealed on Aug. 20, 1919, over the president's veto. In the years that followed, legislation on the subject was enacted by states or municipalities, but World War II again made it a matter of national interest. On Feb. 6, 1942, "war time," one hour in advance of standard time, was put into effect nationally, and continued to the end of Sept. 1945. Well into the third quarter of the 20th century, daylight saving was observed in about half the states (in some cases only locally), usually from the last Sunday in April to the last Sunday in September, as follows:

Alabama	Kentucky	Montana	*Pennsylvania
California	*Maine	Nevada	*Rhode Island
*Connecticut	Maryland	New Hampshire	*Vermont
*Delaware	*Massachusetts	New Jersey	Virginia
*Illinois	†Minnesota	New Mexico	West Virginia
Indiana	Missouri	*New York	Wisconsin
Iowa			

*Last Sunday in April to last Sunday in October.
†4th Sunday in May to Tuesday following Labor day.

Other Countries.—After World War II, many countries abandoned the use of daylight-saving time. Among those retaining it, nation-wide or locally, are Canada, China, France (all year round), Iceland, Norway, Poland, Portugal and the United Kingdom.

See also TIME, STANDARD. (A. MCQ.)

DAY LILY, a common name for flowering plants of the genus *Hemerocallis,* commonly classed in the family Liliaceae (*q.v.*) although they have some botanical features that are characteristic of the Amaryllidaceae. Thus, in contrast to the true lilies (*Lilium*), the richly coloured sepals and petals that comprise the perianth of the flowers of day lilies are united at the base into a tube, but the ovary is superior as in the lilies.

Only about 20 authentic species of *Hemerocallis* have been named. All of these are native only in eastern and central Asia, where they collectively have a wide distribution especially in the temperate areas. All of the species are herbaceous perennials that have a crown of intermingled stems in the soil that spread by branching more or less widely as rhizomes. This gives long life to a seedling plant, provides for its natural spread and makes possible its propagation and multiplication as a natural or as a horticultural clone consisting of separated members that are merely branches of one plant. This is an advantage especially when a plant does not produce seeds or is a hybrid that does not breed true from seeds. From the buds of the stems of a crown there arises a mound of linear and grasslike leaves and scapes that bear flowers. Day lilies are different in appearance as well as in botanical characters from the plantain lilies of the genus *Hosta,* which have large broad leaves and strongly asymmetrical white, lilac or blue flowers.

J. HORACE MCFARLAND CO.

HEMEROCALLIS (H. FLAVA)

Two clones of *Hemerocallis* were brought from the orient into

Europe at an early date. These were described in 1570 and 1576 as *Asphodelus luteus liliflorus* and *Asphodelus phoeniceus*. Two hundred years later the botanist Linnaeus knew only these two clones to which he assigned, in 1762, the names *Hemerocallis flava* and *H. fulva*. In modern times, divisions of these same clones are known as the lemon day lily and the fulvous, tawny or Europa day lily respectively. Thus these two clones have been in propagation for at least five centuries and are cultivated widely in Europe and in North America. In numerous areas the Europa day lily has escaped from cultivation and become naturalized, without the production of seeds. At least a third distinct type (*H. minor*) was known in Europe late in the 18th century. Several new types or species and also noteworthy variants of the *H. fulva* group were brought into Europe during the 19th century. Later, Japanese botanists described new species and English and American botanists gave specific names to various new types that were obtained from the orient as living plants.

Hemerocallis shows noteworthy and conspicuous diversities, especially in features that have horticultural interest and value. Some species have foliage that is continuously green, and one species is evergreen in a subtropical area; but the foliage of most species naturally matures and dies in autumn and the plant is dormant during winter. There are dwarf species, as *H. nana*, with foliage and scapes scarcely a foot in height; but the scapes of *H. altissima* may be eight feet high. Other species collectively have rather complete gradations between these extremes in stature. An individual flower is open for only one period. But the flowers of several types and clones, as the Europa day lily, are day-blooming; for others, as *H. citrina*, the flowers are night-blooming; and certain types (the lemon day lily) have sets of flowers that may remain open from one to three days.

Three main classes of pigments are involved in the colouring of the flowers. In the clear yellow flowers of certain species the carotenoid pigments predominate. In the clear orange-coloured flowers the xanthophyll pigments are abundant. In the group of fulvous day lilies there are also anthocyanin pigments that add fulvous, brownish-red and even rosy-pink shades and tones that are often strongly developed in the mid-zone of the petals or elsewhere to effect various patterns of colouring.

In respect to periods of flowering some species bloom early in spring, others flower during the summer and certain species bloom in late summer and early autumn.

The various species of *Hemerocallis* are surpassed as valuable horticultural subjects by seedlings that have been obtained by hybridization and further selective breeding. These have effected integrations, copigmentations, dilutions and intensifications of pigments, which have resulted in brilliant colouring in patterns not seen previously in the species. There are at least 500 such hybrids; these bear such descriptive names as Mikado, Dauntless, Resolute and Painted Lady. Many commercial nurserymen in the United States specialize in day lilies and some of these grow hybrid seedlings in large numbers. Also there are many enthusiastic hobbyists who grow seedlings by selective breeding. Some of these are located in almost every section of the United States. As a result, it is now possible to obtain clones of day lilies in a diversity of habits of growth, flower colours, and season of flowering that are suitable for culture in gardens throughout the entire United States and in southern Canada as well as in comparable areas in all the other continents.

The soil of any ordinary garden is suitable for day lilies. They are excellent for naturalistic plantings along ledges of rock and along brooks or ponds, but they develop best in sunny exposures and may not have flowers if grown in dense shade. Day lilies may be increased by dividing the clump in late summer or early spring. They have almost no fungous diseases and have none of the viruses that are very destructive of the true lilies.

There has evidently been little use of day lilies as flowering plants in Japanese and Chinese gardens and no noteworthy developments of them in oriental horticulture. But two double-flowered sorts (Kwanso and Florepleno), which have no seeds, arose and were propagated as clones. However, the flowers of day lilies are used as food in certain parts of the orient; locally in China day lilies are cultivated for the flower buds, which are collected when they are of full size. Two of the clones thus grown have been obtained in the United States and distributed under the names Hankow and Chengtu. For many years dried flowers of day lilies could be obtained in packages of one pound and one-half pound sizes in Chinese food shops in various cities in America under the names gum-tsoy, meaning golden vegetable, and gum-jum, meaning golden needles. The dried flowers are cut in segments, soaked in water until they become soft, pliable and gelatinous and added to soups that are already cooked and then the mixture is brought to a boil. Also the flowers may be used as a garnish with preparations of noodles or meat. (A. B. S.; X.)

DAY NURSERY, an institution for the care of infants and young children whose mothers work outside the home or are otherwise prevented from providing proper care. Such institutions, known as crèches (from the French *crèche,* "crib"), appeared in France about 1840 and the Société des Crèches was recognized by the French government in 1869. Crèches or day nurseries were established in most European cities and industrial centres during the second half of the 19th century, the first in Great Britain in 1860. In the United States, day nursery, day or child care centre and nursery school often are used interchangeably to identify various types of day care for children in their own homes and for preschool educational programs (*see* CHILD WELFARE; *Children in Their Own Homes: Day Care;* PRE-ELEMENTARY EDUCATION).

The prime function of day nurseries has been to care for children under school age while the mother is at work. But increasingly their significance to child health, especially in relation to nutrition, healthy surroundings and proper medical supervision, has been emphasized.

The modern day nursery movement in Great Britain developed during the 20th century largely through the leadership of the National Society of Day Nurseries (1906). World War I caused a great extension of the movement when day nurseries were set up throughout most industrial areas. At this time, as earlier, much of the work and expense was undertaken by voluntary committees. The board of education gave a grant in aid from the year 1915, and since 1918, when the Maternity and Child Welfare act was passed, day nurseries have been recognized for grant by the ministry of health. World War II had an even greater effect in extending the use of nurseries, when wholesale evacuation of children was accompanied by employment of women on an unprecedented scale. During World War II the full cost of nurseries was borne by the treasury, although the administration remained with the local authorities. Under the National Health Service act, 1946, charges could be made only for the cost of food. By an amendment act (1952) the cost of day nursery care could be passed on to the parent (due regard being held for his means); in some instances the full cost could be charged.

The alternatives to the public day nurseries are care in private or factory nurseries and child minding. These are regulated under the Nurseries and Child-Minders Regulation act, 1948, which requires all who are taking three or more children for daytime care to register with local authorities and to be open to inspection.

Many oppose nurseries on the ground that they interfere with family life. Psychiatrists particularly emphasize the psychological trauma which may result from separation of the young child from its mother. The day nursery should be looked upon as a response to adverse social and economic conditions in a society that favours married women's working. At the worst it is an alternative to a bad home or one in which the mother is absent for long periods; at the best it is a training establishment where young children learn to do things and to co-operate. Training in regular habits and a sound supervision of health are of great value. The nursery can provide relief to overcrowded households and it can greatly ease the burden of rearing a family; in times of sickness and pregnancy, for the widow and the unmarried mother, it may be a lifesaving factor.

Interesting work has been done in day nurseries where standards of spacing, equipment and staffing have been recommended by the ministry of health and accepted by local authorities. These stand-

ards include an over-all ratio of one staff member to five children, exclusive of domestic staff, with a matron trained in sick children, general or nursery nursing, and experienced in the group care of healthy children; a deputy matron (usually a nursery nurse with at least two years post-certificate experience); a warden who is also a nursery nurse with experience of the play needs of young children; nursery nurses; nursery assistants; and, in training nurseries, nursery students. Standards of accommodation are based on floor spacing of not less than 40 sq.ft. for young babies and 25 to 30 sq.ft. for older children. Children are no longer grouped according to age. Efforts are made to assign a small group of children of varied ages to each trained member of staff and her assistant, a method which allows for individual and continuous care.

Nursery nurse training, regulated by the ministry of education and examined by a national nursery examination board, leads to a national nursery certificate. The course of training can be taken by girls 16 years old or over and lasts for two years. Training with children under and over two years is given at both nurseries and nursery schools and two days a week are spent in further education. The National Society of Day Nurseries, which changed its name in 1942 to the National Society of Children's Nurseries, publishes *The Nursery Journal*. (C. F. Bn.)

DAYR AZ ZAWR (Deir ez Zor), a town in eastern Syria and administrative centre of the *muhafaza* (governorate) of the same name, is situated on the west bank of the Euphrates, which at this point 175 mi. E.S.E. of Aleppo is about 250 yd. wide, with an average depth of 27 ft. Pop. (1960) 42,014. The town is 630 ft. above sea level, and 27½ mi. above the confluence of the Khabur (Habur) and the Euphrates. The suspension bridge at Dayr az Zawr is the crossing-place for the Aleppo-Mosul and Damascus-Mosul routes, and a focal point for roads up the Khabur. It is also on the road from Aleppo to Baghdad via As Sabakha, Abu Kamal, and Ramadi. As a result of its position it is an important centre for cross-desert travel. The town is largely of modern construction, and most of the buildings are of mud brick; they include a barracks, civil and military hospitals, banks and a bazaar, and there are public gardens.

The governorate of Dayr az Zawr had a population in 1960 of 221,290. The area (12,765 sq.mi.) is largely desert, but borders on Al Jazirah (*q.v.*), which is being rapidly developed. Irrigation works have greatly increased the area under cultivation, water being supplied from the Euphrates.

The ruins of the ancient city of Azaura, from which Dayr az Zawr is reputed to have taken its name, are to the southeast of the modern town, which was built in 1867 by the Ottoman authorities to curb the Arab tribes of the Euphrates area. It was the capital of a *vilayet* under the Turks, the seat of the governor, and the centre for a series of Turkish outposts policing the surrounding country. It was occupied by the French in 1921 under the mandate, and became the seat of a large French garrison. In 1941 it was captured by a British force advancing from Baghdad, and in 1946 the town became part of the Republic of Syria.
(M. V. S.-W.)

DAYTON, a city of southwestern Ohio, U.S., and seat of Montgomery county, 52 mi. N. of Cincinnati. It is an industrial, communication and distributing centre, a port of entry, a leading centre of aviation research and the heart of a metropolitan area which includes the cities of Kettering (*q.v.*), Miamisburg, Xenia, Fairborn, Oakwood and Vandalia. Pop. (1960) 262,332; standard metropolitan statistical area (Greene, Miami, Montgomery and Preble counties), 727,121. (For comparative population figures *see* table in Ohio: *Population.*)

Once a favourite Shawnee Indian hunting ground of rolling hills at the junction of the Great Miami, Mad and Stillwater rivers and Wolf creek in a loop of the Great Miami, it was early regarded as a strategic site on the important Maumee-Miami trade route in western Ohio. Nothing materialized until removal of the Indian threat to settlement north of the Ohio river by Anthony Wayne in the Indian wars of the 1790s. The town was surveyed and platted by a small group of Revolutionary War veterans (including Jonathan Dayton from New Jersey, for whom the city was named), and the first settlers arrived by boat in the spring of 1796. The first house, Newcom tavern, built in 1796 by Col. George Newcom, is maintained as a historical museum. Dayton was incorporated as a town in 1805 and had a population of 383 by 1810. It was used by William Henry Harrison in the War of 1812 as a base of supplies for his campaigns against British-held Detroit and Canada, and the Indians under Tecumseh. The opening of the Miami and Erie canal in 1828 made it a centre of agricultural and industrial prosperity. It was chartered as a city in 1841.

Dayton became the home of the cash register after the perfection of the mechanical money drawer by John H. Patterson in the 1880s. The solution of the problem of human flight with a heavier-than-air machine by Orville and Wilbur Wright in 1903 made it the birthplace of aviation. Charles F. Kettering's laboratories there produced fundamental contributions to automotive and aeronautical engineering and research.

The most disastrous of a series of floods in the history of the area occurred in March 1913, with staggering losses of lives and property. This provoked establishment in June 1915 of the Miami Conservancy district, the first comprehensive flood-control project in the United States, which constructed five huge dams and retarding basins to fully protect nine counties from recurrence of such disasters. Construction began in Jan. 1918 and was completed in 1922 at a cost of about $32,000,000. It was financed locally without resort to federal or state aid. This experience helped provoke adoption in 1913 of the first nonpartisan, democratically controlled commission-manager form of government for a large U.S. city. The Dayton plan was used extensively as a model for other cities.

During World Wars I and II experimental aviation laboratories of the U.S. government were located in Dayton. The Wright Air Development centre is responsible for all equipment testing and research, and the Air Materiel command for all supply of the U.S. air force. Both are part of the Wright-Patterson air force base, one of the largest single air installations in the world. The Dayton air force depot (Gentile air force station) is a depot for electronic materials. In the heart of a large diversified industrial complex producing more than 800 precision products, such as aircraft instruments, machine tools, accounting machines, refrigerators and air conditioners, Dayton is also a leading graphic arts production centre, producer of rubber and paper products and of all U.S. government stamped envelopes. Family income and percentage of home ownership are consistently high.

In the area are the Air Force Institute of Technology (1919), Antioch college (1852, at Yellow Springs), Central State college (1887, state supported, at Wilberforce), University of Dayton (Roman Catholic, formerly St. Mary's college, founded 1850), Mt. St. John Normal school (1911, Roman Catholic), St. Leonard Theological seminary (1890, Roman Catholic, at Centerville), Sinclair college (1887), United Theological seminary (Evangelical United Brethren, formerly Bonebrake Theological seminary, founded 1871) and Wilberforce university (1856). There are more than 300 churches and synagogues. Ten hospitals serve the area. Cultural facilities include the Air Force Central museum, Museum of Natural History, Carillon Park Outdoor Transportation museum, the house (preserved as a museum) of the Negro poet Paul Laurence Dunbar (*q.v.*), several other museums, public libraries, a philharmonic orchestra and the Dayton Art institute.

Its wide streets and spacious downtown area introduced on the original plat, the master city planning for parks, streets and landscaping, elimination of railroad grade crossings, absence of a factory district, as well as the attractiveness of its homes, modern business buildings and model industrial plants, help perpetuate Dayton's reputation of being a clean and progressive city. When the state supreme court invalidated its city income tax, its civic-minded citizens overwhelmingly restored it to finance needed local government services. Public recreation facilities include a city park system of more than 1,400 ac., three golf courses, numerous playing fields and a network of recreation centres. These are matched by similar privately sponsored facilities. (D. L. S.)

DAYTON, a city and seat of Rhea county in southeastern Tennessee, U.S., 38 mi. N.N.E. of Chattanooga. It is situated at

the foot of the Cumberland escarpment in a coal-mining region and is the site of several small industrial plants (hosiery, underwear, canneries and bottle works). Its population is about 3,000. The town was founded about 1884 and chartered in 1895. Dayton gained international fame in July 1925 as the scene, in Rhea county courthouse, of the Scopes evolution trial. The admirers of William Jennings Bryan (*q.v.*), the prosecution associate and fundamentalist witness against John Thomas Scopes, founded William Jennings Bryan university (1930) on a hill overlooking the town as a memorial to him. For a discussion of the case *see* SCOPES TRIAL. (K. K. B.)

DAYTONA BEACH, a city of Volusia county, Fla., U.S., 90 mi. S.E. of Jacksonville. It is situated on the Atlantic ocean and the Halifax river, a tidewater lagoon which parallels the ocean. The Halifax river is a portion of the Atlantic Intracoastal waterway, and dock facilities and yacht basins are numerous and are near the centre of the city. The original city, Daytona, was laid out in 1870 by Mathias Day of Ohio, incorporated and named after him in 1876. A commission-city manager form of local government has been in effect since 1922. In 1926 the cities of Seabreeze, Daytona and Daytona Beach were incorporated as Daytona Beach.

Boatbuilding, varied light manufacturing and tourism are the principal industries of the city, which is also a centre of the citrus industry. It is a popular resort with year-round outdoor recreational facilities, including water sports, swimming and fishing. The internationally famous beach of hard, white sand, 23 mi. long and 500 ft. wide at low tide, has been used for automobile speed trials since 1903. In 1935 Sir Malcolm Campbell (*q.v.*) drove the "Bluebird" over the course at 276.82 m.p.h. Automobile racing on the beach is now forbidden, but private cars are allowed on the entire length of the beach. The Daytona International speedway, which includes a 2½ mi. racing trioval with steeply banked curves, a sports car racecourse and a lake for motorboat racing, is a principal test centre for automotive and boating equipment. The city is headquarters of the National Association for Stock Car Auto Racing (Nascar). Daytona Beach also has a greyhound racing track and a *jai alai* (*q.v.*) *frontón*. Recreational opportunities are available at Riverfront park, with its many exotic plants; Oceanfront park, with its large stadium and band shell; an oceanside promenade; and City Island park, an amusement area near the centre of the city.

Bethune-Cookman college for Negroes (1872), Daytona Beach junior college and the Volusia County Community college are located there. For comparative population figures *see* table in FLORIDA: *Population.* (J. E. Jo.)

DEACON, a member of the lowest rank of the threefold Christian ministry or, in various Protestant churches, a lay official who shares in the ministry. In churches where the diaconate exists there is a general continuity, at least in principle, with the early pattern of deacons as a basic but subservient ministerial order and as helpers responsible for the practical and charitable functions of the Christian community. In the Roman Catholic, Orthodox and Anglican churches, however, the diaconate has in practice almost entirely lost its original independent status as one of the major orders and has become in effect a transitional probationership for ordination to the priesthood, customarily lasting for a year. The introduction of a permanent diaconate has been raised, however, and in 1957 Pope Pius XII referred to the possibility of an independent lay order of the diaconate. (For cardinal deacons *see* CARDINAL.) At a high Mass one of the two priests assisting the celebrant is called deacon and the other subdeacon.

In Protestant bodies the diaconate takes several forms. In Congregational (independent) churches the diaconate is usually an elective body of lay officers in a local congregation responsible for financial and administrative affairs and the distribution of the elements at Holy Communion. Such deacons are, as in the New England Puritan tradition, actually the ruling elders of the churches. In Presbyterianism there is provision for deacons' courts, under the presbytery, for the management of church goods. Though in most Protestant churches deacons are local officials, American Methodism has had traveling deacons. On the continent of Europe, especially in Germany and Scandinavia, special diaconal institutes, first founded in Germany by J. H. Wichern in 1833, train deacons for social service and youth work in the parishes. In certain cases these deacons have wider responsibilities; for instance, in Sweden, after additional homiletical training, a *pastorsdiakon* is permitted to preach in the congregations of remote districts where the number of pastors may be insufficient. In some continental Lutheran churches, the term deacon is given to assistant ministers in a parish, even though they are fully ordained priests. Several Protestant churches in Asia and Africa have revived the permanent diaconate. In the constitution of the Church of South India provision is made for lifetime deacons, ordained not only to assist the presbyters in the church services and in "ministering in the temporalities of the church," but also to carry on catechetical, evangelistic and pastoral work. *See* also HOLY ORDERS; MINISTRY, CHRISTIAN.

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DEACONESS, a woman devoted to the pastoral ministry of the Christian church. In the New Testament a deaconess of the church at Cenchraea is mentioned (Rom. xvi, 1), but little is known of the actual functions of such women until the late 4th century. According to the Syriac *Didascalia* and the Apostolic Constitutions they acted as doorkeepers in churches and as assistants to the clergy in the baptizing of women (for reasons of propriety). Their ordination, which resembled that of deacons, conveyed no sacerdotal powers or authority, yet it was partly fear that they would usurp priestly functions (*e.g.*, in Nestorian and Monophysite communities they gave Holy Communion to women and read the Scriptures in public) that led to their decline. Another reason was perhaps the decreasing number of candidates for adult baptism. The order of deaconesses was abrogated by the Councils of Epaon (517) and Orléans (533), but it lingered on for several centuries in other places, especially in the east, where it had always been stronger than in the west.

After the Reformation some deaconess work was introduced among certain Reformed groups in Holland (16th century), but it was not until the 19th century, when women were seeking emancipation, that the modern deaconess movement really began. In 1836 T. Fliedner founded the *Diakonissenanstalt* at Kaiserswerth, near Berlin, where nursing was the chief function of the deaconesses, who did not undertake life service. By 1861 Kaiserswerth had 13 daughter-houses and the movement spread rapidly to other countries, the first house in the United States being founded in Pittsburgh, Pa., in 1849. Florence Nightingale had her first practical experience of nursing with the Kaiserswerth deaconesses in 1851. Nursing remains their chief work, and in the 1960s they had more than 70 daughter houses. After World War II an international deaconess association called *Diakonia* was founded.

In the British Isles, where nursing sisters are not called deaconesses, the function of deaconesses (or church sisters as they are called in some denominations) is to serve under the local clergy or minister in parish work. They have pastoral and theological training, varying according to the church concerned. The first deaconess in the Church of England was dedicated in 1862, but deaconesses were not established as an order until the 1920s. In the 1880s deaconesses were introduced by the Church of Scotland and the English Methodists.

Pastoral or nursing deaconesses are found in most parts of the world where there are Protestant churches; their precise functions and powers, which vary from church to church and from country to country, are concerned in the larger question of the full-time professional service of women in the church.

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DEA DIA, the goddess worshiped in a sacred grove near Rome by the priests known as the Arval Brothers (*q.v.*). She is known only from the minutes of the priestly college unearthed in

modern times at her shrine. The origin and nature of the deity are obscure. Even her name ("divine goddess") is not specific. Thus scholars have equated her with various goddesses, principally Ops (*see* BONA DEA), Ceres, Acca Larentia, Flora (*qq.v.*), Tellus, and Luna, probably none of them accurately. From the nature of the college and the rites in her honour she would seem to be concerned with the fertility of the fields. Her annual festival was celebrated on three days in May.

See bibliography to ARVAL BROTHERS and W. Roscher, *Ausführliches Lexikon der griechischen und römischen Mythologie;* Daremberg-Saglio, *Dictionnaire des antiquités.* (R. B. Ld.)

DEAD SEA, the lake into which the Jordan river (*q.v.*) flows. Its northern half belongs to Jordan; its southern half is divided between Jordan and Israel. The Jordan valley bounds the Dead sea on the north, where part of the shore line consists of deltaic salt marsh. There the valley is 12 mi. wide, with badlands and scrub bordering the delta. It is bounded on the east by the fault escarpment of the flat Moab plateau. The escarpment rises 3,000 ft. above sea level—an average ascent from the lake of 14 ft. per 100 ft. of horizontal distance. It is bounded on the west by the rolling surface of the Judean mountains and northern Negev highlands, where peaks rise to 2,300 ft. above sea level. It is bounded on the south by soft mud flats that gradually rise toward the central ridge of Ha'arava (Wadi al 'Arabah). The Dead sea has a maximum length of 51 mi., a width of 11 mi., an average of 1,080 ft. for its deeper portions and a surface area of 394 sq.mi. (1,020 sq.km.), three-quarters of which is Jordanian territory. Its surface level, which has a seasonal variation of from 10 to 15 ft., lies 1,302 ft. (397 m.) below the level of the Mediterranean sea and is the lowest sheet of water on the earth's surface.

In the summer the absence of rain and the high rate of evaporation cause water levels to drop from 10 to 15 ft. below those of winter. For centuries the level of the lake rose, because of increased rain, increased intake in relation to evaporation, depositional fill, increased flow of subterranean springs or combinations of such factors. From 1879 to 1929, however, the water level rose only 23 ft., and since then it has dropped a few feet. There is no commonly accepted explanation for this phenomenon.

Intake from the Jordan river is 6,500,000 tons daily. Other streams, numerous springs and underground seepage add another 500,000 tons. Four perennial streams—Wadis Hasa, Mawjib, Zerqa and 'Udhemi—flow into the lake. They all enter from the Moab plateau, which receives approximately 16 in. of rain in the winter from moisture-bearing Mediterranean winds that rise over the steep western-facing escarpment. The intermittent streams flowing into the lake from the west originate on the leeward side of the Judean plateau, which receives from 4 to 8 in. of rain in the winter. Rainfall in the Dead sea valley averages 3.4 in. annually in the north and 1.8 in. in the south. Seldom does it exceed 5 in. anywhere in the valley. There is no outflow from the lake. Instead, the water balance is maintained by evaporation, estimated at 120 in. annually (10 mm. daily). Blue-white clouds, which form a mist over the surface of the water, carry off this evaporated moisture.

Dividing the Dead sea nearly in two is Al Lisan ("the tongue"), a peninsula 6 mi. wide and 32 sq.mi. in area. It is covered with soft, white marls. Low, flat and barren, save for scrub on the east, Al Lisan lies exposed to erosion by wind and water. Parts of the plain are highly weathered and sculptured. Winter vegetables are sometimes planted by Bedouins on the peninsula's protected northeastern shore. The sea south of Al Lisan is shallow, ranging from 3 to 30 ft. in depth. The port for the potash works on the southwestern shore is between 6 and 12 ft. deep. Waters reach maximum depths of 1,430 ft. (436 m.) in the northeastern corner of the lake.

Traversing the Dead sea shore clockwise from the Jordan delta one encounters badlands that terminate at the Moab escarpment. The cliff then hugs the shore with major indentations into the plateau's dark-coloured rocks at Wadi Zerqa and Wadi al Mawjib. Springs, wells, small patches of vegetation and tiny deltas built by perennial and intermittent streams break the escarpment's monotonous outline. The next expanse of level land after Al Lisan occurs at Ghawr as Safi. There, along the southeastern edge of the lake, is higher, well-drained land through which Wadi al Hasa flows. At the lake's southern end is soft, impassable mud, then badlands and then Mt. Sodom (or Jabal Usdum; modern Sedom or Sdom). The mountain rises 800 ft. above the lake and is separated from the rest of the Judean highlands by a 1½-mi.-wide valley of broken limestone and sand. At Mt. Sodom is the rock formation said to represent Lot's petrified wife. Twenty miles to the north lies Masada (Metsada), a 1,700-ft. rock cut off from the rest of the Judean plateau by two wadis (river valleys). North of Masada the shore broadens into a sloping shelf pinched out by the Judean escarpment at Ein Gedi. A sheltered oasis on a terrace 300 ft. above the lake, Ein Gedi has three sweet-water springs pouring as waterfalls from heights of 2,000 ft. Hard-rock outcrops force streams into tortuous routes, rendering them almost useless as lines of communication from the Dead sea to Hebron. From Ein Gedi north to the saline mud flats of the northwestern shore, there is no beach. The mud flats are bordered by higher badlands which in turn drop down to the Jordan river.

Geology.—The Dead sea occupies the lowest part of the 350-mi.-long Jordan-Dead sea trench. This depression is a northern extension of East Africa's rift valleys. It is a down-dropped block confined by two parallel faults. The eastern fault of the Moab plateau is more readily visible from the lake than is the western fault that marks the gentler Judean upfold.

In the Jurassic and Cretaceous periods, before the creation of the trench, an extended Mediterranean sea covered Syria and Palestine. During the Miocene epoch of the Tertiary period, upheaval of the sea bed produced the upfolded anticlinal structures of the Transjordan highlands and the central range of Palestine, causing the fractures which formed the Dead sea depression. At this time, the Dead sea probably was the same size as now. During the Pluvial period it rose to a height 700 ft. (220 m.) greater than now. It was a vast inland sea, stretching 200 mi. from the Lake Hule area in the north to 40 mi. beyond its present southern limits. The lake did not spill over into the Gulf of Aqaba because the highest part of the Ha'arava, which is now about 800 ft. (240 m.) above sea level, acted as a dam. This higher elevation is an eastward extension of the central Negev highlands (Hills of Paran).

During the Early Pleistocene epoch of the Pluvial period, heavy stream flow into the lake brought thick sedimentary deposits of shale, clay, sandstone, rock salt and gypsum. In the Middle Pleistocene, calcareous strata of clay, marl, soft chalk and gypsum were dropped upon layers of sand and gravel. With evaporation prevailing over precipitation, as in the Recent epoch, the Pleistocene lake gradually shrank to its present form. In so doing it bared deposits that cover the Dead sea valley to a thickness of from 1 to 4 mi. (2,000 to 7,000 m.). These sediments are called the Neocene-Quaternary (Early Pleistocene) and Lisan (Middle Pleistocene) series. Their soft sediments contrasted with the older, harder Cretaceous-Eocene sandstones and dolomites of the bordering plateaus.

Al Lisan and Mt. Sodom are formations that resulted from young tectonic movements. Mt. Sodom's steep cliffs rise up from the southwestern shore. Its Neocene-Quaternary deposits of rock salt, gypsum, shale and clay lie on older Miocene sandstones. These deposits are the Sodom series. Al Lisan was formed in the Middle Pleistocene. Its strata consist of clay, marl, soft chalk and gypsum interbedded with sand and gravel. Both Al Lisan and beds of similar material on the western side of the Dead sea valley dip to the east. It is assumed that the uplifting of Mt. Sodom and Al Lisan formed a southern escarpment for the Dead sea, depressing the sea bed to the north and east. Later the sea broke through the western half of this escarpment to fill in what is now the shallow end of the Dead sea.

Salinity.—Dead sea water is intensely saline, with solid content of 25% as compared with from 4% to 6% for ocean water. Dead sea salts include magnesium chloride, sodium chloride, calcium chloride, potassium chloride, magnesium bromide and calcium sulfate. At the surface, each litre of Dead sea water contains 227–

275 g. of dissolved salts. At a depth of 360 ft. the water has 327 g. of salts. The high percentage of solids in solution makes the Dead sea extremely buoyant, keeping bathers continually afloat. Fish are not able to live in its waters.

The lake's salts come from saline streams and hot springs. The Jordan river contains a high proportion of sodium chloride and magnesium chloride. Streams that drain into the lake from the plateau leach salts from mountain rocks and sediments in the basin. Additional sources are the numerous sulfur springs that rise from the foot of the escarpments, and hot springs on the bottom of the Dead sea. There is widespread occurrence of asphalt seepage along the shores and floating pieces of asphalt from submarine beds are found on the lake's surface.

History.—Other names for the Dead sea are Salt sea, Sea of the 'Arava, Eastern sea, The Sea, Asphalt sea, Sodomitish sea, Sea of Zoar, Sea of Overwhelming and Sea of Lot. History records the Dead sea in the biblical narratives of Abraham and Lot, and the destruction of Sodom and Gomorrah (*see* SODOM AND GOMORRAH) by earthquake and sulfurous rain. David took refuge at Ein Gedi, and Solomon praised its beauty. Jonathan Maccabeus built a fortress on Masada, and Herod improved it. In A.D. 73 Masada's fortress was destroyed by Romans. Its heroic Zealot defenders, led by Eleazar ben Jair, culminated a three-year defense by mass suicide. During this general period, the monastic group at Qumran managed to preserve the literature of the Dead sea scrolls (*q.v.*).

Navigation on the lake was chronicled by Tacitus and Josephus. Under the crusaders, new navigation dues were levied by Karak's lords. The first modern explorers who attempted to explore the Dead sea, R. Costigan (1835) and T. Molineux (1847), perished from exposure after sailing the lake's northern half. Lieut. (later Capt.) W. F. Lynch of the U.S. navy successfully led a survey party around the entire lake in 1848. A scientific research party sponsored by the sultan of Turkey was conducted by the geologist M. Blanckenhorn in 1908, the year that a party of French Dominican monks, including R. Abel, explored ancient sites.

No modern cities occupy the shores of the Dead sea. No trace remains of the five "plain cities" of Abraham's time (Sodom, Gomorrah, Admah, Zeboyim and Zoar) which occupied the Vale of Siddim (Dead sea area). Archaeologists differ as to their location, although a majority place them at the now-submerged southern end.

Resources.—The world's need for agricultural fertilizer in the 20th century opened a new epoch in Dead sea history. The mandatory government for Palestine and Transjordan (under the League of Nations) granted M. A. Novomeysky, a chemical engineer, the concession to exploit Dead sea minerals in the late 1920s. He formed Palestine Potash, Ltd., which began potash operations in 1930 at Kalya, at the northern end. A southern plant was established at Sodom in 1937. Annual production reached 110,000 tons of potash and 1,000 tons of bromine by 1945. The production process calls for pumping Dead sea brine (1%–1.5% potassium chloride) into shallow earthen pans. The sun's rays, the dry atmosphere and the strong winds of the area evaporate the brine, leaving impure white carnallite. This is pumped to the refinery for fractional recrystallization into a raw material, 97% potassium chloride. Further recrystallization produces magnesium chloride and magnesium bromide.

During the 1948 Arab-Israeli war, the Kalya plant was destroyed. Later in Jordanian territory, it had not been rebuilt by the early 1960s although the new 'Amman-Kalya road was expected to cause the industry's revival. At Sodom, in Israel, a new plant was built in 1955 by the Dead Sea Works, Ltd. A modern road connected Sodom to Beersheba, following Maavar Sodom (Sodom pass). Although most of the potash was exported from Haifa, an increasing quantity was being exported via Eilat. Potash production at Sodom was 110,000 tons in 1958–59. Another plant produced bromine and such compounds as ethylene dibromide and tetrabromoethyne. Lesser quantities of magnesium oxide and hydrochloric acid are also produced.

Relatively sweet water is needed for refining, pan leaching and drinking. At Kalya, water from the Jordan and Wadi Zerqa are adequate. At Sodom, ground-water sources must be used. Wells south of the plant, that tap the sands and gravels of the Lisan series, are the major source of supply.

Other Dead sea minerals that have been exploited include common salt (from brine) and asphaltite (from rocks containing bitumen or as bits that float on the water). The latter material is also used for skin salves. Oil prospecting has taken place on western Mt. Sodom and in the Lisan series, and natural gas discoveries have been made in the area. Other minerals, like rock salt, bituminous limestone, ochre, iron and sulfur occur, but not in exploitable quantities.

The tourist trade suffers from lack of facilities, such as hotels and roads, but both Israel and Jordan are interested in its development. The winter climate is warm and dry. January has a maximum mean temperature of 68° F. and minimum of 51° F. The average monthly rainfall is 1.2 in. and the relative humidity is 61%. Such a climate, added to historic associations, hot springs and awe-inspiring scenery, forms a favourable base for attracting tourists. *See* also PALESTINE.

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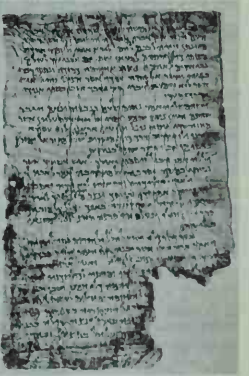
DEAD SEA SCROLLS, the popular name given to a number of Hebrew and Aramaic manuscripts found near the northwestern corner of the Dead sea, in the late 1940s and the 1950s. They shed new light on a previously little-known type of Judaism that existed during the time of Christ and that in many ways resembles early Christianity; it was the Judaism amid which Christ and his first followers lived, thought and wrote.

A Bedouin's accidental discovery of a cave containing some of the scrolls in 1947 or perhaps 1945 was the first of what proved to be numerous finds. In 1947 the scrolls were taken to Jerusalem and sold, some to E. L. Sukenik of the Hebrew university at Jerusalem and the rest to the Syrian Orthodox Archbishop A. Y. Samuel.

In 1950 and 1951 the American Schools of Oriental Research published three of the four documents Archbishop Samuel had purchased. The Hebrew university's collection was published between 1948 and 1954; and in 1956, after the archbishop's scrolls had been bought in the United States and taken to Israel, the last of them was published there.



JOHN ALLEGRO

FRAGMENT OF COPPER SCROLL FROM QUMRAN

In 1949 the cave was excavated by the department of antiquities of Jordan, the French School of Archaeology at Jerusalem and the Palestine Archaeological museum of Jordanian Jerusalem. Hundreds of manuscript fragments were unearthed. Other pieces were purchased through antiquities dealers or directly from the Bedouins who found them. In 1952 and subsequently, ten more caves containing fragments of manuscripts were discovered within a few miles of the first

one, near a valley called Wadi Qumran. One cave held a few more or less complete scrolls like those found in the first cave. In another a scroll made of copper was found in two pieces. Another valley farther south, the Wadi Murabbaat, yielded an entirely distinct collection of fragments, somewhat later in date; others of still later date were found not far away at Khirbet Mird. The enormous mass of texts thus accumulated was deposited in the Palestine Archaeological museum, and sorting, study and preparation for publication were begun by an international team of scholars headed by J. T. Milik of the French School of Archaeology.

The search for manuscripts and for information to help in interpreting them led also to the excavation of a ruin called Khirbet Qumran, on the northern edge of the Wadi Qumran. A series of campaigns in 1951–56 under the direction of R. de Vaux, the head of the French school, uncovered the remains of a complex of buildings, the headquarters of the community that produced the manuscripts. A strong corner tower, a kitchen, halls for meals and meetings, the "scriptorium" where the scrolls were copied, cisterns, baths, mills and a potter's shop were among the principal features of the establishment. Nearby was a cemetery.

BY COURTESY OF THE ORIENTAL INSTITUTE OF THE UNIVERSITY OF CHICAGO

JAR OF THE HELLENISTIC-ROMAN TYPE USED TO STORE THE DEAD SEA SCROLLS. IT WAS FOUND IN CAVE I AT QUMRAN, PALESTINE

In 1960 further discoveries were made in the same general region, but farther south, in Israel. The texts found there do not belong with the Qumran manuscripts, but are of the same nature and date as those from the Wadi Murabbaat.

History of the Qumran Community.—The pottery and coins found showed that the settlement had been established in or about the time of Alexander Jannaeus (103–76 B.C.). A severe earthquake in 31 B.C. caused the abandonment of the site until about 4 B.C. A second period of occupation lasted until A.D. 68, when the community fell prey to fire and sword during the first revolt of the Jews against Rome. Two later phases of occupation attested by coins and pottery were of brief duration and minor importance. They had nothing to do with the religious community that had lived there during the last century B.C. and the first century A.D.

Nothing else is known of the community's history except what can be inferred from its literature, as preserved in the scrolls. This is meagre and indefinite. There was a revered leader, possibly the founder of the group, who was called the Teacher of Righteousness. He was believed to have had a special revelation of the true meaning of the prophetic writings. Attempts to identify him have not succeeded; some scholars think that the title was borne by a succession of individuals.

The Teacher of Righteousness was persecuted by a man called the Wicked Priest. The outcome is not clear. A group called the House of Absalom failed to come to the Teacher's aid; there are references also to other persons, including the Man of the Lie and the Prophet of the Lie. The Wicked Priest may have been a high priest. Identifications proposed for him range from the early 2nd century B.C. to the years just before A.D. 70. Alexander Jannaeus is favoured by a number of interpreters.

The Damascus Document or Zadokite Document, discovered at Cairo in 1910 and represented also by fragments in the Qumran caves, speaks of a migration to "the land of Damascus" and of dwelling in camps under a form of organization similar to that of the Qumran community. The meaning of "the land of Damascus," the time of the migration and the relation of this group to that of Qumran are matters of debate among scholars. The place referred to may have been Qumran itself.

Identity of the Group and Its Relation to Other Forms of Judaism.—The location of the establishment calls to mind the Essenes, a Jewish sect whose settlement above the western shore of the Dead sea is described by the Roman naturalist Pliny. The ascetic, monastic type of religious life and organization represented by the Dead sea scrolls corresponds at many points to what is said of the Essenes by the Jewish writers Josephus and Philo. There are differences that make an outright identification questionable, but the Qumran sect and the Essenes, if not identical, belonged to the same general movement. (*See* also JEWISH SECTS DURING THE SECOND COMMONWEALTH.)

Other groups among the Jews of the period—Pharisees, Sadducees and Zealots, and even Christians—have been connected by scholars with the Qumran sect, but in each case there are prohibitive differences. Arising within the priesthood, in connection with the pre-Maccabean movement of the Hasidim, from which the Pharisees also came, the community of Qumran had evidently broken with the official priesthood. Theologically it belonged to the wing of Judaism that produced the apocalyptic literature. Existence was thought of in terms of a cosmic struggle between the forces of good and evil, "the lot of God" and "the lot of Belial." The group believed that it was already living in the last days, and that it was chosen to take an active, militant part in the war against Belial. The prophetic books of the Old Testament were interpreted as referring to the sect itself and its part in the cosmic drama.

Meanwhile the members lived together, eating and worshiping together, sharing their property, following a way of life strictly regulated by rules of discipline, practising rites of purification and preparing the way of the Lord by an assiduous study of the law. They were ruled by "the priests, the sons of Zadok," and they expected a priestly "Messiah of Aaron" as well as a lay "Messiah of Israel," the "Branch of David" foretold by the prophets.

The texts found in the Wadi Murabbaat come from the time of the second revolt against Rome (A.D. 132–135). They represent no such marginal group as the Qumran community; their writers were orthodox Jews. The name, perhaps even the personal signature, of the leader of the second revolt, Bar Cocheba, appears in letters in what was doubtless its original form, Simon ben Koseba.

Contents of the Scrolls and Fragments.—*Biblical Manuscripts.*—A considerable portion of the Qumran texts are manuscripts of the Old Testament books. Every book of the Old Testament except Esther is represented by at least a few fragments. Pieces of as many as a dozen different manuscripts of some of the books have been identified. Two manuscripts of Isaiah were among the scrolls found in the first cave; one is incomplete, but the other, which contains the whole book from beginning to end, is both the most complete and one of the oldest of all the manuscripts. It was made in the 2nd century B.C., perhaps before the community was established at Qumran. These manuscripts, though for the most part fragmentary, are very important for the reconstruction of the correct text of the Hebrew Old Testament because they exhibit forms of the text as much as 1,000 years older than the best manuscripts otherwise preserved.

By and large they demonstrate to a remarkable degree the accuracy of the later tradition, but there are notable exceptions. Some of the manuscripts present a text related closely to that of the Septuagint, the ancient Greek translation that was the Old Testament of the early Christian church. Various mixed forms of text appear also, providing much new material for tracing the history of the text. A useful basis of comparison is afforded by the 2nd-century biblical texts from the Wadi Murabbaat. They conform closely to the standardized Masoretic (traditional) text of the medieval manuscripts, showing that the process of standardization was being completed in the 1st century, between the stages represented by the texts from the Wadi Qumran and those from the Wadi Murabbaat.

In addition to the manuscripts of books of the Old Testament there are collections of passages selected from one or more books. More or less extensive quotations appear also in commentaries on

a number of books, especially the prophets. Two manuscripts, one of which has been named the Testimonia and the other the Florilegium, are collections of Messianic proof-texts.

Sectarian Literature.—The rest of the Qumran scrolls and fragments contain the nonbiblical works cherished by the community. They cover an extraordinary range of different types of material. Several of the books previously known as the Apocrypha and Pseudepigrapha appear among the Qumran texts. They include Tobit and Sirach (Ecclesiasticus) as well as Enoch and Jubilees. There are also many works not hitherto known at all. Most of them are in Hebrew, but a number are in Aramaic. Only a few examples to illustrate the scope of the material can be mentioned here.

A few texts consist of paraphrases of biblical material. The most extensive is the Genesis Apocryphon, one of the first scrolls found, which was for a while called the Lamech scroll. It presents the contents of several chapters of Genesis, freely retold in Aramaic. The few columns of the badly deteriorated scroll that have been deciphered and published contain parts of the stories of Noah and Abraham, with interesting variations.

The commentaries mentioned above interpret Scripture as referring specifically to the history and doctrines of the sect. Of those published thus far, the most complete is the commentary on Habakkuk, but there are substantial portions of many others.

Some of the texts are of a legal nature. The Damascus Document, cited above in connection with the history of the community, gives strict regulations for the life of the camps. Very similar in many respects but containing also other material is the Manual of Discipline or Rule of the Community, of which one fairly complete copy and parts of others were found. The Rule of the Congregation is another work closely related to the Manual of Discipline but with significant differences at several points.

There are also liturgical works, including collections of hymns and prayers. Among these are the scroll of Benedictions, the Mishmaroth scroll giving directions for the successive assignments of the priestly families in the temple, and most remarkable of all the scroll of Thanksgiving Psalms found in the first cave.

Other texts contain apocalyptic material, dealing with the events of the last days or the conditions of the world to come. One, represented by fragments of several copies found in different caves, is a Description of the New Jerusalem written in Aramaic. Especially interesting in this group is the scroll concerning the coming War of the Sons of Light with the Sons of Darkness, in which are given detailed directions concerning weapons and tactics and predictions of the course of the war. A curious document which perhaps belongs to the same category is contained in the unique copper scroll. It lists places throughout the country where fabulous treasures are supposed to be hidden. (*See* also APOCRYPHA, OLD TESTAMENT.)

Significance for Christian Origins.—The Dead sea scrolls represent a type of Judaism, little known previously, which in some ways remarkably resembles early Christianity. The conception of the cosmic war of light and darkness, the sense of living in the last days and expecting momentarily the end of this world, the common meals and the sharing of property, the ritual baths or baptisms, and some details of organization are among the points of most obvious similarity.

Not a few scholars have thought it probable that John the Baptist had some direct connection with the community of Qumran, at least during his childhood. Parallels have been seen also between the careers and doctrines of Jesus and the Qumran Teacher of Righteousness, but these have been grossly exaggerated. Little is actually known about the life of the Teacher of Righteousness. There is no evidence that he was crucified or that his disciples expected him to rise from the dead.

Obviously John and Jesus were not members of the sect at the time of their public ministry. Not only similarities between John and the men of Qumran but also equally significant differences have been noted, the most important being John's sense of a mission to the whole nation, the lack of any evidence of a closely regulated organization of his followers, and his recognition of Jesus as the one greater than himself who was to come after him.

The teaching and attitudes of Jesus stood in several respects at opposite poles from those of the Qumran community. He was not an ascetic; his attitude to the law differed radically from the rigid legalism of the Qumran sect; he had none of their concern for the matters of ritual observance; he did not establish an exclusive order of saints but proclaimed to all a warning of judgment and a gospel of salvation. In his stress on the conflict between the kingdoms of God and Satan he agreed with the men of Qumran, but unlike them he proclaimed that the victory was already won, and the imminence of the coming kingdom of God was already manifest.

In some particulars of organization and practice, theological vocabulary and perhaps doctrine, the early church may have been influenced, directly or indirectly, by the Qumran sect or by the Essenes living throughout Palestine. The evidence is insufficient to establish more than a possibility. What is most important for the understanding of Christian origins is that the Dead sea scrolls illuminate the religious background of Jesus and his first followers, their spiritual heritage, their common presuppositions and the language and concepts by which the gospel was communicated.

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DEADWOOD, a city in the Black hills of western South Dakota, U.S., the seat of Lawrence county, lies in a canyon 4,533 ft. above sea level. During the 1876 gold rush thousands of miners struggled into Deadwood gulch, and the city gained a reputation, magnified by the "Deadwood Dick" dime novels, as a wide-open outpost of frontier violence. Wild Bill Hickok was killed in a Deadwood saloon Aug. 2, 1876, by Jack McCall and is buried in Mt. Moriah cemetery beside Calamity Jane. Deadwood is a city of narrow streets, with houses clinging in layers to steep, wooded inclines. The economy, based principally on mining, forestry and tourist services, is influenced by the large Homestake gold mine at the city of Lead, about 4 mi. S.W. An annual "Days of '76" celebration and a spirited summer-long melodrama, "The Trial of Jack McCall," portray the excitement of Deadwood's turbulent past. Tourist attractions include the Adams museum (historical items), a granite bust monument of Hickok by Korczak Ziolkowski and the Theodore Roosevelt monument. The population in the 1960s was about 3,000. (J. L. J.)

DEAF AND HARD OF HEARING, TRAINING AND WELFARE OF. The term deaf is frequently applied to those who are deficient in hearing in any degree, however slight, as well as to people who are unable to detect the loudest sounds. In this article the term deaf is applied to those who are so handicapped that they are unable to receive instruction through the sense of hearing. The hard of hearing are those in whom the sense of hearing, although defective, is functional with or without a hearing aid. (D. M. L.)

Children may be born deaf or may acquire deafness in early infancy. There is a serious interference with the normal course of mental and educational development when the deafness is so great as to prevent the hearing of the spoken word. It is through hearing that the normal child learns to appreciate the meaning of words. It is through hearing that the normal child obtains those sound patterns which guide his attempts at speech. The severely deaf infant who is unable to hear spoken language consequently fails to acquire a knowledge of words or language and does not develop the power of speech. Devoid of these common means of communication, such children are isolated from the rest of society and suffer a major handicap in education. Such children

who are mute only through deafness—through failure to hear and imitate speech as do children with normal hearing—constitute a special class of handicapped children for whom special educational provisions are necessary. Muteness divorced from deafness is a rare condition and is not treated here. Medical aspects are discussed under DEAFNESS AND IMPAIRED HEARING; and SPEECH DISORDERS. (*See* also EAR, ANATOMY OF; EAR, DISEASES OF.)

The two main types of deafness are conduction deafness and nerve deafness, and they may occur singly or in combination. The former is due to some obstruction to the passage of sound to the inner ear while the latter is due to a defect of the inner ear or of the nerve fibres from this sensory organ. Infections of the middle ear give rise to many cases of conduction deafness found in partially deaf children, but considerable mystery surrounds the predominant cause of congenital deafness. Surveys show that among children in schools for the deaf and partially deaf about 60% are congenitally deaf. Causes of severe deafness of the acquired type include meningitis and maternal rubella during the first three months of pregnancy.

Nerve deafness may be inherited, but the proportion of such cases is small. The incidence of deafness sufficiently severe to demand special education varies from place to place and country to country.

HISTORY OF THE EDUCATION OF THE DEAF

Early History.—The history of the education of the deaf begins properly in the 16th century. Before this time those born deaf were the subject of philosophic speculation but it was generally assumed that they were incapable of education. Pedro de Ponce (1520?–84) successfully taught some deaf pupils in Spain to speak, read and write, and it is assumed that his methods were followed by Juan Pablo de Bonet who in 1620 published the first book on the subject. This gave rise to a wider interest in the education of the deaf in western Europe.

In England John Bulwer (fl. 1654) wrote on teaching the deaf to speak and read the lips, and he was followed by William Holder (1616–98), John Wallis (1616–1703) and George Dalgarno (1626?–87).

In France similar work had been carried on by abbé Charles Michel Épée (*q.v.*) who made a most profound contribution in developing the natural sign language of the deaf into a systematic and conventional language to be used as a medium of instruction. His work was developed by the abbé Sicard (1742–1822) and gave rise to the manual system or silent method of teaching the deaf.

In Germany Samuel Heinicke (1727–90) educated deaf children orally and later Moritz Hill (1805–74), perhaps the greatest educator of the deaf of all time, developed this method. Thus arose the oral method of instruction which continued to influence the teaching of the deaf and in time became an accepted practice throughout the world.

Great Britain.—Thomas Braidwood (1715–1806) established the first school for the deaf in Great Britain, first in Edinburgh and later in London. This school was of a private nature but at this time the attention of the philanthropic public became focused on the needs of the deaf and funds were raised to establish schools for the deaf generally. The first school for the poor deaf was opened in the Old Kent road, London, in 1792 and later moved to Margate. Edinburgh followed suit in 1810; Birmingham in 1814; Liverpool, 1825; Manchester, 1825; Exeter, 1827; and Doncaster, 1829. By 1870 ten residential institutions for the deaf had been established in England, four each in Scotland and Ireland and one in Wales. In these early institutions the method of instruction was generally a mixed one, and in certain cases an entirely silent mode of instruction was employed. The German oral system, however, was gaining ground rapidly, and the Yorkshire institution adopted it in 1876. From this time onward the oral method, in which lip reading replaces hearing and the children are taught to use speech as a normal means of communication, advanced in favour, and eventually became the accepted method for the instruction of the deaf in the United Kingdom. Elsewhere the oral method proved acceptable although in some schools a method in which oral techniques were combined with manual communication continued to be used with success.

During the greater part of the 19th century the education of deaf children depended entirely on the work of the charitable institutions, but following the Elementary Education act of 1870 further efforts to widen the field of state education gave rise to the Elementary Education (Blind and Deaf) act of 1893–94. This act (which had been anticipated in Scotland in 1890) made compulsory the education of deaf children from the age of 7 to 16 years. In consequence further residential institutions and day schools were opened. From this time onward the schools for the deaf, whether in establishments maintained by independent governing bodies or in schools maintained by local authorities, became an integral part of the state system of education. (E. S. G.)

United States.—The first recorded attempt to teach a deaf-mute in the United States was by Philip Nelson in Rowley, Mass., in 1679, but not until the early 19th century was concerted action taken to educate deaf children. Francis Green of Boston, Mass., whose deaf son was sent to Edinburgh to be educated at Thomas Braidwood's institution, became much interested in the problem. With some ministers he attempted a census of Massachusetts in 1803, when 75 deaf were found. They then estimated that there were 500 deaf persons in the United States and urged the creation of a special school.

In 1810 in New York city the Rev. John Stafford found several deaf children in the city almshouses and tried to instruct them, efforts which later resulted in the founding of the New York Institution for the Deaf (1818). A grandson of Thomas Braidwood, John Braidwood, began to teach a family of deaf children in Virginia in 1812, later establishing a school. In 1812 an investigation disclosed 84 deaf in the Hartford, Conn., area, an estimated 400 in New England and 2,000 in the United States. In 1815 a group of Hartford men organized a society to instruct the deaf, raised $2,278 and sent a young minister, Thomas Hopkins Gallaudet (*q.v.*), to Europe to learn methods of teaching the deaf. Gallaudet studied the sign-language method at the abbé Sicard's school in Paris, which influenced the whole course of the education of the deaf in America. When Gallaudet returned in 1816, he was accompanied by Laurent Clerc, himself deaf, one of the Paris institution's teachers. On April 15, 1817, the Hartford school was opened with subscriptions from other cities amounting to $12,000 and an appropriation of $5,000 from Connecticut, probably the first made in the United States for other than regular schools. This school used the sign language, the manual alphabet and writing as the basis of instruction. In 1819 the federal government granted 23,000 ac. of public land, the proceeds from which formed a fund of $339,000.

In May 1818 the New York Institution for the Deaf was opened with 62 pupils. After an exhibition by the students in 1819 the state legislature appropriated $10,000 and granted "a moiety of the tax on lotteries in the city of New York" which for 14 years formed a good income. In Philadelphia, Pa., David Seixas began teaching deaf children in his home in 1820. After an exhibition of results accomplished in 1821, he secured a charter and a per capita appropriation from the state of $160. The Hartford school lent him Laurent Clerc. New Jersey began at once to send pupils to the Pennsylvania institution, Maryland followed in 1827 and Delaware in 1835. Kentucky in 1823 was the fourth state to establish a school for the deaf, the Kentucky asylum at Danville, which was the first school established distinctly as a state enterprise. In 1863 there were 22 schools for the deaf with 2,012 pupils. Within 60 years of the first foundation, they were established in 31 states, great areas of public land being granted in several instances for such purpose. In all the institutions, up to 1867, the manual system of instruction held sway, though the oral method had been tried at the New York institution.

In 1867 the Clarke school, established at Northampton, Mass., and the Institution for the Improved Instruction of the Deaf, New York city, now the Lexington School for the Deaf, were the first schools instituting oral instruction. Both schools exerted an influence on the early education of the deaf.

Educators of the deaf divided themselves into those who fa-

voured the manual (sign-language) system supplemented by articulation and those who taught speech and lip reading, vetoing the manual method. Manual teachers maintained that certain deaf-mutes would never learn to speak and to read lips; oral teachers considered it unjust to separate the deaf from the hearing because of lack of instruction in the use of the vocal organs. Edward Miner Gallaudet's stand for the teaching of speech to deaf children after his extended European tour of 1867 influenced many instructors. In 1886 tension had modified sufficiently to permit the convention of instructors of the deaf to pass noteworthy resolutions urging endeavours in the schools to teach every pupil to speak and read from the lips. The resulting combined system was defined in the *American Annals of the Deaf*, the instructor's official organ, as follows:

Speech and speech-reading are regarded as very important, but mental development and the acquisition of language are regarded as still more important. It is believed that in some cases mental development and the acquisition of language can be best promoted by the Manual method, and such method is chosen for each pupil as seems best adapted for his individual case. Speech and speech-reading are taught where the measure of success seems likely to justify the labor expended, and in some of the classrooms of most of the Combined-System schools the Oral method is strictly followed.

The combined and the oral systems came into increasing use. Yet even in 1904 the World's Congress of the Deaf at St. Louis, Mo., ruled that champions of the oral method were not friends of the deaf and that every teacher of the deaf ought to have a working command of the sign language. Oralism was helped forward by the establishment of day schools. The Horace Mann school at Boston was the first, starting Nov. 10, 1869, under Sarah Fuller, principal for 41 years, who gave Helen Keller (*q.v.*) her first lessons in speech. The number of day schools increased slowly up to 1894 when there were 15, and more rapidly thereafter. Pupils from oral schools passed on to high schools and colleges, holding their own with those who hear and graduating successfully. According to the National Research council survey of the three methods of education in practice—the oral, manual and combined —no one method is superior to the others, taking into account the educational achievement of the pupils and their basic intelligence.

THE 20TH CENTURY

Through the first half and increasingly in the second half of the 20th century, advances were made in the design, effectiveness and use of audiometers and other apparatus employed in early recognition and accurate diagnosis of hearing deficiency, in hearing aids, in teaching methods and devices used in teaching and in the training of teachers, therapists and other specialists. Increasingly greater stress was laid on the development of residual hearing, really an integral part of the oral method, so that sounds and language ideas are associated. Audiometer tests showed pupils to have from 5% to 85% of available acuity. Auricular training was emphasized to teach the child to perceive the sound of the human voice and to interpret it, giving a vocabulary, improving speech and increasing activity in the psychic acoustic centres.

United States.—The increasing emphasis on the oral method in the U.S. by the second half of the 20th century was breaking down the barriers that separated the totally or partially deaf from people with normal hearing. The teaching of speech and lip reading became generally prevalent so that the use of communication was available to nearly everyone. Provision had been made for the education of the deaf in local institutions in most states. Lacking a state school, the children were sent at public expense to a school outside the state.

All states have compulsory attendance laws for deaf children who are mentally competent. Admittance ages range from 3 to 8 and duration of attendance varies from age 16 to 25. More than half the states have day schools for the deaf in larger cities or a department for training deaf students within the existing school system. It has been estimated that 88.6% of the deaf in the United States have had some schooling. Every state requires periodic surveys for screening out children with hearing defects. Legal requirements vary from annual checks in some states to one survey every three years in others. In this way most children with hearing problems are recognized at least by school age. Students in residential schools for the deaf are given vocational training according to their aptitudes. If this is not sufficient or if facilities are limited, the vocational rehabilitation division of the U.S. department of health, education and welfare will assume the responsibility for further education providing the student's potential ability warrants the expenditure. The vocational rehabilitation division is a national agency with one or more regional offices in each state. This agency will also assist individuals who have sustained hearing impairment after the age of 14, 16 or 18, depending on the state.

Some states have mobile clinics which visit each section or community once a year. Parents may bring their children to be examined, and the specialists there refer them to their local physicians for further medical care. Many of the larger cities have audiology centres for diagnosis, hearing-aid fittings and some rehabilitative measures. Schools of higher education sometimes give concentrated courses for rehabilitating hearing-defective individuals, including speech correction, auditory training and lip reading. There are also summer camps which include speech therapists on the staff.

One of the most notable advances in the care of hearing-defective persons has been the establishment of hospital centres where an audiological service is maintained in the otolaryngology department or correlated with it. There the patient with impaired hearing receives not only complete audiological examination and medical care but also a plan of therapy or recommended procedures. The staff usually includes an otologist, psychologist, physicist, speech and hearing specialist and social worker, and often has access to a psychiatrist. Centres of this type include those at Johns Hopkins, Baltimore, Md., the State University of Iowa hospitals, Iowa City, and the Children's hospital, Los Angeles, Calif.

Higher Education.—A college of accepted standard for the deaf, awarding the usual master's and bachelor's degrees in art and science, was established in Washington, D.C., in 1864 as the highest department of the institution for the deaf founded by congress in 1857. First known as the National Deaf-Mute college, it was renamed Gallaudet college in 1893, and with the Kendall school (secondary) formed the Columbia Institution for the Deaf (renamed Gallaudet college in 1954). Its graduates successfully pursued special courses at many other institutions.

Teachers of the deaf are educated in most states. Degrees are awarded by recognized colleges and universities, and some teachers are enrolled in training programs in institutions for the deaf.

The Volta bureau for the increase and diffusion of knowledge relating to the deaf was founded in 1887 by Alexander Graham Bell (*q.v.*), who had taught his father's "visible speech" system at the Clarke school in 1872 and whose life was largely devoted to helping the deaf. The bureau also maintains a guidance service for parents of children with impaired hearing.

The 1930s saw the beginning of rapid and continuing strides in the development of hearing therapy with several organizations increasing in membership and national scope. Along with schools for the deaf and the U.S. office of education the following became sources of assistance to individuals with defective hearing: American Hearing society, Washington, D.C.; Council of Exceptional Children, National Education association, Washington, D.C.; National Society for Crippled Children and Adults Inc., Chicago, Ill.; John Tracy clinic, Los Angeles, Calif.; vocational rehabilitation division of the U.S. department of health, education and welfare, Washington, D.C.

Deaf-Blind.—By the second half of the 20th century there were six recognized schools with departments for educating deaf-blind children: Perkins institution, Watertown, Mass.; New York institute, New York city; Michigan School for the Blind, Lansing; Washington State School for the Deaf, Vancouver; Iowa State School for the Deaf, Council Bluffs; and California School for the Blind, Berkeley. Children from other states are sent to these schools on a tuition basis. The American Foundation for the Blind

acts as a disbursing centre and clearinghouse for acceptance of fee-basis students. This organization is an excellent source of material for parents seeking aid for deaf-blind children. (D. M. L.)

Great Britain.—The Education act, 1944, improved the position of deaf children and provided for the establishment of nursery schools for the deaf with optional attendance from the age of 2 years with the compulsory period continuous from 5 to 16 years. The act also allowed for the establishment of schools for the partially deaf and for schools for education of a more advanced type.

Where deafness is so severe that the child is unable to acquire a knowledge of language and the power to speak in the natural way, special educational treatment is necessary, and such children are educated in special schools. In other cases the degree of hearing loss may not prevent the acquisition of normal speech and language but yet may constitute a serious handicap to normal educational progress. These children, known as partially deaf, also need special educational treatment which is provided in special schools for the partially deaf or in special classes in schools for the deaf. The policy in the United Kingdom is to segregate the two classes since the basic educational problems are different. In the schools for the deaf the essential task is to teach, by special methods, a knowledge of language and speech. In schools (or classes) for the partially deaf the main work is to carry on the normal process of education with the use of hearing aids and lip reading.

Where the degree of hearing loss is small, children may be trained in the use of individual hearing aids and taught to lip read, and their education successfully carried on in the normal schools. Such children are generally known as hard of hearing. There are three recognized categories of deaf children: grade i, where the hearing loss constitutes no threat to normal education; grade ii, divided into two categories, iia (hard of hearing) and iib (partially deaf), where the hearing loss has not prevented the natural acquisition of language and speech but where special assistance is necessary according to category as follows: in grade iia, by provision of hearing aids or lip-reading instruction, or both, and education in the normal schools; in grade iib, by provision of hearing aids and education in special schools or classes for the partially deaf; grade iii, where the hearing loss is severe and prevents the natural acquisition of language and speech. For children in groups iib and iii education is provided in special schools and attendance is compulsory.

In England schools for deaf children may be either residential establishments or day schools or a combination of both. They may accept severely deaf or partially deaf pupils or in special cases both types. In general the older institutions appear as the residential schools and these are managed by independent bodies of governors. Day schools and other schools established since the beginning of state education are almost entirely managed by local education authorities. In addition to the types of schools for the deaf already mentioned there exist in England two schools for deaf children with additional defects, a secondary grammar school for both deaf and partially deaf boys and girls established in 1946 and a secondary technical school for profoundly deaf boys established in 1955. Entry to the grammar and technical schools is by a national competitive examination and at both schools education is to university entrance level. Training in certain trades is given to deaf boys and girls between the ages of 16 and 19 years at a special department of the Royal Schools for the Deaf, Manchester. Education whether at day or residential schools in the United Kingdom is free.

Qualified teachers must obtain a second qualification to teach deaf children. This second qualification may be obtained by practising teachers by passing the examination arranged by the National College of Teachers of the Deaf or by successfully undertaking a course of one year, for graduates or qualified teachers, which is arranged by the department of education of the deaf at the University of Manchester. Teachers of the deaf are paid according to the standard scales in operation and in addition receive special allowances for the extra qualification.

Research.—Educational research into the many problems of deafness is carried on in various centres. In the University of Manchester department of education of the deaf the whole field of deaf education is studied and there is opportunity for post-graduate work. At other centres, and notably in London, special research is undertaken in relation to deafness in very young children. Deafness clinics have been established in the larger centres of population where early diagnosis is made and preschool training given to deaf infants and to their parents. From this work a new technique of auditory training arose which in the second half of the 20th century was being rapidly extended in all schools for the deaf and partially deaf. The Medical Research council also fosters research on a wider basis into all aspects of deafness as does the National Institute for the Deaf.

The Adult Deaf.—Defects of hearing in the adult population have created a problem of considerable social significance, particularly among the older age groups. In Great Britain, the state, through its national health service, assists such handicapped persons by the free issue of hearing aids while many local education authorities arrange for lip-reading instruction for adults. Clubs and societies of a voluntary nature have been established in most cities and towns to further the social and educational needs of that section of the population suffering from loss of hearing and these organizations are generally affiliated with the British Association of the Hard of Hearing which acts as a national body to further the interests of constituent members and to act as the mouthpiece and instrument of all hard-of-hearing persons in the United Kingdom.

The welfare of the adult deaf (often known as the deaf and dumb) is in the management of charitable organizations which were established in a manner somewhat similar to the older educational institutions (now residential schools) for the deaf. After the passing of the National Assistance act, 1948, in England these independent bodies received an increasing amount of public assistance but remained essentially charitable organizations, each peculiar to its locality. Such a mission, or institute, for the adult deaf is controlled by a local committee which appoints a missioner or superintendent, who may or may not be an ordained minister of religion, to organize its activities which are essentially of a social nature. Unlike schools for the deaf where the teaching method of communication is entirely oral (*i.e.*, by speech and lip reading), the means of communication of the deaf members is generally a combined or mixed one, speech, signs and finger spelling being used in varying degrees.

The National Institute for the Deaf in London is concerned with all aspects of the welfare of the deaf and works through its central headquarters and through its regional associations. It is the recognized source of information on matters relating to the deaf. Other national bodies are the Royal Association for the Deaf and Dumb and the British Deaf and Dumb association, an organization managed by the deaf to further their own cultural interests. The Central Advisory Council for the Spiritual Care of the Deaf and Dumb furthers the spiritual welfare of the deaf throughout England and Wales. (E. S. G.)

Other Countries.—In the Commonwealth of Nations the pattern of education of deaf children is copied largely from that in England, and many teachers in such schools are recruited from that country or trained in the University of Manchester. In Europe also the methods of education bear close resemblance to those in England and Scotland although in France and Spain schools will be found where the silent methods are followed to a much greater degree. A study conducted by the United Nations Educational, Scientific and Cultural organization, *World Survey of Education* (1955), indicated that a number of European countries, the German Federal Republic and Sweden, for example, provide special classes for the hard of hearing in addition to special schools for the deaf; facilities for the correction of speech defects; and require additional specialized training for teachers. Where programs are limited, emphasis is on primary education with some vocational training; boarding school or institutional care may be provided only for deaf-mutes. In many places the responsibility for the education and welfare of the deaf is left to private philanthropic and religious organizations and to private institutions.

In Asia, India and Pakistan provide for primary education and

vocational training for deaf-mutes in special institutions; Thailand maintains one school for the deaf and Indonesia instituted a training school for teachers of the deaf; in Japan the provision of special schooling has been compulsory since 1923 while attendance at such schools through the lower secondary level has been compulsory since 1956.

Argentina, Brazil and Peru in Latin America make some provisions for special education and remedial education for the deaf and hard of hearing.

See also DEAFNESS AND IMPAIRED HEARING; REHABILITATION, MEDICAL AND VOCATIONAL. (M. E. F.)

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DEAFNESS AND IMPAIRED HEARING. The word deafness is commonly used to mean any degree of impaired hearing, from a slight partial to a complete loss of the hearing function. In an effort to clarify terminology, the American Academy of Ophthalmology and Otolaryngology has recommended that use of the word deafness (anacousis) be restricted to losses of at least 82 decibels (American standard). The term implies a handicap sufficiently severe to prevent communication through the ear without some form of amplification. Impaired hearing (hypoacousis) implies a hearing loss of a moderate degree, which, according to the standards laid down by the academy, ranges from 20 decibels to the levels defined as deafness.

Distorted hearing (dysacousis) refers to any impairment of hearing that is not primarily a loss of auditory sensitivity. Such impairment is frequently the result of damage to the central auditory nervous system. Distorted hearing differs from deafness or impaired hearing in that simple amplification does not improve the individual's ability to understand words or sentences. Children suffering from this condition may fail to develop speech, may lose interest in listening and are frequently regarded as deaf. Adults complain that they can hear but cannot understand speech. In such cases amplification results only in increased confusion and is of no practical value.

Unbalanced hearing (diplacusis) is the condition in which the tonal pitch in one ear differs from that in the other.

Frequency of Occurrence of Hearing Impairment.—Statistical studies do not agree on the incidence of hearing impairment. Many data are of dubious accuracy because of variances in testing techniques and the lack of control over acoustic conditions in the testing environment. The better controlled studies indicate that approximately 5% of school-age children have some impairment in one or both ears. When temporary hearing impairment associated with colds is included the figure runs closer to 10%. About 10% of the adult population suffers from significant hearing loss in one or both ears. The incidence of severely handicapping hearing loss in the over-all population is rather difficult to estimate. Most surveys indicate up to 5% of the population is so affected.

Types of Hearing Impairment.—Traditionally, hearing impairment has been divided into three types: (1) conductive; (2) perceptive; and (3) mixed. In recent years four categories have come to be recognized, on the basis of anatomical and physiological studies: (1) conductive; (2) receptive; (3) transmissive; and (4) perceptive. Any combination of these latter four, which are discussed separately below, is referred to as a mixed type of hearing impairment. For a description of the structural features of the ear *see* the article EAR, ANATOMY OF. For a description of the physiology of hearing *see* HEARING.

Conductive hearing impairment results from mechanical interference with the passage of the energy of sound waves through the external ear canal, the tympanic membrane (drum membrane) and the three bones (ossicles) in the middle ear. Any such interference causes a damping of the movement of the stapes (stirrup) with resultant loss of fluid motion in the inner ear, where the end organ of hearing lies. Conductive impairment therefore simply diminishes the loudness of sound; it never causes total deafness.

Receptive.—The end organ of the auditory nerve known as the organ of Corti lies in the inner ear. This is the receptor mechanism of the nerve portion of the hearing apparatus. It is here that the mechanical energies of sound waves transmitted into the fluids of the inner ear give rise to nerve impulses. It is here, in other words, that mechanical energy is encoded into an electrical pattern. Injury to any portion of this receptor mechanism or to the nerve fibres and ganglion cells related to it in the inner ear can cause a loss of hearing for some tones. In receptive impairment, high tones are more commonly affected than low tones.

Transmissive.—The electrical pattern that originates in the inner ear is transmitted along the auditory nerve pathways from the organ of Corti in the inner ear up to the cortex of the brain. Interruption of this transmission system may cause a breakdown in the passage of nerve impulses and a scrambling of auditory perception.

Perceptive.—The auditory cortex is that portion of the brain where the complicated electrical signals originating in the inner ear and transmitted along the auditory pathways finally are decoded. It is at this point that conscious hearing takes place. Damage here causes difficulty in the recognition of sound patterns.

Hearing impairment may be the result of damage to either the mechanical portion or the nerve portion of the hearing apparatus. Damage to the mechanical portion results in a loss of loudness. Damage to the nervous portion results in loss of clarity and discrimination.

Etiology by Age Groups.—The most frequent causes of hearing loss in infants, school-age children, adults of middle age and adults of old age, rated according to age of patient at onset, are as follows:

Infancy.—Hereditary hearing loss may appear in generation after generation of a family, and the nature of the impairment in succeeding generations is frequently almost identical. This loss is the result of failure to develop certain neural elements in the neuroauditory mechanism.

Congenital deformities that result in partial or complete closure of the external canal of the ear and occasionally in deformities of the ossicular chain and middle ear itself cause a conductive-type hearing loss. These deformities, like cleft palates, can occur sporadically without a previous family history.

Infection during the first trimester of pregnancy by the viruses of German measles (rubella) and of chicken pox (varicella) (and several other less-well-defined strains) can cause damage to the developing inner ear. The virus passes from the infected mother into the circulating blood of the embryo, where it attacks the growing nerve cells. Such infections result in varying degrees of distorted hearing (dysacousis).

Syphilis, either congenital or acquired, may attack the nerve tissues of the ear and brain and cause perceptive deafness.

Incompatibility between the blood of the mother and the blood of the child (erythroblastosis fetalis) can cause a destruction of red blood cells in the child that results in severe anemia. Cells thus destroyed cause large amounts of the pigment bilirubin to deposit in the auditory nuclei of the brain stem. Both the reduction in the amount of oxygen in the blood as result of anemia and the pigment deposits can damage the auditory nerve pathways.

Interference with the infant's blood supply at the time of labour as result of undue pressure on the umbilical cord or of difficult birth presentation causes a decrease in circulating oxygen and resultant damage to the nerve portion of the hearing apparatus. Children born prematurely frequently have weak respiratory reflexes. This results in poor oxygen exchange in the lungs and decreased circulating oxygen.

Crushing of the brain by the passage of the head through the

birth canal during labour or as the result of instrumentation can cause multiple neurological lesions, including those that produce nerve-type hearing problems.

Children subjected to severe viral infections in the first year of life may develop hearing difficulties similar to those encountered in prenatal viral infections. Young children are most subject to attacks of meningitis (*q.v.*). These attacks may seriously damage or even completely destroy the hearing.

School Age.—This is the time when children are widely exposed to upper-respiratory infections and middle-ear infections. These may cause scars to form around the ossicles in the middle ear or may damage the drum membrane and thus interfere with the transfer of energy from the membrane into the fluids of the inner ear. Such conductive hearing losses are usually proportional in severity to the severity and duration of the infections.

Third to Fifth Decade.—The two most frequent causes of hearing impairment during this period are otosclerosis and high noise levels.

Otosclerosis is the condition that causes new bone to form in the middle ear in the region of the oval window. It is at the oval window that the inner ossicle, the stapes, comes into contact with the fluids of the inner ear and acts as a piston to conduct the energy of tympanic membrane vibrations into the fluids of the inner ear. In some individuals this new bone welds the footplate against the wall of the surrounding bone and immobilizes it.

Exposure to high noise levels in the range of 100 decibels or more for long periods of time or exposure to sudden concussive sounds such as a gun blast damage the organ of Corti. This damage usually reflects itself in a high tone loss.

Old Age.—Aging persons undergo degenerative processes. Failing circulation chronically decreases the amount of oxygen made available to the nerve tissues. These tissues normally require large quantities of oxygen for their metabolism. Hypoxia is particularly damaging to the nerve tissue in the cortex of the brain.

Prevention of Deafness.—In the 1940s and 1950s interest increased in the prevention of hearing loss through both conservation programs and medical prevention.

Many conservation programs are designed to find cases early so they can be given careful otological and medical examination; the objective of such programs is to correct factors predisposing to hearing loss. Case finding is employed principally in school populations and in large industries where routine testing of hearing is part of the health program. A few pilot studies, however, were being made in Europe and in the United States in the early 1960s of infants examined at well-baby clinics.

Serious attempts are made to control dangerous noise levels in industry and in military establishments. Noise levels of greater than 100 decibels or environments in which individuals are subjected to severe concussive sounds are of particular importance. When noise levels cannot be controlled measures are taken to protect exposed individuals by the use of ear defenders (*i.e.*, prostheses that can be placed in or over the external auditory canal). Protection against noise is more important to some individuals than others. Surveys have shown that individual ear sensitivity to noise varies a great deal in man.

Medical preventive measures include immunization of prospective mothers against all viral infections for which vaccines exist, improved obstetrical care and control of ear infections in children and adults by the removal of obstructing adenoid tissue around the mouth of the eustachian tube. In the geriatric group improved medical methods are needed to ameliorate vascular degeneration and failure of circulation. Finally, the public needs to be made aware of the fact that the use of certain chemicals or drugs, may damage the neuromechanism of hearing.

Restoration of Hearing.—Hearing can be improved by either surgical or prosthetic methods in many instances.

Surgical.—Marked progress was made in the decades immediately preceding the 1960s in the development of surgical techniques to improve hearing. These techniques reached a point where many individuals suffering from middle-ear (conductive) type hearing loss could look forward to an improvement of hearing to a usable level. The surgical objectives are: (1) to establish the continuity of the external auditory canal in persons with congenital closures or postinjury deformities of the canal; (2) to repair damaged drum membranes or replace destroyed drum membranes with new tissue (myringoplasty); (3) to re-establish the function of the ossicular chain and/or create a mobile connection between it and the fluids of the inner ear (tympanoplasty); (4) to eliminate chronic infection (mastoidectomy). No surgical or medical procedure devised by the 1960s was effective in restoring damaged inner ears or nerves.

Special mention should be made of the surgical restoration of hearing in individuals suffering conductive hearing impairment as a result of otosclerosis. In order to free the stapes so its piston-like action may be restored, surgery has been designed to break or remove the new bone that welds the stapes to the edge of the oval window. Such an operation is called a stapes mobilization. If the conductive link between the drum membrane and the stapes can be maintained after the stapes is freed, the hearing should return to the level of efficiency permitted by the functional ability of the auditory nerve. Such improvement will be maintained unless new bone forms again and immobilizes the stapes. A more recent surgical development known as stapedectomy is employed in many instances instead of the stapes mobilization. In this technique the stapes footplate (the piston) or the entire stapes bone is removed from the oval window. The window is then closed by a tissue graft (fascia, vein or fat) obtained from the patient. The stapes bone is replaced by a prostheses (plastic tubing or steel wire) that restores the continuity of the conductive link between the tympanic membrane and the fluids of the inner ear. When the stapes cannot be freed or removed, or when bone continues to re-form after a stapes mobilization, it is possible to create a new window into the inner ear to replace the closed oval window. This window is made in the lateral semicircular canal. It is covered with a thin graft formed by skin and tympanic membrane. Sound-wave energy can then be transmitted directly through the new window membrane into the fluids of the inner ear. Such a procedure is called a fenestration operation. In a few individuals, new bone formation may close the fenestra and reduce the hearing to its preoperative level.

Prosthetic.—Devices to aid hearing have been used for centuries to do one of two things: (1) to collect sound waves, amplify them and introduce them into the ear canal; or (2) to introduce the vibrations of sound directly into the skull.

The earliest form of a hearing aid was probably a hand cupped behind the ear. This was followed by placing a hollowed-out animal horn in the external ear. Complicated sound-collecting chambers made of metal and capable of a considerable amount of amplification eventually were devised.

Devices for introducing sound vibrations directly into the skull were useful only in cases of conductive deafness in which the neural mechanisms were in good condition. Setting the skull into vibration sets up fluid waves in the inner ear (bone conduction). In this manner the damaged middle ear can be bypassed. Devices such as fans have been used; when held between the teeth they act as diaphragms to collect and conduct the energy of the sound waves into the skull.

Alexander Graham Bell made the first electrical hearing aids. The advent of the small dry-cell battery and the electron tube (valve) made great improvements possible. By the 1960s highly efficient high-fidelity instruments had been developed by using mercury batteries and transistors. These were easily concealed and were capable of great amplification. Such prosthetic devices are very helpful to persons with conductive hearing losses and to a smaller number of persons whose impairment is due to damage to the inner ear. Hearing aids are widely used by children as well as adults. (*See* HEARING AID.)

Deaf-Mutism.—A child learns to talk because he hears and as he hears. Children with profound hearing impairments are unable to hear voices under normal circumstances and therefore do not develop speech. This condition is known as deaf-mutism. This lack of speech, contrary to ancient belief, is in no wise a measure of an individual's intellectual capacity. The relations between hearing, speech and language habits in general are so much

a part of growth and development that they are likely to be taken for granted. The mutism resulting from hearing impairment is rare, even in the deaf population, because most individuals born with or acquiring a severe hearing loss before learning to speak usually have some remnant of hearing in one or two octaves in the low tone range. While this is not enough to enable them to develop well-formed speech, it does, in most instances, give the individual an awareness of sound that results in the development of some primitive form of speech signal. Children with partial hearing loss, particularly if it involves one portion of the sound spectrum, develop distorted speech. True deaf-mutism does not occur in those individuals who have acquired speech before their hearing loss. Frequently other conditions, particularly aphasia, are confused with deaf-mutism. Aphasia is not the result of hearing impairment.

See also SPEECH DISORDERS: *Disorders of Speech with Physical Causes;* MENINGITIS; DEAF AND HARD OF HEARING, TRAINING AND WELFARE OF: *The 20th Century;* EAR, DISEASES OF; EQUILIBRIUM, ANIMAL.

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(J. E. Bo.)

DEÁK, FERENCZ (1803–1876), Hungarian statesman, known as "the Sage of the Nation," prominent throughout the three decades which saw the revolution of 1848 and the Austro-Hungarian "Compromise" of 1867, was born at Söjtör, in the county of Zala, where his father had an estate, on Oct. 17, 1803. After studying law, he entered the administrative service of his county and in 1833 was chosen to represent it in the diet in the place of his brother who had resigned because of ill health. He attended the rest of the diet of 1832–36 and those of 1839 and 1841, but although re-elected in 1843, declined to sit because of the scandalous conduct of the election. By this time his integrity, good sense and legal acumen had made him, although not a flashy speaker, the most respected figure of the Liberal opposition. In questions of social and general internal reform, he was invariably on the side of sensible progress; he agreed with Lájos Kossuth in wanting more real independence for Hungary within the Habsburg monarchy, but wanted to achieve this by constitutional methods.

It was Deák who, in 1847, drew up for the "united opposition" the program which was the basis of the settlement sanctioned by the crown in March–April 1848 (*see* HUNGARY: *History*). Because of ill-health he had not stood for election to the 1847 diet, but he joined Count Lájos Batthyány's cabinet on March 17, 1848, as minister of cults and education and in the following months did everything possible to prevent the breach between the court and its Croatian supporters on the one hand and the Hungarian extremists on the other from becoming irreparable. He ceased to be minister when the Batthyány cabinet resigned on Sept. 28. When the revolutionary war had broken out, Deák attempted to intervene with Prince Alfred von Windischgrätz and was arrested by the Austrians. After his release, he had to retire to his estate at Kéhida, where he stayed until the Hungarian revolution ended. A court martial afterward let him go free.

In 1854 Deák took to spending most of the year in a hotel in Pest and soon became the oracle of those who sought a practical policy for the future. He held unwaveringly to one simple proposition: the position created in March–April 1848, and no other, was legally valid and practically acceptable. Any lesser offer from the crown must be rejected. Armed resistance was, however, impracticable; but all demands from the authorities should be answered by passive resistance, as illegal. As he did not abate his claims when Hungary's position was at its weakest, so he did not raise them when Austria's position was weakened, as after the Austrian defeat by Prussia in 1866. His reward was to see Francis Joseph gradually driven to accept his terms in the course of prolonged negotiations in which Deák was increasingly accepted as the mouthpiece of Hungary. The more extreme Hungarian nationalists also bowed to the inevitable, although reluctantly, and the year 1867 brought the "Compromise" (*Ausgleich*). This in effect embodied Deák's view of a settlement which did justice to the claims of both Hungary and the crown. Deák refused to take office in the responsible government created under the Compromise, but remained for some years the inspirer and unquestioned leader of the party, called after his name, which supported his work in the parliament. He died in Budapest on the night of July 28–29, 1876. He had refused all honours and rewards. He had never married. An edition of his speeches, six volumes, by M. Kónyi, appeared in 1882–98.

See F. A. Forster, *Francis Deák, Hungarian Statesman* (1880).
(C. A. M.)

DEAKIN, ALFRED (1856–1919), Australian statesman who was the dominant figure of the Australian commonwealth's early years, was born at Melbourne on Aug. 3, 1856. He practised schoolteaching, law and journalism before entering the Victoria legislature in 1880. By then he had already progressed far on a passionate and wide-ranging study of literature and philosophy, which was long to continue. Carlyle, Ruskin, Wordsworth and Swedenborg were among the great influences on his thought; his fervent interest in spiritualism reflected a desire to find a religion which promised the perfectibility of man. He was one of the outstanding products of the "golden age" in Victoria's cultural history. Deakin came into politics as a radical-liberal, which entailed hostility to large rural interests and support for the protection of secondary industry. Thus, the argument ran, the workingman would achieve a decent standard of living and colonial society more rapidly become sophisticated. The development of irrigation and similar constructive policies were fostered by Deakin as a minister in several governments between 1883 and 1890. Meanwhile he became an outstanding advocate of the federation of the Australian colonies and did much to consummate that policy (1901). In particular, he strove to iron out the many intercolonial differences of opinion and then played a major part in persuading Joseph Chamberlain to accept the Australian demand for near-absolute autonomy.

Deakin became a member of the first federal cabinet and subsequently prime minister (1903–04, 1905–08, 1909–10). Nobody played a larger part in establishing the nation's settled policies: protection, a judicial system of industrial arbitration, exclusion of coloured immigrants, the development of independent armed forces. His belief in imperial federation led Deakin to advocate trade reciprocity within the empire and the establishment of a central secretariat. Throughout, his mental agility, brilliant oratory and administrative finesse continued potent. He occasionally suffered the charge of political hypocrisy, and it would seem that his personal sense of rectitude could overcome more objective standards. He failed to maintain an independent Liberal party, finally coalescing with the Conservatives against Labor. Few, however, would deny Deakin's claim to greatness. He always hoped to spend his retirement in writing and contemplation, but from 1910 his mind steadily weakened. He finally retired in 1912 and died at Melbourne on Oct. 7, 1919.

See W. Murdoch, *Alfred Deakin* (1923).
(O. M. R.)

DEAKIN, ARTHUR (1890–1955), British labour leader, who was the dominant figure in British trade unionism in the decade after World War II, was born at Sutton Coldfield, Warwickshire, on Nov. 11, 1890, a cobbler's son. He began work at 13 in a steel plant in south Wales. He became an active trade unionist during World War I, and a full-time union official in 1919. In 1932 he was appointed national secretary of the General Workers' group of the Transport and General Workers' union and removed to London. He became assistant general secretary under Ernest Bevin in 1935, and when Bevin joined the war cabinet in 1940, Deakin took over the general secretaryship of the largest union in the country. In 1945, when it was clear that Bevin would never return to the union, Deakin was confirmed in his leadership by a large popular vote. From then until his death his dominance over British trade unionism was perhaps even greater than Bevin's had been in the 1930s. Deakin was a highly skilled wage negotiator,

but he stood firmly behind the Labour government's policy of wage restraint. His anti-Communism was always to the fore, and in 1948 he broke up the World Federation of Trade Unions, of which he was president at the time, rather than continue to associate with the Soviet unions. After the fall of the Labour government in 1951, his firm opposition to the Bevanite challenge did much to maintain both C. R. Attlee's leadership and the adherence of the Labour party to a strong western defense policy. Deakin was made a privy councilor in 1954. He died suddenly at Leicester on May 1, 1955, after addressing a May day meeting.

(R. J.)

DEAL, a member of the Cinque Ports (*q.v.*) confederation and a municipal borough in the Dover parliamentary division of East Kent, Eng., 8 mi. N.N.E. of Dover by road. Pop. (1961) 24,791. Opposite Deal and offering a natural harbour and good anchorage lie the Downs, a roadstead enclosed by the North and South Forelands and the infamous Goodwin sands (*q.v.*).

Deal claims to be the place where Julius Caesar landed in 55 B.C.; the 2,000th anniversary of this event was commemorated by a tablet. The town is recorded in Domesday Book as *Addelam*—a low open plain upon the seashore. During the period A.D. 410–1500 the inhabitants lived mostly at Upper Deal where the parish church of St. Leonard (*c.* 1280), half a mile from the shore, now stands. As a defense measure Henry VIII erected in 1539 Deal, Sandown (in the original borough) and Walmer castles. Walmer castle is the official residence of the lord warden of the Cinque Ports; Deal castle, damaged in World War II, was later restored; Sandown castle was destroyed by the action of the sea. With the building of these castles and the silting up of the rival Sandwich haven, Deal's prosperity grew apace. Merchants' houses, shops, taverns, playhouses and fishermen's cottages, all centred on sea business, arose in narrow streets on the shingle waste lining the shore, which became the haunt of smugglers. Lower Deal is still mainly a business area, but the narrow streets of houses remain. In the days of sailing, merchantmen and ships of war came into the Downs, and the town thrived on the victualing and servicing of these ships. The boatmen along the coast were then known, lauded and derided as "hovellers," and the Deal men, hovellers, pilots and lifeboat men, were reputed for their skill and daring. William Penn sailed from Deal in 1682 on his first voyage to America. Increasing in importance as one of the primary ports of 17th-century England, Deal was granted in 1699 its charter of incorporation which freed it from the jurisdiction of Sandwich, although under the Cinque Ports confederation it remains a limb of that Cinque Port. Deal has its own commission of the peace and is a quarter sessions borough. A navy yard for the supply of equipment and stores to ships of war was maintained in Deal from about the time of Elizabeth I. In 1864 it was demolished, and the Victoria town estate was built on the site with the rise of Deal's popularity as a seaside holiday town. The promenade pier, totally destroyed during World War II, was rebuilt. The borough, which now includes Walmer, Great Mongeham and part of Sholden, has a three-mile promenade. The town is Georgian in style, although retaining its maritime character, and has a large residential population. It is a well-known centre for deep-sea fishing and for golf; three championship courses are available. There are a number of light industries including brushmaking, plastics, precision engineering and boatbuilding; nearby is the Betteshanger colliery, the biggest of the East Kent coal mines. In Deal is the depot of the royal marines. (L. H. S.)

DEAL, a term commonly used to designate the soft woods derived from the Scots pine (*Pinus sylvestris*), which is called yellow or red deal, and the Norway spruce (*Picea abies*), which is called white deal. The former is by far the better timber. Deal is exported from Scandinavia and the U.S.S.R. *See* also PINE; SPRUCE.

DEALFISH, the name applied to marine fishes of the genus *Trachypterus*, which, together with the oarfish (*q.v.*), comprises the family Trachypteridae, or ribbonfish. Dealfish inhabit the middle waters, probably not below 200 fathoms, and are characterized by a long, laterally compressed body, short head, narrow mouth and feeble dentition. The dorsal fin extends the length of the back, the anal is absent, the caudal, when present, is reduced; the pectoral fins are small. In young dealfish some of the fin rays (hornlike projections of the fin skeleton) are prolonged in an extraordinary way. Dealfish, which may reach a length of eight feet, have a world-wide distribution. All the specimens found at the surface of the sea have been more or less mutilated by the release from the enormous pressure under which they are accustomed to live. The commonest species is the northern dealfish, *T. arcticus*.

DE AMICIS, EDMONDO (1846–1908), Italian writer who was a follower of Alessandro Manzoni and the author of popular travel books and children's stories. He was born at Oneglia, Oct. 31, 1846. He began his career as an army officer closely associated with a military journal, and his first publication was a series of sketches of military life, *La Vita Militare* (1868). On retiring from the army he traveled widely and published several books on the cities and countries of Europe. Of his books for children, *Cuore* (1886), written in the form of a diary, is best known and was translated into more than 25 languages. De Amicis died at Bordighera, March 11, 1908.

See M. Martini, *Edmondo de Amicis: L'homme, l'oeuvre, le témoin d'une époque* (1950).

DEAN, originally a title of one of military rank possessing authority over ten (from late Lat. *decanus,* "one set over ten"); later of a civil judge over ten districts. Probably the earliest ecclesiastical use was by St. Benedict (*c.* 520), who, in founding the monastery of Monte Cassino, placed a dean over each group of ten monks. Since that time it has become the title of various ecclesiastic and lay officials.

In the Roman Catholic Church the dean of the Sacred College of Cardinals is the senior cardinal bishop who, in the absence of the pope, presides in the consistory. The chief cleric on the staff of a cathedral may be called dean, archpriest, archdeacon or provost. In some dioceses there are rural deans at the head of groups of parishes.

In the Church of England the dean of a cathedral of old foundation is president of the chapter of canons and prebendaries (*see* CATHEDRAL). Appointed by the crown, he is independent of and ranks next to the bishop. The cathedrals of later foundation (*e.g.,* Portsmouth) have for their head a provost (Lat. *praepositus*), who discharges much the same duties as a dean. A rural dean is a clergyman who has the oversight of a rural deanery which is a subdivision of an archdeaconry within the diocese. The collegiate churches of Westminster and St. George's, Windsor, are governed by a dean; the chapels royal are grouped under one dean, who is bishop of London; and the peculiars (Battle, Bocking, Guernsey and Jersey) each have a dean. The bishop of London by virtue of his bishopric is dean of the province of Canterbury. The dean of arches is a lay judge, and the only judge who possesses authority to pass sentence of deprivation upon a clerk in holy orders.

In Scotland the dean of the chapel royal and of the order of the thistle is always a minister of the Church of Scotland.

The president of a convocation is called a dean in the Protestant Episcopal Church of America.

The word dean in general secular use means the head or senior member of certain bodies, as for instance the dean (French *doyen*) of the diplomatic corps. In Scotland the president of the faculty of advocates is dean of the faculty, and the head of a merchant company or guild is its dean. In many British universities the senior professor in a faculty or the one acting as chairman is called the dean of the faculty. The dean in the colleges of Oxford and Cambridge is usually a fellow who supervises the conduct and discipline of the undergraduates, and is often assisted by a junior dean. (J. W. L.)

In the United States the dean of a college is in charge of educational operations, responsible for the selection of faculty members, curriculum, instruction, college entrance and graduation, and budget and equipment. The dean (sometimes chairman or head) of a division, department, college or school of a university has similar responsibilities, including, at the graduate level, the arrangement of instructional programs leading toward graduate degrees. A graduate dean may co-ordinate work leading toward

graduate degrees and involving more than one division or department, or a broad division, as arts and sciences. Most U.S. colleges and universities and some secondary schools have a student personnel service; often this is headed by a dean of students or by a dean of men and a dean of women in charge of student educational, vocational and personal counseling, extracurricular activities and other noninstructional programs and services. In some universities a dean of administration or dean of the faculty is administrative assistant to the president.

DEAN, FOREST OF, a district in the west of Gloucestershire, Eng., between the rivers Severn and Wye. It is oval in form, 20 mi. long and 10 mi. wide, and still retains its true forest character. The surface is undulating, its elevation ranging from 120 to nearly 1,000 ft., and its sandy soil renders it suitable for the growth of trees, mostly beeches and oaks. An ancient royal forest, it was made into a National Forest park in 1938, controlled by the Forestry commission, which directly administers 26,000 ac. The commoners of the forest still retain rights of sheep pasturage, and their verderers' court still meets at the historic Speech house, while Free miners operate small coal pits. There are also larger coal mines, some small industries at Lydney, Coleford and Cinderford, many small farms and extensive orchards. Roman antiquities include a well-preserved road, a villa and an iron ore working at Weston-under-Penyard (Ariconium). (H. L. En.)

DEANE, RICHARD (1610–1653), English military commander who was one of the Commonwealth's generals-at-sea, was a younger son of Edward Deane of Temple Guyting in Gloucestershire, where he was baptized July 8, 1610. He joined the parliamentarian forces on the outbreak of the Civil War and held a command in the artillery under the earl of Essex in Cornwall in 1644, taking part in the surrender after Lostwithiel. Appointed comptroller of the ordnance, he commanded the artillery at Naseby and during the campaign in the west of England in 1645, and commanded Cromwell's right wing at Preston (Aug. 1648). He was one of the commissioners for the trial of Charles I and a member of the committee which examined the witnesses. He signed the death warrant. When, in Feb. 1649, the office of lord high admiral was put into commission, Deane, Edward Popham and Robert Blake were the first commissioners, with the title of generals-at-sea. Deane had a shore command, as major general, during the campaign against the Scots in the summer of 1651. He was ordered to rejoin the fleet in Dec. 1652 and took part in the battle with the Dutch off Portland in Feb. 1653. He was killed on June 2, 1653, at the outset of the battle off the North Foreland. Deane was given a state funeral and buried in Westminster abbey (June 24), but his remains were disinterred at the Restoration.

DEANE, SILAS (1737–1789), first American diplomat sent abroad, was born in Groton, Conn., on Dec. 24, 1737. He graduated from Yale in 1758, taught school, was admitted to the bar in 1761, entered trade and in 1767 plunged into politics to oppose Great Britain's Townshend acts. From 1774 to 1776 he served as a delegate from Connecticut in the continental congress. In March 1776 congress sent him to France as a secret agent to obtain financial and military assistance and to investigate the possibility of an alliance. Within a year of his arrival he sent at least eight cargoes of arms, valued at more than 6,000,000 livres, to America, an important contribution to the decisive victory over the British at Saratoga in Oct. 1777. In Paris Deane fell under the influence of Dr. Edward Bancroft, an old friend who had become an English spy. In Nov. 1777 congress recalled Deane, but before leaving Paris he signed the treaties of commerce and alliance on Feb. 6, 1778, that he and two other commissioners, Arthur Lee and Benjamin Franklin, had negotiated. In the United States Deane was confronted with charges of embezzlement and disloyalty. Although never proven, those charges led to his ruin.

Deane returned to France in 1780 as a private citizen and prepared letters to old friends in America attacking the French alliance and recommending a reconciliation with England. He placed the letters in the hands of the English, who pretended that they had been intercepted and had them published in *Rivington's Royal Gazette*, a Tory paper in New York, in the autumn of 1781, just when Americans were jubilant over the victory at Yorktown. Angry Americans now denounced him as a traitor. As the war ended, therefore, Deane began a lonely exile, first in Ghent and then in London, where in 1784 he published his defense in *An Address to the Free and Independent Citizens of the United States.* Five years later Deane decided to attempt to re-establish himself among his own people. He booked passage for America on the Boston packet but died on board, Sept. 23, 1789, under mysterious circumstances, in the harbour of Deal, England. Despite his alleged wrongdoing, Deane had helped bring about the French alliance that contributed to his country's independence. He never admitted doing wrong and died believing himself a victim of injustice.

Bibliography.—The only biography, George L. Clark, *Silas Deane: a Connecticut Leader in the American Revolution* (1913), is inadequate. More reliable, mainly for Deane's diplomatic career, is Julian P. Boyd, "Silas Deane: Death by a Kindly Teacher of Treason?" *William and Mary Quarterly*, 3rd series, xvi, pp. 165–187, 319–342, 515–550 (April, July and Oct. 1959). *See* also Charles Isham (ed.), *The Deane Papers*, in the New York Historical Society, *Collections*, xix–xxiii, 5 vol. (1887–91). (A. De C.)

DEARBORN, HENRY (1751–1829), American soldier and secretary of war under President Jefferson, was born at Hampton, N.H., on Feb. 23, 1751. He attended local schools and then studied medicine with a physician. Upon hearing of the battle of Lexington, he left the practice of medicine to join the provincial forces and served as an officer at the battle of Bunker Hill, Arnold's expedition to Quebec (where he was taken prisoner and exchanged), battle of Saratoga, Valley Forge, battle of Monmouth, Sullivan's expedition against the Indians, and the siege of Yorktown. He kept a detailed journal throughout the war, which gives a valuable first-hand account of the principal campaigns of the Revolution. Upon the organization of the new U.S. government in 1789, President Washington designated Dearborn U.S. marshal for the District of Maine, and in 1792 he was elected to congress, where he served as a Republican for two terms. He was secretary of war through the administration of President Jefferson, 1801–1809. In 1803 he issued an order for "erecting barracks and a strong stockade" at "Chikago," "with a view to the establishment of a Post." The important part which this post, Ft. Dearborn, played in the early history of Chicago has given his name a lasting association with that city. In Jan. 1812 President Madison appointed him senior major general of the U.S. army. Upon the outbreak of the War of 1812 with England, he undertook to carry out an extensive plan of campaign, including an invasion of Canada at several points. After a long succession of delays and reverses, he was relieved of his command in July 1813. In 1822 President Monroe appointed him minister to Portugal. He died in Roxbury, Mass., June 6, 1829. (H. D. Sm.)

DEARBORN, a city in Wayne county, Michigan, U.S., adjacent to southwest Detroit (*q.v.*) and traversed by the Rouge river. It was the birthplace of Henry Ford (*q.v.*), who played an inextricable part in the city's history and development, and is the home of the Ford Motor company.

Settlement of the area by homesteaders followed the War of 1812 and Pekin, Greenfield and Springwells townships (all now partially included in Dearborn) were established. Pekin township, later called Dearborn, then Bucklin, was renamed Dearborn to honour Gen. Henry Dearborn (*q.v.*). Dearborn village was incorporated in 1893 and chartered as a city in 1925. The city's industrial growth had its beginning with the construction of the United States arsenal in the 1830s (disbanded in 1875), and was accelerated by the building of the Ford-Rouge plant after World War I, the amalgamation with the city of Fordson (formerly Springwells) in 1928, and the post-World War II industrial boom.

Dearborn is also a residential community with mostly private homes. Apart from the Ford establishments, several factories of the Chrysler corporation and other industrial plants are located in the city. Cumulatively, business interests pay more than 75% of the local taxes and provide Dearborn's residents with one of the highest per capita incomes in the U.S. The city has a highly rated, modern school system which includes the Henry Ford Community college. In 1956 Fairlane, the Ford estate, became the

Dearborn centre of the University of Michigan. Medical care is provided by Oakwood hospital, the Dearborn Medical centre and St. Joseph's retreat. Residents are provided with numerous recreational facilities including Camp Dearborn, a 626-ac. area located 35 mi. from the city.

Tourist attractions include the Ford Motor Company's Rotunda, one of the largest permanent industrial exhibition buildings in the world and the starting point for guided tours of the 1,200-ac. Rouge plant; the Edison institute, an educational corporation consisting of the Henry Ford museum with its notable collections of Americana, Greenfield Village which consists of about 100 historic buildings collected from all parts of the United States and from England, and the Greenfield Village schools; and the Dearborn Historical museum.

The population of Dearborn was 112,007 in 1960. For comparative figures *see* table in MICHIGAN: *Population.* (E. K. R.)

DEARNE, an urban district (1937) in the Hemsworth parliamentary division of the West Riding of Yorkshire, Eng., 9 mi. W. of Doncaster and 39 mi. S.S.W. of York by road. Pop. (1961) 26,453. The river Dearne, a tributary of the Don, flows through the southern end of the district and to the north are undulating moorlands. Bolton-upon-Dearne with its church dating from Saxon times, Goldthorpe with collieries, Thurnscoe on the Roman Icknield street and Thurnscoe East adjoining the Hickleton Main colliery make up the urban district. Mining has largely taken the place of agriculture, and other industries include hosiery and clothing factories.

DÉAT, MARCEL (1894–1955), French political leader who moved from socialism to fascism and collaborated fervently during the German occupation of France in World War II, was born at Guérigny (Nièvre) on March 7, 1894. After graduating in philosophy at the École Normale, he became a school teacher. Entering politics, he was a Socialist deputy from 1926 to 1928 and was re-elected in 1932. Dissatisfied with the subtleties of Léon Blum, he advocated participation in bourgeois governments and a more active (and authoritarian) socialism, with the slogan "Order, Authority, Nation." In July 1933 he, Adrien Marquet and other dissidents from the Socialist party (Section Française de l'Internationale Ouvrière) formed the Parti Socialiste de France. He was air minister for a few months in 1936, in Albert Sarraut's cabinet. He lost his seat in June 1936 but won another early in 1939.

Déat became a fervent advocate of Franco-German friendship. A satyr in appearance, but dynamic in manner and of great ability, he became a leader of French fascism. In 1939 he published his famous article "Mourir pour Dantzig?" in his journal *L'Oeuvre* and he opposed France's declaration of war on Germany. After the armistice of 1940 he remained in the German-occupied zone of France, where he denounced the leading Vichy ministers (other than Pierre Laval) for half-heartedness. He survived three attempts on his life by members of the resistance. Finally in March 1944 he became a minister in Laval's government; as secretary of state for labour and national solidarity he increased the speed at which French workers were deported to German factories. He fled to Germany as the Allies advanced and in Sept. 1944 formed a new government with Fernand de Brinon and other collaborators.

After the collapse of Germany, Déat disappeared. In June 1945 he was condemned to death *in absentia* for treason. It was later discovered that he had led a wandering life until 1947, when, under an assumed name, he became a school teacher in Turin, where he died on Jan. 5, 1955. (P. W. C.)

DEATH (BIOLOGICAL). The state of death has always been obscured by mystery and superstition and may only be truly defined biologically as the absence of potential life. More specifically, this means the lack of ability to synthesize new molecules in an integrated organized system. The usual criteria of life, such as respiration, reduplication and transportation of substrates and ions, are not in themselves necessary for potential life at any given time. For example, bacteria, which are the smallest integrated cellular units that contain the normal components of a cell, including a membrane and nuclear and cytoplasmic material, may be completely dehydrated at low temperatures to a dry powder. At a later time, in the proper environment, they may be brought back to a state in which they are able to perform their normal functions. Only when an irreversible rearrangement of the structural molecules has taken place, *i.e.*, one that forever prevents duplication, may it be said that death has occurred.

This article deals primarily with the biology of mammalian death. For a discussion of the legal aspects of death *see* DEATH (LEGAL ASPECTS).

It has long been of interest to speculate whether viruses are living or dead. Most viruses consist of two major components: a protein and a nucleic acid. The latter may be either deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) and is considered to be the material responsible for carrying genetic information (*see* NUCLEIC ACIDS). A virus outside a host cell is completely inanimate, according to all the usual criteria, and must be considered dead. However, after a virus enters a cell it is able to utilize the cell's substrates and enzymes to replicate itself. The synthesis of new "life" with replication of virus particles often results in the rupture and "death" of the host cell.

Unicellular organisms such as bacteria, fungi, some plant cells and mammalian germ cells have the ability to perpetuate themselves indefinitely. However, this ability is dependent on the surrounding environment. The presence of an unfavourable temperature, pH, salt concentration or toxic substance, or the absence of an essential nutrient, may prevent reduplication or may even stimulate disintegration to the small organic compounds from which all macromolecular structures originally arose. Although almost all mammalian cells have the ability to divide in tissue culture, only the ovum and spermatocyte have the opportunity to leave the organism and thus escape the autolytic process that occurs following cessation of circulation and death of the whole organism.

Death of the Entire Organism.—The diagnosis of death in the mammalian organism is usually based on the following criteria: the absence of peripheral pulse and heartbeat, the absence of respiration, the lack of corneal reflex and the presence of a bluish colour (cyanosis) that results from a lack of oxygen in the blood. The discoloration is seen most easily in the mucous membranes of the mouth and lips and in the nail beds.

Other criteria of death can be noted much later. *Algor mortis,* the decrease in body temperature after death, occurs at a rate that depends on the temperature of the external environment; if the environmental temperature is known, the time elapsed following death may be easily calculated. *Rigor mortis* indicates the postmortem rigidity of the skeletal muscles, principally the muscles of the head, neck and lower extremities. *Livor mortis,* the purplish-red discoloration of the skin in the dependent portions of a cadaver, results from a settling of the blood due to gravity.

The essential components of most mammalian organisms include nervous, circulatory, respiratory, gastrointestinal, excretory, endocrine and supportive organ systems. In general, parts of one or more of these systems may be injured for variable periods of time without causing irreversible changes. However, there is a "hierarchy"; *i.e.*, some of these systems are much more essential than others. For example, large portions of bone may be lost forever and a kidney may cease functioning for several hours; but if organs such as the heart stop working for only a few minutes irreparable damage occurs. Once the heart stops beating and circulation ceases, the lack of essential nutrients, including oxygen, quickly causes the death of all other organ systems.

Death of Tissues.—Each tissue of the mammalian body is arranged in a manner and form that is consistent with its function. All tissues consist of a large number of different types of cells including blood cells, supportive muscles and connective tissue cells, nerve cells and extracellular substances such as collagen. However, each organ (group of tissues performing a special function) usually has only one main type of functioning cell. The basic heart cell, for example, is a muscle cell that contracts and, in synchrony with thousands of similar heart cells, pumps the blood through the circulatory system. The kidney tubule cell both secretes into and absorbs material from the excretory canalicular lumina. The liver cell synthesizes many essential body proteins,

including albumin. The lung endothelial and epithelial cells regulate the passage of oxygen and carbon dioxide across the alveolar septa. The nerve cell, through various chemical reactions, transmits a potential across its membrane and down its processes. The gastrointestinal cells first break proteins, lipids and carbohydrates into smaller fractions and then transport them into the circulatory system. Finally, the cells of the endocrine organs secrete various hormones that are important in the regulation of tissue function.

Each tissue consists of thousands of cells, only a small proportion of which are necessary for adequate functioning of the organ. This reserve capacity is well illustrated in the case of the kidneys. In unilateral disease, the diseased kidney may be surgically removed without impairing the total kidney function. One lung, large portions of the gastrointestinal tract, the entire spleen, theoretically two-thirds of the liver and all of many endocrine organs, if supplemental hormones are given, may be removed without resulting in obvious malfunctioning of the organism.

However, tissues vary markedly in their inherent ability to regenerate, once a portion of the tissue has been damaged. The cells of the hematopoietic system, the mucosa of the gastrointestinal and genitourinary system, and the skin are in a continual state of division. Damage to these tissues, however severe, usually is corrected by a rapid and complete regeneration of the injured portion. In a second group of tissues the cells are not dividing constantly but they will regenerate if given the proper stimulus. This second group includes the liver, lung, spleen, kidney, bone and connective tissue. In a third group are the tissues that rarely if ever regenerate in the adult state; the two outstanding examples in this category are the heart and the brain. Death of cells in these organs leads not to regeneration but to replacement by scar tissue or, in the case of the brain, by a cystic space.

Tissues, in addition to being characterized according to their ability to regenerate, may be placed in one of at least three grades according to their rate of autolysis, or self-destruction. Once the circulation of the blood has irreversibly ceased, degradation proceeds much more rapidly in some tissues than in others. In general, those tissues that have a high capacity for synthesizing proteins also are subject to a high rate of self-degradation; such tissues contain large amounts of hydrolytic proteolytic enzymes, called cathepsins, which take part in degradation. Tissues with a high rate of autolysis include the adrenals, testes, pancreas, gastrointestinal tract mucosa and malignant tissues. In a second group are those tissues that normally have a very high rate of metabolism and require large amounts of energy to maintain a steady state. These tissues include the liver, kidneys and endocrine glands. In a third group are those tissues whose rate of self-degradation is very slow, presumably because their inherently low rate of metabolism reduces the amounts of nutritional substrates and oxygen they require. These tissues include the skin, mesodermal tissue, muscle, bone, cartilage and blood vessels.

It thus becomes clear that the site of injury is of prime importance in the death of tissues. Localized physical trauma to organs that regenerate slowly or autolyze quickly is much more serious than damage to systems that regenerate quickly and autolyze slowly. The same conditions obtain when the injury is widespread, as in systemic diseases. Those organs that fail to regenerate, such as the heart, or autolyze quickly, such as the adrenals, are danger areas that should be protected with every therapeutic measure available.

Death of Cells.—*Causes of Injury to the Cell.*—A large number of agents, if present in certain concentrations and under certain circumstances, will kill cells either in vitro or in vivo. Among these agents are bacteria and viruses. Bacteria may act either directly by interfering with a cell's metabolism or indirectly by elaborating a toxin that inhibits the action of certain compounds (*e.g.*, deoxyribonuclease). Viruses act in one of three ways after they penetrate the cell wall. Many viruses presumably remain latent and have no measurable effect on the cell's metabolism; some stimulate cellular division, as exemplified by the production of tumours; others interfere sufficiently with cell metabolism to result in lysis and cell death.

Nutritional deficiencies also cause death of cells. Included in this group are deficiencies of vitamins, essential amino acids and essential fatty acids. Cells apparently are able to synthesize nucleic acids from degraded simpler molecules already present. Carbohydrates are also readily synthesized from two-carbon fragments, but a deficient carbohydrate supply seriously inhibits cellular reactions that require energy.

Many disease states in mammalian organisms are characterized by hormonal deficiencies or hormonal imbalances. An absolute deficiency of insulin will quickly cause death because of a lack of glucose in the cell for conversion to energy. Similarly, a lack of the hormones supplied by the pituitary, adrenal, thyroid or other endocrine glands causes serious disturbances in the cell's metabolism and eventually results in cell death. The lower organisms and most tissues cultivated in vitro contain sufficient numbers of adequate autoregulatory mechanisms and do not require extracellular hormones.

A large number of analogues and antimetabolites are used in the study of cell metabolism. Most of these materials are synthesized in the chemistry laboratory for the purpose of blocking a specific intermediate reaction in the cell, thus causing a deficiency of a necessary product or the accumulation of a toxic compound during intermediate nucleic acid, protein, carbohydrate or lipid metabolism. It is thought that similar if not identical compounds accumulate in various disease states and contribute to cell death.

There are more than 100 known inborn errors of metabolism in mammalian physiology in which hereditary enzymatic deficiencies exist and result in injury either through the production of large amounts of toxic intermediates or by causing a deficiency of necessary products. These diseases include galactosemia, glycogen storage diseases, phenylketonuria and albinism.

One of the major causes of injury to the cell in the adult organism is the process of aging. It is a curious paradox that although an individual's gross appearance changes noticeably as he ages, few changes occur in his cells. Many of the gross characteristics of the elderly result from changes in water content, the appearance of scar tissue, the loss of elasticity in the skin, accentuation of blood vessels and general debilitation. Nevertheless, only an occasional abnormality such as the presence of lipochrome pigment is noted when cells are examined microscopically. This pigment, found usually near the nucleus and completely uncharacterized, may be seen in the heart, liver and adrenal tissue. It may represent an abnormal product or merely a high concentration of a normal intermediate. In either case it probably produces a deficiency of an essential compound.

Part of the aging process may be ascribed to arteriosclerosis and the decreased oxygen and nutritional supply associated with narrowed vessel lumina. The cessation of hormone production by the gonads in late life probably contributes to the general process of aging; certainly heredity plays an important role. The primary cause of aging, however, remained unknown in the 1960s. *See* also GERONTOLOGY AND GERIATRICS: *Biology of Senescence;* PATHOLOGY.

Structure of a Cell.—Ultimately the death of an organism involves the death of all the cells in the tissues of the organism. In order to gain some appreciation of the mechanisms of cell death, it is first necessary to discuss the structure of the generalized type of cell. In specialized cells one or more components may be emphasized or reduced.

(For additional information on cell structure *see* the articles BIOLOGY: *The Living Organism as a Natural Body: Cell Structure;* CYTOLOGY; ZOOLOGY: *Morphology.*)

All cells consist of protoplasm bounded by a membrane and divided into two portions, a nucleus and cytoplasm. The nucleus in man contains 46 chromosomes, which can be seen with the light microscope at the time they undergo division. Each chromosome contains thousands of the hereditary unit called the gene (*q.v.*), which is composed principally of deoxyribonucleic acid (DNA) bound to a histone protein. The nucleic acid is a macromolecular structure, presumably arranged in a double-stranded helix and consisting of hundreds of nucleotides. Each nucleotide contains a purine (adenine or guanine) or a pyrimidine

(thymine or cytosine), a sugar (deoxyribose) and a phosphate molecule. Closely associated with the chromosomes are structures called nucleoli. The nucleoli contain principally ribonucleic acid (RNA) and function in the regulation of nucleic acid and protein synthesis in the nucleus. The ribonucleic acids differ from deoxyribonucleic acid in the substitution of uracil for thymine and ribose for deoxyribose. The sequence and order of the purine and pyrimidine bases presumably establishes a template whereby identical molecules are matched and replicated instantaneously by the pre-existing model. The synthesis of deoxyribonucleic acid, ribonucleic acid and proteins is thought to occur on such complicated templates. The nucleus has no mitochondria and thus no respiratory enzymes and to perform its functions must depend on energy generated in the glycolytic pathway or on adenosine triphosphate (ATP) molecules synthesized in the cytoplasm. The nucleus, in addition to directing cell division, serves the important function of synthesizing two important coenzymes, diphosphopyridine nucleotide (DPN) and triphosphopyridine nucleotide (TPN). The membrane of the nucleus consists of two protein components, each 75 Å in width, separated by a space of approximately 150 Å. At several intervals are numerous pores 200–300 Å in width through which, presumably, nuclear-cytoplasmic communication occurs. The nuclear membrane is considered to be an extension of the endoplasmic reticulum, the main structural framework of the cytoplasm.

The endoplasmic reticulum consists of a series of intercommunicating canaliculi and cisternae that permeate the entire cytoplasm of the cell and provide a system of transportation within the cell. According to this concept, fluid within the cisternae deep in the cytoplasm is in direct continuity and equilibrium with the extracellular fluid. Small ions, substrates and water molecules may pass freely throughout the cell, but passage across the membrane, 75 Å in width, is thought to involve enzymatic carriers. The microsomes, the smooth membrane portion of the endoplasmic reticulum, may form pockets for storage of synthesized proteins (Golgi apparatus) or vacuoles (lysosomes) where macromolecules or phagocytized particles may be degraded by hydrolytic enzymes. The ribosomes, a second component of the endoplasmic reticulum, consist of granules 75 Å in diameter attached to the outer surface of the smooth membrane and also free in the cytoplasm. These coarse granules have been found to consist principally of ribonucleic acid and protein and are believed to be the site of protein synthesis in the cell. The amino acid units that form proteins originate in the free pools of the cell, are activated by adenosine triphosphate (ATP) molecules, then are transferred to a soluble ribonucleic acid and finally are attached to the nucleic acid of the coarse granules, where a protein is synthesized by means of a specific template previously described.

The energy supply of the cell is largely provided by mitochondria, double-membrane structures with internal cristae. The adenosine triphosphate (ATP) synthesis reactions are largely localized in these structures. In addition, these organelles are the sites of oxidation of substrates, including lipid, to carbon dioxide and water.

Large vacuoles containing lipid, glycogen or pigment are seen occasionally in the cells and probably represent dilated cisternae of the endoplasmic reticulum. Situated between these various organelles is the soluble fraction of the cell containing free pools of amino acids, purines, pyrimidines, carbohydrates, fatty acids and soluble proteins. The structural interrelationships remained unelucidated in the early 1960s although several enzymes concerned with the degradation of glucose had been found in this fraction. The plasma membrane, the final extension of the endoplasmic reticulum, bounds the outside of the cell; the membrane is permeated by pores called the intracellularis caveolae, which in turn communicate with the cisternae of the endoplasmic reticulum. Occasionally, direct communications with other cells are noted and are called intracytoplasmic bridges.

It has been shown that the protein and nucleic acid of bacteria, yeast and mammalian cells in logarithmic growth are not turning over but are merely duplicating themselves coincident with cell division. In contrast, most cells of the adult organism are not undergoing rapid cell division (growth) but are changing the concentration of enzymatic proteins by constant degradation and synthesis in response to the extracellular environment. The materials involved in this "dynamic equilibrium" include lipids and to some extent carbohydrates, although the latter are principally degraded by oxidation in conjunction with the synthesis of high-energy compounds. This chemical state of flux is well recognized and is a necessary regulatory mechanism that enables the cells of the body to adjust to the changing demands and environment of the organism.

Less well recognized but equally important are the movements that can be seen in all parts of the cell with the phase microscope. Certain portions of the cytoplasm become more fluid in nature while other parts attain a rigid stability. These transformations (formerly called sol-gel transformations) are known as reversible denaturation phenomena and are believed to represent folding and unfolding of the peptide chains in various proteins. Both the mitochondria and the coarse granules (ribosomes) of the endoplasmic reticulum move throughout the cell's interior. In particular, the mitochondria often migrate to those portions of the cell that require energy; *e.g.*, around the nucleus immediately preceding mitosis. The nucleus may also be seen rotating in a counterclockwise direction. The plasma membrane portion of the endoplasmic reticulum is often undulant, changing its form and shape according to the metabolic activity of the cell. Thus, in addition to a chemical flux, there exists a structural "dynamic equilibrium."

Sequence of Injury to the Cell.—The sites of synthesis in the cell appear to be the sites most susceptible to injury. Once a protein, for instance, is formed, it appears to be relatively invulnerable to damage. However, the site of synthesis, presumably a template composed of nucleic acid and protein, demands a spatial sequence of molecules that is easily disrupted; if the site is disturbed, all synthetic reactions are abruptly halted. Interference with protein synthesis eventually results in cellular protein deficiencies. Interruption of nucleic acid synthesis blocks all stages of cell division. The cell loses the degraded nucleic acid and protein products to the extracellular medium. Initially, glycogen or lipid accumulates but the cell is soon forced to oxidize these products for energy.

Many hours after the initial insult to the cell, structural alterations are noted. The canaliculi of the endoplasmic reticulum may become swollen with water, the mitochondrial cristae are disrupted and the soluble protein structures are disorganized. The number of stored energy molecules in the form of adenosine triphosphate (ATP) decreases markedly from normal. The cytoplasm imbibes water and appears diffusely stained when examined with hematoxylin and eosin. This is called cloudy swelling. The nucleus may not stain in this manner, but it may rupture and release nuclear material to the cytoplasm (karyorrhexis), or it may become swollen (karyolysis), or the chromatin material may shrink to a small dark mass (pycnosis).

Following disruption of the cytoplasmic architecture and in particular the sites of energy synthesis in the mitochondria, the changes become irreversible and the cell is unable to maintain its normal ionic equilibrium. The normally high ratio of potassium to sodium is abruptly reversed, further large quantities of water are introduced in the cell along with sodium ions and eventually the cell bursts (cytolysis). The cell, as the final result of injury, becomes a conglomerate mass of denaturated proteins with small amounts of degraded nucleic acids found within.

Summary.—Since the maintenance of cellular metabolism depends on so many interrelated intermediates, the destruction of any one of the essential components of the cell (be it nucleic acid, porphyrins, ions, water, carbohydrate, fat or protein) will eventually result in the degradation of all other components and in cell death. Similarly, injury to any structural organelle of the cell (be it endoplasmic reticulum, mitochondria or nucleus) that cannot be quickly repaired will eventually result in cytolysis. As previously mentioned, it is believed that the sites of synthesis are most susceptible to injury—in particular the templates associated with the chromosomes and the coarse granules of the endo-

plasmic reticulum. Next most susceptible to injury are the substances that apparently are vulnerable because they are involved in so many reactions of the cell, including the energy process; these substances are the coenzymes diphosphopyridine nucleotide (DPN), triphosphopyridine nucleotide (TPN) and coenzyme A.

In the process of cell injury, the most important factor is the disturbance in the autoregulatory mechanism since this is the controlling factor in repair of the cell. Practically nothing was known in the early 1960s concerning it. The mechanism by which 19 different amino acids are directed to 19 different soluble ribonucleic acid molecules and further transferred to a complex template composed of purine and pyrimide bases lined up in an exact sequence is a feat never duplicated outside the cell. The control of high-energy phosphate molecules as a result of carbohydrate, lipid and even protein degradation involves a very complex system. Only a few of the numerous feedback mechanisms had been even slightly elucidated by the early 1960s. They were presumed to number in the thousands.

The death of a cell may be caused by a multitude of injurious agents. If the reserve capacities and synthetic potentialities of the cell are not badly interrupted, the autoregulatory mechanism will tend to repair and replace the damaged areas. If the injury is so severe as to preclude this compensatory response, structural and chemical disorganization quickly ensues; the fate of the cell is thereby determined and the process proceeds remorselessly, relentlessly to its inexorable conclusion.

See also TISSUE CULTURE; BIOCHEMISTRY; HISTOLOGY; LIFE SPAN, ANIMAL; MEDICINE AND SURGERY, HISTORY OF: *The Rise of Scientific Medicine in the 19th Century;* PHYSIOLOGY.

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DEATH (LEGAL ASPECTS). This article deals with certain legal aspects of death, particularly those relating to registration, presumption of death, and burial. For the law pertaining to the disposition of property after death, *see* ESTATE AND INHERITANCE TAXES; ESTATES, ADMINISTRATION OF; INHERITANCE; INTESTATE SUCCESSION; WILL. Other legal aspects of death are treated in AUTOPSY; CAPITAL PUNISHMENT; CORONER; EUTHANASIA; MEDICAL JURISPRUDENCE. For the burial practices of primitive peoples, ancient civilizations and the major world religions, *see* CEMETERY; FUNERARY RITES AND CUSTOMS.

REGISTRATION AND PRESUMPTION OF DEATH

United States.—It is generally provided that the state departments of health in the U.S. have charge of the registration of deaths, provide the necessary forms and blanks for obtaining and preserving such records and procure the faithful registration of each death. For this purpose the states, as a general rule, are divided into registration districts, in each of which there is a registrar charged with the registration of births and deaths. In Massachusetts and in some other states this duty was imposed upon each town clerk.

It was provided by statute in most states that the body of any person whose death occurs in the state should not be buried, cremated, deposited in a vault or otherwise disposed of or removed from or into any registration district, or be temporarily held pending further disposition, more than 72 hours after death unless a permit for burial, removal or other disposition had been properly issued by the registrar of the district. Whenever practicable, registrars were prohibited from issuing such burial or removal permits until a complete and satisfactory certificate of death had been filed. Death certificates of most states conform closely, in content and arrangement, to the standard form recommended by the United States public health service. Standard certificates are revised periodically, in consultation with state health officers and registrars, the medical profession and consumers of vital statistics. In general, the certificates contain: (1) the place of death, including state, county, city, town, etc., length of stay in place of death, name of hospital or institution; (2) usual residence of deceased, including state, county, etc.; (3) full name of deceased; (4) date of death—month, day, year; (5) sex; (6) colour or race—as white, Negro, Indian, etc.; (7) marital status; (8) date of birth; (9) age at death; (10) usual occupation and kind of business or industry; (11) birthplace, state or foreign country; (12) citizenship; (13) father's name; (14) mother's maiden name; (15) veteran status; (16) social security number; (17) informant's signature; (18) cause of death; (19) autopsy, if performed; (20) information regarding time, place, etc., if death was caused by accident, suicide or homicide; (21) certification of medical attendance on decedent, fact and time of death, including time last seen alive; (22) date, signature and address of physician or official making medical certification; (23) name and location of cemetery or crematory, and date of interment or cremation; (24) signature and address of funeral director; (25) signature of registrar, date certificate was received and registered number. The cause of death must generally be stated so as to show the disease or sequence of causes resulting in the death.

In nearly all states, fetal deaths are registered on a separate form entitled either "certificate of stillbirth" or "certificate of fetal death." A few states register a fetal death as a birth and also a death. The regulations in the majority of states require reporting of fetuses born dead after 20 weeks (or five months) of gestation. An increasing number of states adopted regulations which required reporting of all fetal deaths, regardless of gestation age. For deaths occurring without medical attendance, it was made the duty either of the funeral director or other person who learned of the death to notify the local health officer. The latter was required to investigate immediately and certify the cause of death. When, however, he had reason to believe that death might have been due to an unlawful act or neglect, he was required to refer the case to the coroner or medical examiner for investigation and certification. Funeral directors must file the certificate of death with the local registrar and obtain a burial or removal permit prior to any disposition of the body. They must deliver the permit to the person in charge of the place of burial. (H. L. D.)

Presumption of Death.—As in English law, the fact of death may be proved by presumptive evidence; *e.g.,* the unexplained absence of a person for seven years. Since such a finding of death is a finding of fact, the subsequent return of the absentee upsets all action based on his presumed death. Thus if a probate court has distributed all his property on a finding of his death, the acts of the court become void and the absentee may recover his assets from anyone into whose hands they have come. Many states sought to deal with this problem by statutes giving courts power to distribute property after unexplained absence for a prescribed period as well as after death, and the distribution of the property under such a statute may not be attacked by the returned absentee.

The common-law presumption of death permitted an inference as to the fact of death but not as to the time of death. Thus, in a common disaster such as an airplane or automobile accident, the common law had no procedure to determine who died first. Any person whose property interest depended on the order of death lost because of inability to make his case. Order of death is frequently important. The family home may be jointly owned property which passes to the survivor; the beneficiary of an insurance policy sometimes is entitled to the proceeds only if he survives the insured; in the case of a childless couple, order of death may determine whether the property passes from owner to spouse and then to her blood relations or to the owner's relations. The civil law established certain presumptions as to order of death based upon differences in age and sex. Most U.S. states adopted a uniform simultaneous death act which provides that, in the absence of proof of the order of death, the property of each deceased person is to be disposed of as if he survived; in other cases where order of death is important, such as those involving insurance policies or jointly held property, special rules are provided. The statute was made applicable only if the owner failed to provide his own rules in his will, and modern wills commonly provide for common disaster even where order of death is known. (A. DM.)

England.—The registration of burials in England goes back to the time of Thomas Cromwell, who in 1538 instituted the keeping of parish registers. Statutory measures were taken from time to time to ensure the preservation of registers of burials, but it was not until 1836 (the Births and Deaths Registration act) that the registration of deaths became a national concern. Hence it is only from this date that vital statistics became reliable. The law for England was consolidated by the Births and Deaths Registration acts, 1874 and 1926. When a person dies in a house, information of the death and the particulars required to be registered must be given to the registrar within five days, by the nearest relative of the deceased present at the death, or in attendance during the last illness of the deceased, or by one of the other categories of persons defined in the act. If this information is given in writing, it is still necessary for the person giving the notice to sign the register within 14 days of the death. Penalties are prescribed for failing to give information and for giving false information.

It is also necessary to provide a medical certificate stating the cause of death; if this requirement cannot be satisfied, it is the duty of the coroner to authorize a post-mortem or to hold an inquest.

The body of the deceased cannot be disposed of before the certificate of the registrar, or order of the coroner, has been delivered to the person effecting the disposal; *i.e.*, the person by whom the register of burials in which the disposal is to be registered is kept, or, in the case of a burial in a churchyard or graveyard of a parish or ecclesiastical district under the Burial Laws Amendment act, 1880, the relative, friend or legal representative who is responsible for the burial of the deceased. Where, however, the disposal is by burial, the person effecting the disposal may proceed with the burial if satisfied by a written declaration in prescribed form by the person procuring the disposal that a certificate or order has been issued. The person effecting the disposal must, within 96 hours of the disposal, notify the registrar in the prescribed manner as to the date, place and means of disposal.

It is the duty of the father or mother of a stillborn child to give information to the registrar of the particulars required to be registered concerning the stillbirth.

The registration of deaths at sea is regulated by the Births and Deaths Registration act, 1874, together with the Merchant Shipping act, 1894.

Death can be proved by the production of a certified copy of the entry in the register of births and deaths, which is evidence not only of the fact of death but also of the date of death, the sex, rank or profession of the dead person and the cause of death.

Presumption of Death.—The fact of death may, in English law, be proved not only by direct but by presumptive evidence. When a person disappears and is not heard of for seven years, the presumption of law arises that he is dead (*Nepean* v. *Doe*, 1837, 2 M. and W. 894). Under the Matrimonial Causes act, 1950, any married person who alleges that the other party to the marriage is dead may, if domiciled in England, present a petition to the court to have the death presumed and the marriage dissolved. In such proceedings the fact that for a period of seven years the other party had been continually absent from the petitioner, and has given no reason to suppose that he or she is living, shall be accepted as evidence of death until the contrary is proved. In Scotland, by the Presumption of Life (Scotland) act, 1891, the presumption is statutory. In those cases where people disappear under circumstances which create a strong probability of death, the court may, for the purpose of probate or administration, presume the death before the lapse of seven years.

The question of survivorship, where several persons are shown to have perished by the same calamity, has been much discussed. The governing principle was laid down by s. 184 of the Law of Property act, 1925: where two or more persons have died in circumstances rendering it uncertain which of them survived the other or others, such deaths shall (subject to the order of the court), for all purposes affecting the title to property, be presumed to have occurred in order of seniority, and accordingly the younger shall be deemed to have survived the elder. This section has given rise to a number of questions of interpretation, and it has been laid down that, to exclude this presumption, there should be evidence leading to a definite and warranted conclusion that one died before the other (*Re Bate: Chillingworth* v. *Bate*, 1947 2 A.E.R. 418).

Air raids during World War II occasioned a series of such problems. For example, *Re Lindop: Lee-Barber* v. *Reynolds* (1942 2 Ch. 377), where the bodies of a husband and wife were found in a house that had been struck by an explosive bomb, the evidence showed that they must have both been killed instantly by the blast of the explosion. It was ruled by Justice Bennett that since it was impossible on the evidence to say that the two deaths must have been simultaneous, the statutory presumption was not rebutted and the wife, as the younger, was deemed to have survived her husband. In *Re Howard: Howard* v. *The Treasury Solicitor* (1944, P. 39), where a husband, wife and son were all killed in the same house on the same date but with the son in a different room from his parents, whose bodies were dismembered while their son's was not, it was held that the husband and wife died simultaneously but not the son. In *Hickman* v. *Peacey* (1945 A.C. 304), where four persons, two of whom had made wills benefiting some of the others, were killed by the explosion of a bomb bursting in a London house, there being no evidence whether any of the deceased survived the others, it was held, by a majority of the legal members of the house of lords that in the absence of such evidence the younger should be deemed to have survived the elder.

On the other hand, in *Re Pringle: Baker* v. *Matheson* (1946, Ch. 124), where a provision in a will was expressed to take effect on the simultaneous death of the testator and her sister, and both were, in fact, killed by the same bomb, the court gave effect to this provision irrespective of technical questions as to survivorship.

Civil Death.—This is an expression used in law in contradistinction to natural death. Formerly, a man was said to be dead in law (1) when he entered a monastery and became professed in religion; (2) when he abjured the realm; (3) when he was attainted of treason or felony. Since the suppression of the monasteries there has been no legal establishment for professed persons in England. The act abolishing sanctuaries (1623) did away with civil death by abjuration; and the Forfeiture act, 1870, that on attainder for treason or felony. (W. T. Ws.)

Canada.—The rules relating to the registration of deaths in Canada vary considerably from province to province. In general, whenever a death occurs, an appropriate person (normally a relative) is required to complete an official form setting out the deceased's personal particulars and to send it to a district registrar. At the same time, a certificate of the cause of death is required to be completed and sent to the district registrar either by a doctor or, where the death occurred in suspicious circumstances, by a coroner.

Upon receipt of these two documents the usual practice is for the district registrar to issue to the funeral director or person proposing to bury the body (1) an acknowledgment that the death has been registered and (2) a burial permit. Except in unusual cases, the rule is that no body may be disposed of without a burial permit or some similar authorization.

Presumption of Death.—As in England, a court may presume death to have occurred on indirect evidence and, in particular, after an unexplained absence in excess of seven years. No presumption, however, will be made as to when death occurred in that seven-year period. A litigant whose case depends on showing that a missing person died either before or after a particular event (as frequently happens in questions concerning inheritance) will have to produce more concrete evidence than a mere unexplained absence for seven years. Any distribution of property made upon a presumption of death will be inoperative if the supposed deceased reappears.

Canadian courts have generally refused to grant an order presuming death except as incidental to deciding a recognized dispute, such as one concerning the title to property or the validity of a marriage. In particular, no such order would be granted at the

instance of a petitioner whose only reason for asking for it was that he or she wished to remarry. In some provinces this restriction has now been abolished by statute. (A. Jo.)

BURIAL

Growth of Statutory Law.—*England.*—The right of the Englishman to burial in the parish churchyard was akin to his right to occupy his pew during church services. Both rights were subject to regulation by the church authorities. In consequence, prior to the middle of the 19th century, the English ecclesiastical courts exercised a legal secular authority over the burial of the dead which they had gradually absorbed from the ancient civil courts to which it originally belonged. While the right of burial became a common-law right, and thus a parson might be guilty of a misdemeanour for opposing the burial of a parishioner in the churchyard, his refusal to read the burial service was cognizable only in the ecclesiastical court. Except for the limited jurisdiction of religious societies, the control of burial has been statutory since the Burial acts of 1847 and 1852.

By the Cemeteries Clauses act, adopted in 1847, parliament set up a method whereby authorized companies could devote land to cemetery purposes for burial both of members and nonmembers of the Established Church and sell exclusive rights of burial therein. This innovation was followed, during the ensuing years, by 15 acts, 13 of which remain in force, in whole or part, and which constitute the English law of burial.

The comprehensive Burial act of 1852 provided for the restriction and discontinuance of metropolitan interment (expressly excluding St. Paul's cathedral and Westminster abbey) as well as means whereby a church vestry could appoint a "burial board," with corporate powers, authorized, with the approval of the secretary of state, to acquire land for a burial ground, to acquire an existing cemetery or to contract for burial rights in an established cemetery, to erect a chapel thereon, to embellish and manage the resultant cemetery, to sell exclusive burial rights therein, to fix fees for interments and the construction of vaults and monuments, etc. The act fixed fees for certain pauper burials and charged the secretary of state with over-all regulation of the cemetery.

The 1852 act was sporadically supplemented at various times by penal, public health and other allied acts, without disturbing the general scheme. By an act of 1900, the relevant powers and duties of the secretary of state were transferred to the Local Government board and, in 1919, by the Ministry of Health act, to the minister of health.

Some of the major provisions of the various burial acts are as follows: 1880: churchyard burial without religious rites was authorized, with the reservation that no such service should be held in a manner designed to "bring into contempt or obloquy the Christian religion"; and the use of the burial service of the Church of England was authorized for burial in unconsecrated ground; 1882: in lieu of the previous denial of churchyard burial to a suicide (who, prior to the prohibition of an 1823 statute, had been impaled in a public highway), interment, though without Christian burial rites, was required; 1900: burial authorities were authorized to have consecrated and to maintain a burial ground, or a part thereof, for particular religious denominations; 1902: burial authorities were empowered to erect and maintain crematories, subject to governmental approval.

United States.—While adopting the English common law, the American courts never considered themselves bound by the decisions of the ecclesiastical courts, and since English burial was largely governed by the latter and there was a paucity of English common-law material on the subject, the American courts were left free to frame their decisions influenced by the American objection to religious control of temporal affairs. To the extent that the English pattern of churchyard burial existed in the early colonies as a result of the control of churchyards by trustees of religious societies, the English ecclesiastic influence was felt. Generally, however, and particularly in the more sparsely settled portions of the country, secular regulation and control prevailed from the outset.

As in England, by the middle of the 19th century the need for greater governmental restriction of intramural burial asserted itself and, in 1847 in New York, for example, a comprehensive Rural Cemetery act was passed. During the subsequent years, state and local statutes throughout the country followed the pattern of protecting the health of the growing communities while ensuring decent burial to its members by authorizing the creation of cemeteries under lay ownership and control. In general, these laws were designed, as were the English acts, to restrict burial in populated centres and to authorize corporations to establish and maintain cemeteries and to regulate them for the protection of the dead and of the social and religious sentiments of the living. Such cemeteries may be sectarian or nonsectarian, and they may be owned and operated, in whole or in part, by religious, fraternal or benevolent societies for the burial purposes of their members.

The corporations that dedicate their lands to these purposes sell exclusive rights of burial in single graves or in plots containing space for a number of graves. Interments are made and the graves maintained under rules and regulations adopted by the cemetery corporation, which constitute the contract between the "lot owners" and the corporation. Such rules may restrict the use of the burial rights by race or creed (although the former restriction has been under growing attack).

The particular statute in force determines whether the cemetery may or may not be operated for the private profit of the owners of its stock. Generally, they are regulated by local or state statutes; in some cases, as in New York, a cemetery board administers the prevailing statutes and undertakes to regulate and protect clashing public and private interests.

The burial rights acquired by the lot owner are treated as real property; subject to the rules of the cemetery corporation, they may be transferred (at least before interment), and they pass, by operation of the law of inheritance, to the heirs of the holder in a manner usually regulated by local statute. The cemetery corporation "cares" for the graves and plots, as well as for the other portions of the cemetery affording access and egress; the lot owner pays an annual charge fixed by the rules or provides a "perpetual-care fund," held in trust by the cemetery corporation, the interest on which provides the funds needed to maintain the proper appearance of the cemetery.

Interment, by rule in some cemeteries, is limited to a single body in a grave; in others, multiple burials are permitted. Lot owners are also permitted to contract for the construction of vaults or mausoleums, gravestones and other monuments. In conjunction with conventional operation, some cemeteries maintain large public mausoleums and sell rights of single or multiple deposits in crypts. Others maintain crematories and, in connection therewith, columbaria, where the ashes of those cremated are marked and retained.

Right of Burial.—In every age, the public interest has commanded a disposition of human remains consonant with existing mores. The dictates of modern western civilization require burial or cremation, so that neither public sentiment nor public health be violated. But private sentiment also finds recognition: the right of the living to control the disposition of their bodies, when dead, in a manner not incompatible with the feelings of the survivors and the public; and the right of the survivors to exercise the privilege, in consonance with the wishes or beliefs of the dead. Generally, by statute or rule of substantive law, the deceased's wishes find fulfillment; then follows the priority of the desires of the surviving spouse and, in turn, those of the next-of-kin, in order of relationship. But in determining conflicting claims, the courts, exercising "a benevolent discretion, giving heed to all those promptings and emotions that men and women hold for sacred in the disposition of their dead, must render judgment as it appraises the worth of competing forces" (Justice Cardozo in *Yome* v. *Gorman,* 152 N.E. Rep. 126).

Duty of Burial.—English burial law charged the "householder," him "under whose roof the body lies," with the duty of promptly conveying the corpse, decently covered, from the place of death to a place of interment, and a willful violation of that duty was a common-law offense. The duty was paramount, as

against the surviving spouse (though, ordinarily, the surviving spouse would be the one under whose roof the body lies), the relatives and the authorities, unless the householder and the decedent's estate were indigent, when it would fall upon the public authorities. However, modern statutes generally provide for public intervention and payment of the necessary expense. The problem of who shall bear the costs, therefore, usually arises when the decedent's estate, which is primarily liable to those who have furnished the necessaries for decent burial, lacks the needed funds, although a surviving husband, parent or other close relative charged with the duty of maintenance and support during life may be held liable, even against the adequate estate of a wife or a minor child. Lacking any other source of payment, the common law imposed liability upon the unfortunate householder; under existing statutes, the public purse bears the burden.

Burial must be "decent," a standard that prescribes a minimum generally reflected by existing statutes. The definition of decent, however, is often contested by creditors of the deceased when the estate is insolvent, or by legatees or next-of-kin who do not want their legacies whittled away by undue burial expense. When such controversy arises, the courts hold the scope of decent to be variable, with the social standing of the deceased and particularly his financial condition at death the most important factors. Generally, the issue revolves about the extent of expenditure rather than its purpose, since, ordinarily, reasonable items such as the expense of preparing the body for burial, its transportation, the cost of a burial place and stone marker, religious services at the grave and needed mourning apparel for next-of-kin are deemed necessary and entitled to payment in preference to the decedent's debts and beneficences.

Disinterment.—Once a body is buried, the law guards the grave against unwarranted intrusion through the imposition of criminal penalties for unauthorized violation. However, local statutes invariably permit exhumation in the public interest, principally to aid in the detection of crime, and frequently regulate disinterment when sought for private reasons. In the latter cases, the reasons for disinterment generally must be compelling, although when removal is sought by next-of-kin for religious or sentimental reasons or the interment was intended to be temporary, and all concerned consent, removal will ordinarily be permitted.

Disinterment may be compelled, with adequate provision for reinterment, by the public authorities under the exercise of the "police power," as when a cemetery is abandoned or neglected, for reasons of health, or when other public benefit is involved, such as, for example, the location of highways.

In some countries (*e.g.,* France and the nations of Latin America), where it is the custom to rent rather than to sell burial rights, failure of survivors to pay the stipulated rentals results in disinterment by the cemetery authorities, and these cemeteries are often marked by piles of unidentifiable bones in remote corners of the cemetery grounds.

Other Regulations.—Provisions for medical death certificates, the proper transportation of bodies, burial permits and the supervision of burials and places of interment vary in detail from locality to locality, but generally are designed to detect criminal acts that have resulted in death, to ensure that communicable diseases are not transmitted, that bodies are unexposed and that even the friendless and indigent are given prompt and decent burial; also that bodies are not mutilated by autopsy, or otherwise, or used for dissection without the consent of those entitled to the privilege of burial. Again, for reasons of health and sentiment, local regulations aim to protect the graves of the dead from desecration and, in many cases, to protect the survivors from exploitation at the hands of those concerned with the burial and safekeeping of the bodies of the dead. Underlying these various acts is adherence to standards of respect for the dead and protection of the health and sentiments of the living.

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(P. E. JA.)

DEATH RATE. The death rate is usually measured by the annual number of deaths per 1,000 of the population. Thus, 1,702,000 deaths were registered in the United States during 1960; the population in 1960 was 179,323,175 (including Alaska, Hawaii and excluding armed forces overseas), the death rate was therefore 9.5 per 1,000 of the population. The corresponding rate for England and Wales in 1960 was 11.5 per 1,000.

TABLE I.—*Average Annual Death Rates per 1,000 Population in Selected Countries for Specified Periods and Years, 1901–60*

Period or year	U.S.	Canada	Eng. and Wales	France	Italy	Sweden	Mexico	Ceylon	U.S.S.R.
1901–10	15.5	*	15.4	19.4	21.6	14.9	32.7	*	29.7
1911–20	13.9	*	14.5	18.6	20.4	13.1	*	*	*
1921–30	11.7	10.7	12.2	17.0	16.8	12.2	25.5	25.5†	22.7
1931–40	10.9	9.8	12.0	15.8	14.1	11.6	21.8	23.0	18.3‡
1941–50	10.2	9.6	12.5	15.5	12.9	10.5	21.8	17.1	9.6§
1955	9.3	8.2	11.7	12.2	9.3	9.5	13.7	10.8	8.2
1960	9.5	7.8	11.5	11.4	9.7	10.0	11.7	...	7.1

*Not available. †1930. ‡1940. §1950.

International Comparisons.—Death rates for selected countries for various years are shown in Table I. During the period 1950–60 death rates of about 12 per 1,000 or less were recorded in all major countries of Europe, the United States, Canada, Australia, New Zealand and certain countries in Latin America and Asia. Death rates were higher in countries of retarded economic development where sanitary conditions and health facilities were relatively poor. In some countries in Latin America, Asia and Africa the death rate (except for the European minorities) is estimated at 20 or more per 1,000 population. In many countries, large numbers of deaths escape registration and the death rates obtained from official statistics are therefore too low. For instance, the official statistics of India show an average annual death rate of 14.1 per 1,000 in the years 1950–55, but it is believed that the rate was actually near 25 per 1,000.

The death rate is influenced by the age distribution of the population as well as the conditions of health and mortality. In the European countries, especially those in northwestern Europe, a comparatively large fraction of the population is made up of middle-aged and elderly people who, of course, are subject to higher mortality rates than young people. The middle-aged and the elderly are proportionately much fewer in the countries of Asia, Africa and Latin America. It is for this reason that Ceylon, for instance, has a lower death rate than England and Wales, although conditions of health in Ceylon are not so good as those in Britain. The very low death rate of the Jewish population in Israel (5.7 in 1960) is explained by the fact that this population consists largely of relatively recent immigrants, few of whom have yet reached an advanced age.

Expectation of Life.—A better measure of mortality than the death rate is the expectation of life at birth, also known as the average length of life. This figure represents the number of years the average newly born child would live if the risk of mortality at each age remained constant as of the year or period for which it is computed. As a measure of mortality, the expectation of life at birth has the advantage of being independent of the age distribution of the population. The lower the level of mortality, the greater is the expectation of life.

In the United States in 1958, the expectation of life at birth was 69.4 years. The figure for males was 66.4 years and for females, 72.7 years. The corresponding figures for England and Wales in 1959 were 68.1 years for males and 73.8 years for females. In most countries, females have a greater expectation of life than males, being subject to lower mortality rates at all or nearly all ages.

Data on the expectation of life in certain countries for various periods between 1941 and 1959 are shown in Table II. Expectations of life exceeding 65 years for males and 70 years for females are shown for Canada, Czechoslovakia, Denmark, France, east and west Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, Australia, New Zealand and the Jewish population of Israel, in addition to the United States and England and Wales. Expectations of less than 60 years for both sexes were

the rule throughout most of Asia, Africa and Latin America, including many countries which are not listed in Table II for lack of exact information.

Trends.—There has been a steady decline of death rates in Europe and the main areas of European settlement overseas since about the middle of the 19th century (*see* Table I). In England and Wales, the average death rate from 1851 to 1870 was somewhat more than 22 per 1,000 population; during the years 1951–60 it averaged less than 12 per 1,000. The decline in France was from a level of about 24 during 1851–80 to slightly less than 12 in 1956–60. Italy experienced an even greater decline of the death rate, from an average of 30 in 1871–80 to 9.7 in 1960. In the United States, the death rate dropped from an average of 15.7 during 1901–10 to less than 10 in the decade 1951–60.

The improvement in mortality conditions is measured more exactly by increases in the expectation of life at birth. For white males in the United States, the expectation of life at birth increased from 46.6 years in 1900 to 66.4 years in 1958. The increase for white females was from 48.7 to 72.7 years. In England and Wales, the expectation of life at birth for males rose from 40.2 years in 1841 to 68.1 years in 1959; the increase for females was from 42.2 to 73.8 years.

It was only toward the middle of the 20th century that the progress of medical science and intensified public health activities brought about great reductions of death rates in Asia, Africa and Latin America. Before World War II, death rates in those parts of the world were almost universally high, but impressive declines were recorded in the death rates of many countries in these regions since 1946. The death rate in Mexico, which ranged between 22 and 26 from 1925 to 1944, dropped to 11.7 in 1960. In Ceylon, the death rate fell from 25.5 in the period 1921–30 to 9.1 in 1959. Equally great declines were experienced in Costa Rica, Malaya, Singapore and Formosa. Important reductions of death rates also took place in many other countries of Latin America, Asia and Africa. These changes have been attributed largely to the extensive use of insecticides, inoculations and antibiotics for the control of endemic and infectious diseases.

TABLE II.—*Expectation of Life in Selected Countries*

Country	Year or period	Expectation of life at birth—years	
		Males	Females
Americas			
Argentina	1947	56.9	61.4
Canada	1955-57	67.6	72.9
Chile	1952	49.8	53.9
Costa Rica	1949–51	54.7	57.1
El Salvador	1949–51	49.9	52.4
Panamá	1952–54	60.4	63.1
United States	1958	66.4	72.7
West Indies, Jamaica	1950–52	55.7	58.9
Europe			
Austria	1949–51	61.9	67.0
Belgium	1946–49	62.0	67.3
Czechoslovakia	1958	67.2	72.3
Denmark	1951–55	69.9	72.6
England and Wales	1959	68.1	73.8
Finland	1951–55	63.4	69.8
France	1952–56	65.0	71.1
Germany, east	1956–57	66.3	71.0
Germany, west	1958–59	66.7	71.7
Hungary	1958	65.1	69.4
Ireland	1950–52	64.5	67.1
Italy	1954–57	65.8	70.0
Netherlands	1953–55	71.0	73.9
Norway	1951–55	71.1	74.7
Poland	1958	62.8	68.9
Portugal	1957–58	59.8	65.0
Sweden	1957	70.8	74.3
Switzerland	1948–53	66.4	70.9
Yugoslavia	1952–54	56.9	59.3
Asia			
Cambodia	1958–59	44.2	43.3
Ceylon	1954	60.3	59.4
Cyprus	1948–50	63.6	68.8
India	1941–50	32.5	31.7
Israel (Jews)	1959	70.2	72.3
Japan	1959	65.2	69.9
Philippines	1946–49	48.8	53.4
Thailand	1947–48	48.7	51.9
Africa			
Ivory Coast (indigenous)	1956–58	35.0	
Rep. of the Congo (Africans)	1950–52	37.6	40.0
Guinea (rural)	1954–55	30.5	
Southern Rhodesia (indigenous)	1953–55	48.0	49.0
Oceania			
Australia	1953–55	67.1	72.8
New Zealand (Europeans)	1950–52	68.3	72.4
U.S.S.R.	1957–58	64.0	71.0

Source: United Nations, *Demographic Yearbook*, pp. 602-609 (1960).

Infant Mortality.—The greatest reductions have been achieved in the death rates of infants in the first year of life. Mortality at this age is usually measured by the ratio of deaths of infants under one year of age, during a calendar year, per 1,000 live births occurring in the same calendar year. This ratio is known as the infant mortality rate. During the 1870s in England and Wales, the infant mortality rate was approximately 150 per 1,000 live births; by 1960 it had been reduced to 21.7 per 1,000. Equally large or even larger reductions have occurred in other European countries since the last decades of the 19th century. Infant mortality rates during 1960 in different countries of Europe ranged from 16.6 per 1,000 in Sweden to 77.5 per 1,000 in Portugal and 87.3 per 1,000 in Yugoslavia. The infant mortality rate in the United States averaged 25.7 per 1,000 live births in 1960.

Official infant mortality rates are published for most countries of the world, but in many cases these statistics are unreliable. Infant mortality rates in the less developed countries of Latin America and Africa, and in some Asian countries, are believed to range upward from 100 infant deaths per 1,000 live births.

Economic and Social Classes.—There is a downward gradation of death rates in passing from the lowest to the highest economic and social classes of a community. For instance, a study based upon the United States census of 1930 and death statistics for ten states in that year showed the following death rates per 1,000 males between the ages of 15 and 64 years in various occupational groups: unskilled workers, 13.1; semiskilled workers, 9.9; skilled workers, 8.1; clerks, proprietors, managers and officials, 7.4; professional men, 7.0. The lowest death rate of occupational groups was that of agricultural workers, 6.2 per 1,000. There is evidence that these variations result primarily from differences in the environment associated with different occupations and that the occupational risks involved have only a relatively small influence.

The nonwhite population of the United States suffers higher mortality than the white population, primarily because of the inferior economic and social position of the nonwhites. Thus, the expectation of life at birth for nonwhite males in 1959 was 60.9 years, while it was 67.3 years for white males. The figures for nonwhite and white females were 66.2 and 73.9 years, respectively.

Causes of Death.—Death rates may also be computed according to the cause of death; in this case, the rates are usually expressed per 100,000 of the population. Thus, heart disease, the leading cause of death in the United States, claimed 659,410 deaths in that country during 1960, or 366.4 per 100,000 of the population. The 1960 death rates for other leading causes of death were, in order of rank: cancer, 147.4; cerebral hemorrhage, 107.1; accidents, 51.8; diseases of early infancy, 37.0; influenza and pneumonia, 36.6; general arteriosclerosis 20.3; diabetes mellitus, 17.1; congenital malformations, 12.0; and cirrhosis of the liver, 11.2. The ten causes mentioned were responsible for 85% of all deaths.

Striking changes in the death rates for certain causes have occurred in the United States since 1900. The death rate for tuberculosis was 201 per 100,000 in 1900, but only 5.9 per 100,000 in 1960. Preventive measures practically eliminated typhoid fever and diphtheria as causes of death; their death rates fell from 36 and 43, respectively, in 1900 to 0 in 1960. On the other hand, the rates for some causes of death increased. Mortality from heart disease in 1960 was more than 2½ times that of 1900. The cancer death rate rose from 63 in 1900 to 147.4 in 1960. A large part of the increase in the death rates for heart disease and cancer may be attributed to the increase in the proportion of elderly persons in the population and to improvement in diagnosis. The death rate for diabetes mellitus rose gradually from 10 in 1900 to 17.1 in 1960. Automobile accidents claimed 20.6 of every 100,000 lives in 1960.

See BIRTH RATE; POPULATION; *see* also references under "Death Rate" in the Index volume.

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Current death rate statistics are summarized annually in the *Britannica Book of the Year* under "Birth and Death Statistics."

(J. D. D.)

DEATH VALLEY, in Inyo county, Calif., is lower, hotter, and drier than any other area in the United States. It is bounded on the east by the Grapevine, Funeral and Black mountains and on the west by the Panamint range. Although genetically related to numerous other valleys in the arid southwest, Death valley is in many ways unique. Some 550 sq.mi. of the valley's floor lie below sea level, culminating at Badwater (−282 ft.). Summer temperatures frequently exceed 120° F., and on one occasion an extreme high of 134.6° was recorded. Average annual precipitation is a little over two inches. In spite of the heat and aridity, many species of plants are to be found, especially in the higher sections, and several species of birds and mammals inhabit the valley throughout the year.

Made a national monument in 1933, the valley affords much in the way of scenic and historic interest. It was first seen by white men in 1849, when a party of emigrants crossed it on their way to California. The name "Death valley" is attributed to these early visitors, who suffered many trials in crossing the desolate wastes of the valley floor. Except for occasional prospectors the area was seldom visited until the 1870s, when gold was discovered in the surrounding mountains and borax deposits were found in the valley. Borax production during the 1880s gave rise to the famous 20-mule team wagons, used to haul the product to Mojave, Calif. Later the valley became a major winter resort area.

Among the people associated with Death valley the best known is Death Valley Scotty, a legendary character whose exploits were supposedly financed by gold taken from a mysterious secret mine. In reality his ventures were financed by Albert Johnson, a retired Chicago business man.

See G. P. Putnam, *Death Valley and Its Country* (1946).

(C. R. Sr.)

DEATHWATCH, a popular name given to small beetles of two distinct families that often burrow and live in old furniture and produce a ticking sound commonly supposed by the superstitious to foretell the death of an inhabitant of the house. The name is often applied to *Xestobium rufovillosum* and *Anobium punctatum* (family Anobiidae) but belongs more properly to the former insect. The sound is a mating call and is produced by the adult beetle striking the front of the head upon a hard surface.

Certain book-lice (order Psocoptera [Corrodentia]) are sometimes known as lesser deathwatches, but the ability of such minute soft insects to produce audible sound is doubtful. The names *Atropos pulsatoria* and *Troctes divinatorius,* given to two of the common species, bear witness to the old superstition regarding the fateful significance of the sound.

DEAUVILLE, a seaside resort of northern France, in the *département* of Calvados, lies at the mouth of the Touques river opposite Trouville and across the Seine estuary from Le Havre, 89 km. (55 mi.) W. of Rouen by road. Pop. (1954) 5,211, increasing in summer to around 80,000. Because of its beautiful gardens Deauville is called the beach among the flowers. It is a fashionable resort in summer with many luxury hotels, a casino and two racecourses, and in winter it is an educational centre for students needing bracing air. Founded by the duc de Morny in 1866, Deauville was built on the checkerboard plan with wide avenues. In the Franco-German War the German advance stopped just short of the town; in World War II it was in German hands from June 1940 to Aug. 1944.

(J. A. Va.)

DE BARY, HEINRICH ANTON (1831–1888), German botanist, whose researches were influential in the development of the modern concept of parasitism and infection and in the transition from the anatomical to the developmental approach to the study of fungi. Born at Frankfurt am Main on Jan. 26, 1831, he received a medical degree (Berlin) in 1853, but soon turned to research in botany. After teaching at Tübingen, Freiburg and Halle, he was professor of botany and rector at Strasbourg from 1872 to 1888. He died there on Jan. 19, 1888.

De Bary is regarded as a founder of modern mycology and plant pathology. In his *Untersuchungen über die Brandpilze* (1853), he maintained that the fungi associated with rust and smut diseases of plants were the cause of these diseases rather than the effect. His proof (1865) of the necessity of two hosts, wheat and barberry, in the life cycle of stem rust of wheat was the initial demonstration of heteroecism in rusts. He worked out the complicated life cycles of many other fungi and was among the first to study host-parasite interactions. His *Morphologie und Physiologie der Pilze,* etc. (1866) and *Vergleichende Morphologie und Biologie der Pilze,* etc. (1884) are basic mycologic reference works. De Bary summarized knowledge concerning bacteria in his *Vorlesungen über Bakterien* (1885) and published important papers on the slime molds and various algae. His essays on apogamy (1878) and symbiosis (1879) were provocative and influential. His classic *Vergleichende Anatomie der Vegetationsorgane der Phanerogamen und Farnen* (1877; English ed., 1884) had great effect on the development of concepts in plant anatomy. De Bary influenced botany not only through his own work but also through the many men who studied under him and afterward became distinguished.

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(J. W. Tt.)

DE BEER, SIR GAVIN RYLANDS (1899–), British zoologist, antiquarian and man of letters, whose main work concerned evolutionary problems, was born in London on Nov. 1, 1899, and was educated at the École Pascal, Paris, and at Harrow school and Magdalen college, Oxford. He remained at Oxford in the department of comparative anatomy until 1938 and during World War II served as Lieut. Col. in the Grenadier guards. He was professor of embryology at University college, London (1945–50) and then became director of the British museum (natural history). He was president of the 15th International Zoological congress held in London in 1958. De Beer showed the failure of the germ layer theory in Urodela. He analyzed the development of the skull in vertebrates and (with J. P. Hill) found vestiges of the egg tooth in marsupial embryos. He discovered the sternum in *Archaeopteryx* and showed the specialized, degenerate nature of Ratitae. Antiquarian interests are shown in his interpretation of the route of Hannibal's march across the Alps, the use of blood group data in tracing the origin of Etruscans from Asia Minor, the transcription of a first manuscript by Edward Gibbon and the discovery of manuscripts settling the first ascent of Mont Blanc.

De Beer's publications cover a wide range and comprise more than 350 books, monographs and papers. His zoological publications include the demonstration of the importance of pedomorphosis (retention in the adult of juvenile or infantile characteristics) and the principle of clandestine evolution and of mosaic evolution.

(Ed. He.)

DEBENTURE AND DEBENTURE STOCK: *see* Investment Paper.

DEBIR: *see* Kirjath-Sepher.

DE BONO, EMILIO (1866–1944), Italian general, a marshal of Italy, notable especially under the Fascist regime, was born at Cassano d'Adda on March 19, 1866. He joined the Bersaglieri (light infantry) as a second lieutenant in 1887, fought in Eritrea and was on the general staff in the Italo-Turkish War. In World War I he first commanded a regiment of Bersaglieri and, earning rapid promotion, was a brigadier in the battle of Gorizia (1916) and a major general in command of the IX corps at the Piave (1918).

A strong nationalist, De Bono was an early convert to Fascism and took part as a *quadrumvir* with Mussolini in the march on Rome in 1922. He was given the post of chief of police and commander of the Fascist militia and was made governor of Tripolitania in 1925 and colonial minister in 1929. Appointed commander-in-chief when Italy invaded Ethiopia in 1935, he was replaced shortly after but rewarded with a marshal's baton.

During World War II, De Bono gradually detached himself

from the politics of Mussolini, and on July 24, 1943, he voted against him at the decisive meeting of the Fascist grand council. He was charged with treason, found guilty by the Fascist tribunal at Verona and executed on Jan. 11, 1944.

He wrote *La guerra come e dove l'ho vista e combattuta io* (1935) and *La preparazione e le prime operazioni* (1937).

DEBORAH (in the Douai version of the Bible, DEBBORA), the name of two women mentioned in the Old Testament.

Deborah, the nurse of Rebecca, was buried under the "Oak of Weeping" below Bethel (Gen. xxxv, 8). It has been suggested that this tree is connected with the "palm of Deborah," between Bethel and Ramah (Judg. iv, 5), the home of the second Deborah.

This latter is the famous prophetess and "judge," who, in company with Barak, son of Abinoam, delivered Israel from a Canaanite oppression. Two narratives of this exploit have been preserved, an account in prose in Judg. iv and a descriptive poem in Judg. v. They differ in one or two important details. The most obvious contrast is in the identity of the enemy overthrown. The prose narrative makes the enemy Jabin, king of Hazor, though a prominent part is played by his commander in chief, Sisera, who lived at Harosheth-haggoyim. In the poem Jabin does not appear and Sisera is an independent king. It is possible that the introduction of Jabin is due to the conflation of two traditions, one of which referred to Sisera while the other was parallel to the story of the defeat of Jabin, king of Hazor, by Joshua (Josh. xi, 1–9) at the Waters of Merom. Another contradiction is to be found in the manner of Sisera's death. In Judg. iv he is murdered in his sleep, in Judg. v he is struck down from behind while drinking a bowl of milk.

Assuming that the tradition preserved in Judg. v is the older, the actual history of the events can be reconstructed. Israel holds the wilder parts of the country, the hills and the forests, but the Israelite settlements in the central range are cut off from those in the northern hills by a chain of Canaanite (Egyptian?) fortresses down the plain of Esdraelon. For the time the plain dominates the hills; the Israelites are disarmed and their communications are cut. At the instigation of the prophetess Deborah, and possibly aided by her spells, Barak raises the clans of Ephraim, Benjamin, Machir (Manasseh), Zebulon, Issachar and Naphtali. Asher, Dan, Gilead (Gad) and Reuben hold aloof. Judah and Simeon are not mentioned. The Israelite clans fall on the enemy at Taanach; a thunderstorm, in which Israel sees the coming of Yahweh, strikes terror into the Canaanites; their chariots are useless on the sodden ground, and the Kishon, swollen by torrential rains, sweeps away the fugitives. Sisera escapes on foot, pursued by Barak; taking refuge in the tent of Heber the Kenite, he is treacherously slaughtered as he drinks. The poem is one of the most important documents of ancient times. It is contemporary with the events to which it refers, and is therefore invaluable as a picture of the life of Israel in the early days of the settlement. Further, it is in itself a magnificent lyric outburst, and proves a very high standard of poetic skill in ancient Israel.

See G. A. Cooke, *History and Song of Deborah* (1892). (T. H. R.)

DEBRECEN, one of the most important towns of eastern Hungary, and a *megye* (county) in its own right, is about 138 mi. due east of Budapest by rail. Pop. (1960) 129,671 (mun.). It lies on the southwestern extremity of the sandy plains of the Nyírség region and has long been famous for its fairs and markets in livestock. It was founded in the 14th century and acquired prominence 200 years later, during and after the Turkish occupation. The walled city was a refuge for peasants fleeing from the Turks and developed into one of the remarkable Hungarian municipalities, urban in their great nuclei of settlements, rural in their interests, which remained semiautonomous under Turkish rule. The city acquired properties stretching into the Hortobágy steppe on the west. It had a noted trade in horses, cattle and sheep during and after the Turkish regime, and was distinguished also in religion, culture and politics. It was long known as the Calvinist Rome because of its importance to the reformed creeds in east central Europe. (In 1939, 65% of the population was reckoned as Calvinist.) Debrecen housed Hungary's oldest printing press, built in 1561, and the 16th-century Protestant college, with its faculties of law and theology, was the nucleus of the later university. In 1849 Lajos Kossuth (*q.v.*) proclaimed in Debrecen the independence of Hungary from the Habsburgs, and the city fell to the Russians when their help eventually made possible the quelling of the revolt. In 1944, when the Germans were driven westward by the Soviet armies, Debrecen was for a while the centre of the provisional government of Hungary.

The city walls were long ago replaced by a roughly circular pattern of boulevards and gardens. The rail network, with seven lines converging on the city, and an even closer web of roads have maintained and developed trade and industry. (H. G. S.)

DEBS, EUGENE VICTOR (1855–1926), U.S. labour organizer and five times Socialist party candidate for president, was born in Terre Haute, Ind., on Nov. 5, 1855. At 14 he left high school to work for the Vandalia railroad. In 1875 he became an organizer and in 1880 a national officer in the Brotherhood of Locomotive Firemen. He became city clerk of Terre Haute and in 1885 a member of the Indiana legislature. After trying unsuccessfully to federate the various existing railroad brotherhoods he became president in 1893 of the newly established American Railway union, an industrial union. When the union began a strike in 1894 against the Pullman Car company, Debs assumed leadership and as a result served a jail sentence for contempt of court. This made him a national figure.

Debs became increasingly critical of traditional political and economic ideas, especially of capitalism. Sympathetic toward Populist doctrines, he campaigned for William Jennings Bryan in 1896 and supported an abortive co-operative colonizing project. In 1898 he led in establishing the Socialist party (name adopted in 1901). In 1905 he helped found the Industrial Workers of the World but soon withdrew because of its radicalism. In 1900, 1904, 1908, 1912 and 1920 Debs was the Socialist candidate for president. In 1912 he received 899,164 votes, about 6% of the total popular vote. In 1920 his vote exceeded 900,000 despite the imprisonment for wartime pacifism in violation of the 1918 Espionage act. His sentence was commuted by President Harding in Dec. 1921, but his citizenship was not restored.

Not an intellectual or a hard-headed politician, Debs won support through warmth of personality, integrity of character and sincerity of conviction. He earned his living primarily as a lecturer and as a contributor and editor for various periodicals. Among the best known of his many writings are the pamphlet *Unionism and Socialism* (1904) and the book *Walls and Bars* (1927). He died at Elmhurst, Ill., Oct. 20, 1926.

See Ray Ginger, *The Bending Cross: a Biography of Eugene Victor Debs* (1949); A. M. Schlesinger (ed.), *Writings and Speeches of Eugene V. Debs* (1948). (D. E. WY.)

DEBT, PUBLIC. This term is used to denote obligations of governments, particularly those evidenced by securities, to pay certain sums to the holders at some future time. Public debt is distinguished from private debt, which consists of the obligations of individuals, business firms and nongovernmental organizations. The debt owed by the national government is usually referred to as the national debt and is thus distinguished from the public debt of state and local government bodies. In the United States, bonds issued by the states and local governments are known as "municipals." In the United Kingdom, debt or loans incurred by local authorities are referred to as corporation or county loans, thus distinguishing them from central government debt, which is frequently referred to simply as funds. In the past, paper money was frequently regarded in the United States as a portion of the public debt, but in more recent years such money has been regarded as a distinct type of obligation, not a part of the public debt in the usual sense of that term. This change is partly the result of the fact that paper money is usually no longer payable in gold, silver or other specific items of intrinsic value. Public debt is an obligation of a government, and while individuals are called upon in their capacity as taxpayers to provide funds for payment of interest and principal on the debt, their own property cannot be attached to meet the obligations if the government fails to do so. Similarly, government property normally cannot be seized to meet these obligations. With sovereign governments the

debt holders can take only such legal action to enforce payment as the governments themselves prescribe.

This article is organized according to the following outline:

I. Forms of Public Debt
1. Long-Term and Short-Term Debt
2. Direct and Contingent Debt and Revenue Bonds
3. Internal and External Debt
4. Marketability
5. Other Bases for Classification
II. Development and Growth of Government Borrowing
1. Great Britain
2. United States
3. Canada
4. Debt and National Income
5. Magnitude of Debt in Various Countries
III. The Economics of Public Debt
1. Effects of Borrowing
2. Economic Effects of the Debt Itself
3. Effects of Debt Retirement
4. Debt Burden on Future Generations
IV. Should Governments Borrow?
1. Objections to Borrowing
2. The Case for Borrowing
3. Debt Limitation Laws
V. Debt Retirement Policy
1. National Debt
2. State-Local Debt Retirement
VI. Debt Management
1. Policies on New Borrowing
2. Management of Existing Debt

I. FORMS OF PUBLIC DEBT

Public debt can be classified in a number of different ways:

1. Long-Term and Short-Term Debt.—One simple way of classifying debt is on the basis of the length of time from issue until repayment. Long-term debt is that due at a relatively distant date in the future, such as ten years or more, and is normally evidenced by bonds. This category roughly coincides with the older term funded debt, although the latter concept includes debt with maturity from one to ten years as well. When the term funded debt originated in England, it was used to denote a debt whose interest was paid from specific funds or taxes. In time, however, it was extended to cover all debt due only after a relatively long period, or having no set maturity date. The "funds" were redeemable only at the option of the government.

Virtually all government debt in the United States has been issued for a definite time period, the lone exception being one $600,000,000 federal issue of 1900. However, some governments, particularly the British, have frequently issued bonds without a fixed maturity date but payable (technically, callable) after a certain date. These issues are known as consols (*q.v.*) because some of the early issues involved the consolidation of various separate debt issues.

The term intermediate debt is frequently used for obligations due in the period between five and ten years, although these issues are sometimes included in the long-term category. U.S. treasury notes (not to be confused with paper money, some issues of which were called treasury notes) usually fall within this category. In Great Britain, outstanding government debt having a period of five to ten years to run to redemption is considered short-term or medium-term. Treasury bills, which are essentially three-month promissory notes, are excluded from this classification.

Short-term debt is that with a maturity date of less than five years. Debt of this type that matures in one year or less constitutes floating or unfunded debt as distinguished from funded debt, noted above. In both the United States and Great Britain, extensive use of short-term debt began with World War I and became of particular importance during and after World War II. It was originally regarded as an emergency source of revenue only, to be repaid or funded as soon as possible. Ultimately it became a more or less permanent element in the debt structure, largely because of its lower interest cost and greater flexibility. In the United States there are two major forms: treasury bills, with maturity of one year or less, and certificates of indebtedness, due in one to five years. States, provinces and local governments usually employ short-term borrowing only in anticipation of tax revenues due in the near future, the credit instruments involved being known as tax anticipation notes. The principal forms of short-term debt in Great Britain are treasury bills (first authorized by statute in 1877) and ways and means advances from the Bank of England. Local authorities in Great Britain also carry a substantial volume of short-term debt secured on rates and revenues. Tax anticipation notes are unknown in the United Kingdom. The usual instrument evidencing such debt is the deposit receipt.

2. Direct and Contingent Debt and Revenue Bonds.—Direct obligations consist of securities issued by governmental units themselves, the governments being fully and directly responsible for payment of interest and principal. By contrast, contingent liabilities consist of securities issued by governmental corporations or government-owned corporations that are guaranteed as to principal and interest by the government. In the United States before 1941, for example, funds for the Reconstruction Finance corporation, Federal Housing agency and other governmental corporations were obtained by the issuance of bonds by these organizations, with guarantee by the federal government. In 1941 the government began to use direct obligations to finance these activities because of the lower interest rate. At times in the 1950s, however, the contingent method was again employed to some extent. In Canada, funds for the Canadian National railways, the Hydro-Electric Power Commission of Ontario and similar government-owned corporations are raised by bonds issued by these corporations and guaranteed by the respective governments. Similarly, in Great Britain loans have been guaranteed by the central government where the body raising the loan is one carrying out work deemed to be of public welfare, such as the North of Scotland Hydro-Electric board.

In the United States, at the state-local levels, substantial use is made of revenue bonds issued by various government-owned commercial enterprises such as toll highways, municipal power and transit systems, and are not guaranteed by the governments. By the early 1960s more than half of all state debt and 30% of local debt consisted of revenue bonds. These inevitably require a higher interest rate than direct obligations but they create no obligation for the taxpayers. Frequently they can be issued without regard to constitutional and other restrictions that require a popular vote on general obligations.

Reports of totals of debt outstanding may or may not include contingent liabilities and revenue bonds, and practice on reporting of these forms of debt varies from country to country.

3. Internal and External Debt.—Public debt, especially that of a national government, is frequently classified on the basis of whether it is owned within the boundaries of the issuing jurisdiction or outside. Sometimes the distinction is based on whether the bonds are payable in the money of the issuing country or of a foreign country. While the classification on this second basis is similar to that on the former, it is by no means identical; bonds payable in the home currency may be owned outside, and vice versa. The external debt includes war debts and reparations owed to other governments (*see* WAR DEBT; REPARATIONS). The United States has very little externally held debt, and all of it is payable in U.S. dollars. Canada, on the other hand, has a substantial external debt, some of it payable in U.S. dollars. Great Britain also has a substantial external debt, most of it payable to the United States.

External debt is usually regarded as much more significant than internal debt because it represents a claim of foreigners against the real national product of the country. Payments of interest and principal can be made only by a transfer of goods to the foreign country through an excess of exports over imports. If the tariff policy of the debt-holding country prevents the debtor country from maintaining an excess of exports over imports, commitments cannot be kept, and international ill will and even armed intervention may result.

4. Marketability.—In terms of marketability, public debt takes three forms. First, debt may be represented by nonnegotiable notes executed directly between the government and lenders. Second, the debt may take the form of nonnegotiable securities of specific denominations widely distributed to the public, such as the U.S. savings bonds that were employed extensively to finance

World War II. Unlike the usual government obligations, these bonds were issued in small denominations, as low as $25. Since they could not be sold they could not depreciate in monetary value. They were redeemable at any time; interest was not paid on a periodic basis, as with the marketable securities, but accrued over the life of the bond and was paid at maturity along with the principal. The British equivalent was the national savings certificate, first introduced during World War I.

The great bulk of all government debt, however, consists of the third type—marketable securities. These securities are negotiable and sell freely on the market. They are usually issued in relatively large denominations, $1,000 or higher, and interest is paid by check or coupon on a periodic basis. Since they are salable, the price fluctuates from time to time. The price will rise above maturity value when the current market interest rate falls below the interest rate which they bear; the price will fall below the maturity value when the current rate rises or when fear develops about the ability of the government to pay interest.

5. Other Bases for Classification.—Government debt can also be classified on several other bases:

Voluntary or Compulsory Character.—Under normal circumstances the purchase of securities is entirely voluntary, but in a few instances during war periods the purchase has been made compulsory. (See *Debt Management* section, below.) In other instances features of the law have made purchase for all practical purposes imperative. This was true of the national banks in the United States from 1863 to 1936. They were required by law to hold government bonds as security behind the national bank notes which they issued. In Great Britain, the holding of large blocks of government debt, as for example by each of the "big five" banks, is entirely voluntary, but supported by long tradition.

Interest Features.—Governments must, of course, pay interest on their obligations if they are to sell them in the market on a voluntary basis. But compulsory loans sometimes do not carry interest. When paper money was regarded as a part of the national debt, this element also did not bear interest.

Interest may be paid on a periodic basis through checks sent to the holders or through redemption of coupons attached to the bonds when they are issued. Savings bonds issued in small denominations, however, are usually handled on the discount basis; that is, they are sold for a smaller sum than the maturity value and the interest thus accrues over the years of their life and is received by the holder when he cashes in the bond.

Callable Features.—If government bonds are callable they are payable at the option of the government after some date prior to maturity, at maturity value or with some premium added. The callable feature enables governments to retire (redeem) the debt sooner than otherwise without having to pay substantially more than maturity value. It also enables governments to issue new bonds with a lower interest rate if the market rate falls.

Use of Funds.—The term dead weight debt is sometimes used, particularly in Great Britain, for debt incurred for the conduct of a war or the meeting of depression-induced deficits. Thus this debt is not represented by specific capital assets of equivalent value as is debt incurred to finance capital improvements.

II. DEVELOPMENT AND GROWTH OF GOVERNMENT BORROWING

The evolution of government borrowing was very slow. Extensive use of loans by governments became possible only after the ruler became differentiated from the state and after the continuity of the state became distinct from the persons of the rulers. Other factors were also necessary—the development of a regular revenue source for repayment of loans, a monetary system and an organized money market. The earliest loans of medieval and premedieval years were either forced loans or the personal borrowing of the sovereign. The first examples of government borrowing in its modern form occurred in medieval Genoa and Venice when the city governments borrowed on a commercial basis from the newly developed banks. But only with the commercial and industrial revolutions and the general development of the money markets did borrowing become a significant element in government finance.

1. Great Britain.—Government borrowing in Great Britain dates back to the end of the 17th century. In 1691, legislation pledged the receipts from beer and liquor taxes as security for a loan of £1,000,000. As Table I indicates, the trend of the debt was upward throughout the next 150 years largely because of wars; by 1802 it had reached £523,000,000, and by 1840, £827,000,000. The second half of the 19th century witnessed gradual reduction of the debt, to £610,000,000 in 1900, the significance of the debt being reduced still more by the growth of the economy over this period. World War I brought a tremendous increase, the 1920 figure being £7,828,000,000. The 1920s showed little reduction and the figure rose slightly during the depression years. World War II brought the level to £21,366,000,000 in 1945 and the figure rose in the postwar period—partly as a result of nationalization of industry—to over £27,000,000,000 in the early 1960s.

2. United States.—In the United States, when the federal government was formed in 1789, it assumed the debts of the states and various other obligations incurred during the American Revolution, which were funded into a single debt issue of $75,000,000. The government was highly successful in avoiding additional borrowing in the early years, except for the War of 1812, and during 1835 all federal debt was eliminated. (*See* Table I.) The years

TABLE I.—*Growth of National Debt in United Kingdom, United States, France, Germany, Japan and Canada*
(in 000,000 of currency units shown)

Year*	United Kingdom of Great Britain and Northern Ireland† (pound sterling)	United States‡ (dollar)	France§ (old franc)	Germany‖ (deutsche-mark)	Japan¶ (yen)	Canada♀ (dollar)
1697	14	—	—	—	—	—
1757	77	—	—	—	—	—
1781	187	—	—	—	—	—
1791	—	75	—	—	—	—
1802	523	81	—	—	—	—
1815	834	100	1,272	—	—	—
1820	800δ	91	3,590	—	—	—
1825		84	4,123	—	—	—
1830	—	49	4,890	—	—	—
1835	832□	0	4,557	—	—	—
1840	827	4	4,682	—	—	—
1845	818	16	5,810	—	—	—
1850	804	63	5,426	—	—	—
1855	789	36	6,965	—	—	—
1860	799	65	10,262	—	—	—
1865	790	2,678	13,865	—	—	—
1870	768	2,436	12,310	487	5	78
1875	742	2,156	21,185	120	56	116
1880	730	2,091	21,597	388	247	152
1885	703	1,579	24,943	587	240	196
1890	678	1,122	26,152	1,242	255	237
1895	627	1,097	27,258	2,205	299	253
1900	610	1,263	30,080	2,421	506	265
1905	756	1,132	30,610	3,327	1,292	266
1910	720	1,147	32,750	5,014	2,605	336
1915	1,104	1,191	39,023	10,955	2,506	449
1920	7,828	24,299	240,242	184,864	3,278	2,248
1925	7,597	20,516	418,075	2,413	4,901	2,417
1930	7,469	16,185	480,173	10,375	6,003	2,177
1935	7,687	28,701	324,013	14,253	9,613	2,846
1940	9,083	42,968	708,715	52,060	23,481	4,027
1945	21,366	258,682	1,831,859	323,615Δ	150,795	15,713
1950	25,921	257,377	4,133,000	6,672	316,800	16,751
1955	27,775	274,418	5,856,000	20,131	857,400	17,951
1960	27,599•	284,700	8,404,000	25,634	542,000	20,997

*Fiscal years as of which data are reported vary as between countries and over the periods covered for the same countries, as a rule. Data for 1940–45, unless especially noted, taken from *Public Debt, 1914–1946*, United Nations, Department of Economic Affairs (1948), and for 1950 and 1955 from *Statistical Year Book: 1955*, pp. 487–539, United Nations, and *International Financial Statistics*, vol. ix, no. 10 (Oct. 1956), prepared by the Statistics Division of the International Monetary Fund, Washington, D.C. 1960 figures are from UN Department of Economic Affairs.

†Data from 1697–1828 inclusive are gross national debt figures from E. L. Hargreaves, *The National Debt*, p. 291 (London, 1930). Data from 1836–1935 inclusive are "net national debt" compiled from British official "Accounts and Papers" by subtracting exchequer balances from total debt. Figures from 1950 to 1960 are sterling debt and foreign currency debt.

‡Data from 1791 to 1850 taken from *Annual Report of the Secretary of the Treasury on the State of the Finances for the Fiscal Year Ended June 30, 1903*, p. 63; from 1855 to 1935 from *ibid*, pp. 562–563 (1943). Receot years taken from *Treasury Bulletins* and *Annual Reports*.

§Data up to 1935 computed from the *Annuaire Statistique de la France*.

‖From the *Statistisches Jahrbuch für das Deutsche Reich* and for 1940, *Bonk for International Settlements, Thirteenth Annual Report* (May 1944). Figures from 1950 and subsequent years are for West Germany.

¶These data, except 1950 and 1955, were computed from Japanese government sources, especially the *Financial and Economic Annual of Japan*, Department of Fioances.

♀Data taken from *The Canada Year Book*.

δ1828.

□1836.

•The total gross debt of U.S. on Jan. 1, 1835, was $33,733.05.

ΔSept. 30, 1944.

•March 31, 1959.

1835–36 were the only ones in the history of the country in which there was no federal debt at all. The American Civil War, financed to the extent of only about 25% by taxation, pushed the debt to the total of $2,678,000,000 in 1865. Most of this debt was retired through budget surpluses during the following decades; debt reduction proceeded so far that the bonds available for security behind national bank notes became inadequate. The debt remained relatively constant in the 1890s and during the early 1900s. World War I brought an increase to $26,000,000,000, consisting in part of short-term and intermediate-term securities and in part of Liberty Loan bonds. In the 1920s the government was able to reduce the debt to a low point of $16,185,000,000 in 1930, primarily by use of budget surpluses. Interest costs were materially reduced through replacement of old issues by new ones at lower interest rates.

The 1930s brought budget deficits because of the depression and the efforts to stimulate recovery. Despite extensive borrowing, which raised the total debt to $42,968,000,000 by 1940, interest rates fell sharply as a result of the surplus of money capital and federal reserve action. A substantial part of the borrowing was on a short-term basis, partly because the interest on such loans was extremely low. With the outbreak of World War II, borrowing rose sharply and by 1946 the debt had reached $269,000,000,000. Substantial attention was given during the war to management of the debt with a view toward insuring a low interest rate, promoting the sale of bonds to individuals in order to minimize inflationary pressures, and obtaining an adequate supply of funds for the government. The treasury department sought to obtain maximum sales of savings bonds to individuals and stressed the payroll deduction system of sale. Interest rates were "pegged" for the war period, that is, the government essentially guaranteed that they would not rise, so that persons would not delay buying bonds in the hopes of higher interest rates in the future. Bond interest was held at 2.5%, except for the 2.9% figure on savings bonds and low rates on short-term securities. In practice it was necessary to borrow a substantial portion of the total (about 40%) from the banks and the federal reserve system, with consequent inflationary pressures.

In the postwar period the debt fell to a low of $252,000,000,000 in 1948, and then gradually rose to $296,500,000,000 by Dec. 1961. This increase was caused by budget deficits in a number of these years, arising primarily from a high level of defense spending and the unwillingness of congress to hold taxes high enough to meet this level. Some efforts were made to increase the portion of the debt represented by long-term bonds, but they were not pursued, largely because of the higher interest rates.

There were several controversial issues relating to the debt in the postwar years. One was the question of whether or not the federal reserve system should hold down interest rates in order to check an increase in government interest costs. Despite the fact that inflationary pressures called for higher interest rates, such a policy was followed until 1951, when, under an accord between the treasury and the federal reserve system, the rates were permitted to rise. The long-term bond rate ultimately reached a high of 4.72% in Jan. 1960, compared with the 2.5% figure of the pre-1951 period. By 1959 the treasury found it impossible to sell long-term securities at the maximum figure set by law (4.25%), itself a subject of controversy after 1958. By early 1961, however, a way out of the impasse had been found by adopting the practice of selling bonds at a discount.

The states incurred substantial debts in the early part of the 19th century, largely for public improvements, and some found themselves in financial difficulties. As a result, borrowing came nearly to an end until after 1900; after that date there was further borrowing, particularly for highways. After 1945 the state debt increased sharply and reached a total of $18,500,000,000 by 1960. Much of this additional borrowing was for highway purposes. The local governments have traditionally borrowed more than the states, largely because of the nature of their functions. Local debt in the 20th century increased steadily and had reached $51,400,000,000 by 1960. Table II shows the growth of federal, state and local debt in the United States.

TABLE II.—*Government Debt in the United States, Selected Years, 1902–60*
(in $000,000,000)

Fiscal Year	Federal	State	Local	Total	Total per capita
1902	1.2	.2	1.9	2.3	41.50
1913	1.2	.4	4.0	5.6	57.68
1922	23.0	1.1	9.0	33.1	300.49
1932	19.5	2.8	16.4	38.7	309.92
1934	27.1	3.3	15.7	46.0	363.86
1936	33.8	3.4	16.1	53.3	415.85
1938	37.2	3.3	16.1	56.6	436.00
1940	42.9	3.6	16.7	63.3	478.75
1942	72.4	3.3	16.4	92.1	683.13
1944	201.0	2.8	14.7	218.5	1,578.75
1946	269.4	2.4	13.6	285.3	2,018.20
1948	252.3	3.7	15.0	270.9	1,847.47
1950	257.3	5.3	18.8	281.5	1,855.74
1952	259.1	6.9	23.2	289.2	1,841.66
1954	271.3	9.6	29.3	310.2	1,909.84
1956	272.8	12.9	36.3	321.9	1,924.60
1958	276.4	15.4	42.8	334.6	1,931.20
1960	286.5	18.5	51.4	356.4	1,987.50

Note: Figures are those for the end of the fiscal year.
Source: U.S. Bureau of the Census, *Governmental Finances in the United States, 1902 to 1957; Governmental Finances in 1958;* U.S. Treasury *Bulletin.*

3. Canada.—Canada's debt began with $75,000,000 at the time of confederation in 1867, when certain obligations were taken over from the provinces. The figure grew slowly until 1915, in contrast to the reduction in the United States, largely because of government railroad financing. World War I pushed the figure to $2,200,000,000 by 1920; the total rose as the Canadian National railways was developed, fell slightly in the late 1920s, rose to $5,000,000,000 with depression borrowing, and reached $18,000,000,000 at the end of World War II. Some debt reduction was then attained and the figure fell to about $17,000,000,000 by 1950. By Jan. 1960 it had risen to $20,000,000,000 as a result of several years of deficits. The path of provincial and local borrowing in Canada was similar to that in the United States, though it had a much slower rate of growth.

4. Debt and National Income.—The absolute figures of growth in government debt tend to exaggerate the actual growth in the debt relative to the economy as a whole. In the first place, the general price level has increased significantly over recent decades; since the debt obligations are stated in fixed monetary terms, the relative magnitude declines as the price level goes up. The general rise in prices over a period thus reduces the problems created by the debt for the government, and the magnitude of the adverse effects of the interest payments on the economy. The gain occurs, of course, at the expense of the bondholders, whose real economic position is worsened by the change.

Secondly, the rise in national income reflecting an increase in output reduces still more the real significance of a fixed sum of debt for the economy, and the portion of national income which is affected by the interest payments. The combined effects of the real and monetary influences can be illustrated by expressing the size of the debt as a ratio to gross national product over a period of years. Data for the United States are shown in Table III. The ratio fell from 87% in 1947 to 44% in 1958, although the

TABLE III.—*Ratios of Publicly Held National Debt to Gross National Product and Net Interest Payments to National Income, United States, 1947–58*

Calendar year	Gross national product	Publicly held debt at mid-year*	Ratio of debt to gross national product	National income	Net interest paid by federal government	Ratio of net interest to national income
	(in $000,000,000)		(per cent)	(in $000,000)		
1947	234.3	203.7	86.9	198,177	4,167	2.1
1948	259.4	195.2	75.3	223,487	4,264	1.9
1949	258.1	195.2	75.6	217,690	4,400	2.0
1950	284.6	201.3	70.7	241,876	4,509	1.9
1951	329.0	191.3	58.1	279,313	4,709	1.7
1952	347.0	192.0	55.3	292,155	4,729	1.6
1953	365.4	193.8	53.0	305,573	4,846	1.6
1954	363.1	197.0	54.3	301,794	5,006	1.7
1955	397.5	200.3	50.4	330,206	4,920	1.5
1956	419.2	195.5	46.6	350,836	5,238	1.5
1957	442.5	192.0	43.4	366,503	5,632	1.5
1958	441.7	195.1	44.2	366,183	5,545	1.5

*Federal securities held outside U.S. government agencies and trust funds and the federal reserve system.
Source: U.S. Joint Economic Committee, Study Paper No. 19, *Debt Management in the United States,* p. 28, p. 31 (1960).

TABLE IV.—*Public and Private Debt Outstanding in the United States, 1947–58*
(in $000,000,000)

End of year	Total public and private debt*	Publicly held*			State and local government	Corporate	Individual and noncorporate	Ratio of federal to total debt (per cent)
		Total federal	Federal government	Federal agency				
1947	394.8	200.7	200.0	0.7	14.4	108.9	70.8	50.8
1948	410.3	193.2	192.2	1.0	16.2	117.8	83.1	47.1
1949	429.5	199.7	198.9	.8	18.1	118.0	93.7	46.5
1950	469.5	197.9	196.7	1.2	20.7	142.1	108.8	42.2
1951	500.2	194.7	193.4	1.3	23.3	162.5	119.7	38.9
1952	530.5	198.2	196.9	1.3	25.8	171.0	135.5	37.4
1953	560.5	202.2	201.0	1.2	28.6	179.5	150.2	36.1
1954	586.9	205.3	204.3	1.0	33.4	182.8	165.4	35.0
1955	647.4	206.7	204.3	2.4	38.4	212.1	190.2	31.9
1956	682.3	200.5	197.8	2.7	42.7	231.8	207.3	29.4
1957	711.8	200.2	195.6	4.6	46.7	243.9	221.0	28.1
1958	743.9	206.4	202.3	4.1	50.9	246.9	239.7	27.7

Note: Detail may not add to totals due to rounding.
*Federal securities held by government agencies and trust funds and by the federal reserve system not included.
Source: U.S. Congress, Joint Economic Committee, Study Paper No. 19, *Debt Management in the United States*, p. 29 (1960).

publicly held debt remained about the same in magnitude. The table excludes the debt held in government trust funds. The ratio of net interest payments to national income likewise fell, despite a rising interest rate level over this period. In Great Britain the ratio of national debt to gross national product fell from 221 in 1952 to 136 in 1958, although the size of the debt increased slightly over the period.

TABLE V.—*Gross National Debt of Various Countries and Ratios of Debt to National Income*

Country	Currency unit	Fiscal year*	National debt outstanding (in 000,000)†	Ratio of national debt to national income‡
Africa				
Egypt	Egyptian pounds	1957	330	...
Ghana	West African pounds	1958	17	6
South Africa	South African pounds	1957	1,062	59
North America				
Canada	Canadian dollars	1958	18,368	77
Costa Rica	colones	1957	406	21
El Salvador	colones	1955	24	...
Guatemala	quetzales	1957	45	8
Haiti	gourdes	1957	270	17
Honduras	lempiras	1957	28	5
Mexico	pesos	1956	4,705	6
Panamá	balboas	1957	55	22
United States	dollars	1959	284,706	71
South America				
Argentina	pesos	1956	73,395	49
Bolivia	bolivianos	1953	37,484	...
Brazil	cruzeiros	1956	156,276	21
Chile	pesos	1955	32,400	4
Colombia	pesos	1957	1,213	10
Ecuador	sucres	1957	1,070	11
Peru	soles	1957	5,909	...
Venezuela	bolivares	1956	27	§
Asia				
Burma	kyats	1955	602	15
Ceylon	rupees	1957	1,123	22
Malaya	Malayan dollars	1956	766	...
India	rupees	1959	47,761	27
Iran	rials	1958	32,859	...
Japan	yen	1958	487,000	6
Philippines	pesos	1959	1,662	18
Thailand	baht	1957	5,809	14
Turkey	liras (Turkish pounds)	1958	4,904	16
Australasia				
Australia	Australian pounds	1958	3,982	86
New Zealand	New Zealand pounds	1958	787	82
Europe				
Austria	schillings	1958	16,187	11
Belgium	fraocs	1957	323,721	78
Denmark	kroner	1957	8,848	33
Finland	markkaa	1957	169,000	19
France	francs	1957	7,010,000	45
Germany (west)	deutschemark	1958	21,436	12
Greece	drachmas	1956	9,285,300	14
Ireland (Eire)	Irish pounds	1957	352	76
Italy	lire	1958	5,047,200	40
Netherlands	guldens (guilders)	1956	18,461	70
Norway	kroner	1957	7,801	33
Portugal	escudos	1956	11,718	24
Spain	pesetas	1956	126,486	41
Sweden	kronor	1958	18,362	35
Switzerland	francs	1957	6,864	25
United Kingdom	pounds	1959	27,458	155

*Debt figure given is that for the end of the fiscal year indicated.
†Expressed in units of the native currency.
‡For 1957, except for those countries for which the debt figure is for a year prior to 1957; for these, the ratio is that of the year for which the debt figure is given.
§Under 1%.
Source: United Nations, *Statistical Yearbook* (1958). Detailed explanation of the items included in various countries can be found in this source.

Another measure of the relative magnitude of the national debt is that of the ratio of total national debt to all debt in the economy—governmental, corporate and private. The data for the United States from 1947 to 1958 are shown in Table IV; during these years the ratio of national debt to total debt fell almost by one-half.

5. Magnitude of Debt in Various Countries.—An adequate comparison of debt burdens in various countries is difficult to make. The reported figures are by no means entirely comparable because they vary in their treatment of debt incurred for various commercial enterprises, loans from foreign countries, special issues and the like. The relative importance of the national debt and the debt of subordinate units of government also varies, and figures for the latter are not available for many countries. Any comparison of absolute figures of debt in monetary terms is of limited value and may be very misleading because of problems of conversion to a common monetary unit. The only meaningful figure is the ratio of national debt to national income, and the significance of these figures is greatly lessened by the inaccuracy of national income data for many countries. In others the figures have never been compiled. Figures of national debt and of the ratios of debt to income are shown in Table V.

III. THE ECONOMICS OF PUBLIC DEBT

An understanding of the effects of government debt on the economy is essential as a basis for the evaluation of policies concerning borrowing, debt management and debt retirement. It is important to distinguish the effects of the borrowing, as such, from the effects of the debt itself, once incurred, and from the effects of the retirement of the debt. Each aspect will be discussed in turn.

1. Effects of Borrowing.—The effects of borrowing are dependent in part upon the source of the funds; a sharp distinction must be made between borrowing from the central banking system (the Bank of England in Great Britain and the federal reserve system in the United States) and borrowing from other sources. The former, which essentially involves the creation of money and is closely related to the printing of paper money, will be discussed below. The term borrowing as used in this section, unless otherwise indicated, refers only to borrowing from sources other than the central bank.

Borrowing transfers purchasing power in the form of cash or bank deposits from the lender to the government. Thus the act of borrowing is deflationary in that it tends to reduce total spending in the economy. The magnitude of this effect depends, of course, upon the extent to which the funds would have been spent, either on consumption or on business expansion, had the money not been borrowed by the government. If the funds would merely have been held idle, the borrowing has no contractionary influence. But if people reduce consumption to buy government bonds, as they may do if the government conducts an extensive savings bond drive, or if the effect of the government borrowing is to tighten the money capital market and reduce the funds for private investment, some reduction in total private spending in the economy will occur.

However, if comparison is made between the financing of government expenditures by borrowing and financing them by taxation, almost certainly the borrowing method has less effect in reducing private spending than the taxation method. On this basis it is usually maintained that borrowing is an inflationary method of financing government—relatively, that is, compared with taxation. There are two primary reasons for this difference. In the first place, taxation, by its compulsory nature, will force some persons to curtail consumption or spending for business expansion when they prefer not to and would not do so merely because the government was selling additional bonds. To a much greater extent government bonds will be purchased with funds which would have been saved in any event, and much of which would not have been used, at least directly, for business expansion. Secondly, the purchase of bonds does not reduce the net wealth of the lender, since he has merely substituted bonds for cash. Thus he does not feel himself poorer, as he would if he had been taxed an equivalent

amount, and is less likely to reduce his total spending. If the government borrows from commercial banks at a time when they have excess reserves, the banks can extend the loans to the government without any curtailment of private lending, and thus there is no net reduction in spending at all, although the banks' future lending capacity is reduced.

If the over-all effect of the government expenditure and borrowing program is considered, the net effect is likely to be expansionary, that is, to increase national income in real or monetary terms. The expenditure by the government represents a net addition, in full, to total spending, while, as noted, the borrowing is likely to reduce spending by an amount less than the total borrowed, since some will be absorbed from idle funds. On this basis, government borrowing is often said to be inflationary. However, it is important to note that it is not the borrowing that is inflationary but the expenditure of the funds obtained from borrowing.

There is one exception, however, to the rule that borrowing, in itself, is not inflationary. If the government borrows from the central banking system, the amounts involved are simply created by the central bank, being credited to the account of the government. When the government spends the money, the amounts will become reserves of the commercial banks, and thus the banks will be able to increase loans. This type of borrowing, as well as the expenditure of the money by the government, is inflationary. It is not basically different from the printing of additional paper money. Accordingly, in the United States, its use is specifically prohibited by law. By contrast, it has been widely employed in Great Britain. Even in the United States, however, when the government has sold bonds, the federal reserve system has often simultaneously bought government securities in the open market in order to prevent the interest rate from rising. This practice was common during World War II. The net effect is exactly the same as if the bonds were sold directly to the federal reserve system, the only difference being the one of appearance. By such a policy any effect that borrowing might have in checking business investment by lessening the supply of money capital is eliminated, and thus all or almost all of the anti-inflationary effect of the borrowing of the funds.

Two other effects of government borrowing may be of importance in certain periods. First, government borrowing, which involves an exchange of cash for bonds, lessens the liquidity of the lenders; it places their wealth in a form that is not so readily spent, even though their net wealth is not reduced. Secondly, if heavy government borrowing is regarded as undesirable and irresponsible, it may lessen confidence in the future and reduce both business and consumer spending. This effect is most likely to occur in a severe depression when pessimism about the future is widespread anyway.

In summary, a program of government expenditures financed by borrowing is almost certain to be expansionary, except in the unlikely case that the fear of the borrowing causes such a severe loss in business confidence as to offset the other influences. The expansionary effect is likely to be greater than that of a similar program of expenditures financed by taxation. Total spending will tend to rise; thus, in a depression, when unemployment exists, real national income will tend to rise. In a period of full employment the general price level will increase. However, the expansionary influence is less than would occur if the program were financed by the issuance of paper money or borrowing from the central bank, since these policies in no way reduce private spending, whereas usual borrowing will do so to a limited degree.

2. Economic Effects of the Debt Itself.—Distinct from the effects of borrowing on the economy are those of the debt itself. One basic principle must be noted initially; the existence of a domestically held debt does not reduce or increase the net wealth of the country. The debt may have certain effects on the operation of the economy, and thus may affect national income levels indirectly. But in itself it does not alter the over-all wealth. The bonds represent obligations of the government, and thus of the taxpayers. They constitute personal wealth of the bondholders. Thus they do not constitute a portion of the real wealth of the country, since their value as personal wealth is offset by the obligations against the taxpayer. Or, in reverse, the obligations of the taxpayers are offset, from the standpoint of society as a whole, by the personal wealth in the form of the bonds held by the bondholders. If the debt had never been incurred, and the government expenditures had been financed by taxes instead, the bonds would not exist, but neither would the obligations of the taxpayers. The real wealth of the country consists of material objects which convey benefits to the people of society and, in a broad sense, knowledge and skill of the people; the total amount is not affected, except indirectly, by the presence or absence of government debt outstanding.

However, the government debt does have important effects upon the functioning of the economic system. In the first place, since the bondholders consider the bonds as personal wealth, they regard themselves wealthier than they would if the debt had not been incurred and the expenditures had been financed by taxation. Thus they may be inclined to spend a higher percentage of their income on consumption; saving is less imperative because of the larger accumulated reserve which they feel that they have. If all persons regarded the sum of their future tax liabilities in the same fashion, the wealth element represented by the bonds would be offset by these. But they normally do not do so. The net effect is to increase somewhat the total percentage of national income spent on consumption, and to raise the real level of national income or the general price level.

Secondly, the existence of the bonds places the holders in a more liquid position because this portion of their wealth can readily be converted into cash. They can increase their spending quickly if they choose to do so. The existence of this liquid reserve is an important factor in lessening the decline in spending at the outbreak of a depression, and is in this sense a stabilizing element in the economy. It is one of the few significant advantages offered by the existence of the debt.

The debt also places financial institutions, and particularly commercial banks, in the position of having highly liquid assets that can be converted to cash in order to increase reserves and expand lending. Thus they can largely escape from central bank credit restriction policies, unless the central bank is willing to allow government bonds to drop well below par. But the existence of a large debt makes the government unwilling to see bond prices drop because it will have to pay a higher interest rate on new issues as old ones come due and must be refunded. From 1945 until 1950 in the United States the treasury department succeeded in ensuring that the federal reserve system did not allow bond prices to drop, and thus may have aggravated inflationary pressures during this period. After 1932, the year of the 3½% conversion loan, Great Britain pursued a policy of low long-term government rates. Such a structure was, however, essentially artificial and was abandoned in 1952 when the weapon of the bank rate was again brought into operation.

In contrast to these expansionary effects of the debt, in one respect a debt may have dampening effects on the economy, particularly during periods when there is some tendency toward unemployment. If fear of the possible adverse effects of the debt upon the economy becomes widespread, total spending, especially by business firms for expansion of plant, may be reduced. The fears may be vague and largely unfounded but nevertheless may have a significant influence upon the economy. They are most marked in a period of depression when businessmen are pessimistic anyway, as evidenced by attitudes during the 1930s. During prosperous periods, fears of the debt tend to disappear.

Other effects of the debt arise from the interest obligations to which it gives rise. The annual payments for interest on the national debt in the United States in the 1960–61 fiscal year were roughly $9,600,000,000 or 11% of the total budget; state and local government interest was about $1,300,000,000 in 1959. Great Britain's interest payments constituted 12% of the total ordinary budget expenditures in 1959; Canada's were 9%. These interest payments (unless met from continued increases in the debt, a practice normally considered to be undesirable if not disastrous) must be covered by higher tax revenues. There are three undesirable consequences. The additional taxes may have certain ad-

verse effects on the economy, particularly in impairing incentives for work and business development which are not offset by the receipt of the funds by the bondholders. The net effect of the payments is likely to have a dampening effect on total spending, since the bondholders are, on the average, likely to spend a smaller percentage of the sum than the taxpayers would have. This is an advantage, of course, in inflationary periods. Heavy interest charges tend to restrict government expenditures for other functions, which may be extremely important to the welfare of society.

On the whole, therefore, under most conditions the net effect of the debt is without question undesirable, particularly because of the effects in furthering inflation on the one hand and hampering incentives (through the taxes necessary for interest payments) on the other. The only significant merit is the cushioning effect on the decline in spending that occurs when a depression starts. This effect could, of course, be obtained in other ways. One additional merit has frequently been advanced: the existence of the government debt provides a particularly suitable outlet for the savings of persons in the lower income groups for whom security and liquidity are very important, and a secondary reserve for banks. These functions could, of course, be served by far less debt than most governments had outstanding in the early 1960s. Closely related is the argument that the existence of a large national debt facilitates the conduct of central bank credit control by providing suitable media for open-market activities, the ramifications of these activities being widespread when the debt is widely held.

3. Effects of Debt Retirement.—The effects of debt retirement are in large measure the reverse of those of borrowing. Retirement is possible, of course, only if tax revenues are sufficiently high to produce a surplus over current expenditures. The retirement in itself is expansionary, since purchasing power is transferred from the government to the bondholders. Some of this is likely to be spent, although the percentage thus used is not likely to be high. To the bondholders the repayment of the bonds does not represent income but merely a change in the form of their capital. The bulk of it will probably be reinvested in other securities rather than be used for consumption, though some holders are likely to use the money for consumption once it is returned to them. The exact effect depends, of course, upon the nature of the holders of the bonds that are repaid; if the holders are banks they naturally cannot spend the money on consumption. However, even if the money is not spent on consumption, the debt retirement may stimulate spending for business expansion. The funds repaid will be used in part to purchase other securities; this will tend to drive the security prices up and thus make borrowing cheaper. The general increase in the supply of money capital will tend to facilitate private borrowing. The only exception is the repayment of bonds held by the central bank; this has the effect of reducing bank reserves and thus in itself is deflationary.

If the over-all program of debt retirement and the budget surplus necessary to provide the funds for retirement are considered, the net effect is clearly deflationary. The taxes will exercise a dampening effect on total spending; as noted, the net expansionary effect of the receipt of the funds from the retirement of the bonds is limited at best. As a consequence total spending in the economy is almost certain to decline. The net effect depends upon the types of taxes imposed to provide the surplus, the nature and reaction of the bondholding groups to the use of funds, and the responsiveness of business expansion to increased availability of money capital.

4. Debt Burden on Future Generations.—It has long been argued that the financing of governmental activities by borrowing results in the transfer of the costs of the activities from present to future generations, since persons in these generations must pay higher taxes to meet interest and principal obligations. This argument is generally regarded by economists as invalid. Future generations inherit both the bonds and the obligations to pay them; they are thus neither richer nor poorer than they would be if the debt had not been incurred, except as a result of the difficulties incident to the debt and its retirement noted in preceding sections. The real cost of any governmental activity, war or otherwise, is borne in the form of reduced consumption and investment, harder work and the like during the period in which it is carried on, regardless of the methods of financing. The only burden on the future is that arising from the depletion of natural resources or slower rate of investment, and these are not affected by the method of financing used.

In recent years, question has been raised about this principle, and some writers have stressed the adverse effects on future generations arising from the effects of the taxes necessary to pay interest, and the inflationary influences. At least one economist, J. M. Buchanan, has gone beyond this to argue that there is a real burden on the future generations when the debt is repaid, because the taxpayers suffer a net loss, yet the bondholders experience no gain because they merely exchange their bonds for cash. But this argument ignores the fact that standards of living, as usually defined, depend upon actual goods and services available, and these are not reduced by the process of debt repayment, except from secondary effects as noted.

The argument of the two preceding paragraphs is applicable, of course, only to domestically-held national debt. Foreign-held debt gives a claim to foreigners against national output; payment of interest and principal requires export of goods and thus a reduced domestic standard of living. Similar reasoning applies to state or local debt held outside the community; payment of interest and principal constitutes a decline in the real incomes of the people of the area as a whole, and thus the burden was effectively shifted to future generations when the original activity was financed by borrowing.

IV. SHOULD GOVERNMENTS BORROW?

Traditionally, borrowing has been regarded as an exceptional source of revenue to be employed only when specifically justified by the circumstances of the case. By contrast, taxation has been considered to be the normal source of government revenue to be employed in all instances except when conditions warrant the use of borrowing. Accordingly, the case against borrowing will be discussed first.

1. Objections to Borrowing.—The traditional argument against borrowing is, of course, the interest burden to which it gives rise, an argument equally applicable to private and government borrowing. The interest obligations require either higher levels of taxes, with possible adverse effects upon the economy, or lower expenditures for other purposes. The payment of interest may easily result in a transfer of purchasing power in favour of the higher income groups, contrary to accepted standards of equity in income redistribution.

As noted in the preceding section, the financing of expenditures by borrowing instead of taxation, and the debt itself, once incurred, tend to produce inflationary effects in periods of full employment because they increase total spending. With full employment, any increase in government expenditures not offset by an equivalent decline in private spending for consumption or business expansion will lead to inflation. Thus, since borrowing is less deflationary than taxation, the financing of the expenditures by borrowing will encourage inflation. This is the basic argument against the use of borrowing instead of taxation from the standpoint of the goal of economic stability. It is primarily relevant to national government borrowing because the national government must assume the primary responsibility for lessening economic instability. But state and local borrowing is, of course, equally inflationary.

Borrowing, if freely employed, can easily lead to increases in government expenditures beyond levels regarded by society as the optimum, and may reduce the pressures for efficiency and elimination of waste. As governments consider expenditure levels, the adverse reaction to taxation serves as an offset against the favourable response to the services and facilitates the attainment of a balance between government-produced services and privately-produced services. But if borrowing replaces taxation, and is generally accepted as a suitable routine method of financing, the pendulum will swing in the direction of increased governmental

activity, and appropriate balancing is lost. The best evidence of this danger is to be found in the history of state and local government finance in the early 19th century in the United States when large sums of money were borrowed for purposes of limited usefulness to society. The basic trouble with borrowing is its relative painlessness, so long as people disregard the future consequences.

There is always the possibility that a government may accumulate so much debt that it will lose the confidence of the people and will possibly reach the point where it cannot meet its obligations. Loss of confidence will make borrowing of additional funds in an emergency difficult, and may check economic development by lessening optimism on the part of businessmen toward the future. If a government goes so far into debt that it cannot meet its obligations, its credit is seriously impaired. A national government, with its extensive taxing potentialities and its control over the banking system, could scarcely find itself in a position where it could not meet interest obligations or be able to sell bonds. But if the debt exceeded certain levels the government might be unable to sell bonds extensively to individuals, and thus might be forced to resort to borrowing from the central bank, the most inflationary form.

These arguments constitute a very significant case against general reliance on borrowing. The case against it is particularly strong in periods of full employment; for the local governments beyond levels at which interest can be met easily from current sources; and in all circumstances in which governments are relatively irresponsible with regard to future problems created by present policies.

2. The Case for Borrowing.—There are three primary circumstances in which government borrowing is usually regarded as justifiable:

a. In a period of unemployment and depression, the basic argument against the use of the borrowing method—that it tends to generate inflation—is not relevant. Any expansionary effect which the financing of the government expenditures by borrowing instead of taxation may have will tend to bring about an increase in output rather than an increase in the general price level. Accordingly, the use of borrowing may be regarded as justifiable, in terms of the goal of lessening the severity of depressions and attaining greater economic stability. However, the other objections against borrowing remain, and suggest the need for keeping a restraint on the borrowing, particularly at the state and local levels. Some persons regard these objections as serious enough to overrule the justification for depression borrowing as a means of encouraging recovery. But this has become a minority point of view. Avoidance of borrowing in a severe depression would require sharp curtailment in activities and an increase in taxes. These would not only aggravate the depression but would be politically intolerable. Even if the point of view that governments cannot succeed in bringing recovery from depression by deliberate action is accepted, it must be recognized that some national government reliance on borrowing in depressions is inevitable and justifiable to avoid aggravating the depression.

Some persons have argued that in depressions the national government should not finance its expenditures by borrowing but should rely on the issuance of paper money. This method would avoid such limited contractionary effects as borrowing would cause and would avoid interest burdens and other difficulties created by the debt. However, this method of financing is such a painless one that once governments begin to rely upon it there is danger that they will not discontinue it after economic conditions have changed. The result would be disastrous inflation. Furthermore, the use of the method, even if not carried to the point of abuse, could easily cause general loss of confidence in the government, increase pessimism about the future and check business investment still more. Actually, the same advantages can be attained with much less danger by borrowing, directly or indirectly, from the central banking system.

b. The use of borrowing is regarded as inevitable in periods of major war. If taxes were increased sufficiently to finance all war costs they might seriously impede the war effort, both by impairing incentives to work and reducing over-all morale of the people. The limits of taxation that are economically and politically tolerable may well be below the sum that represents the maximum feasible allocation of resources to war effort. To go further would interfere with the primary goal of such a period, the winning of the war. Similarly, adequate tax increases would aggravate the inequities of the tax structure; an over-all level that would reduce total consumer spending to a level equal to the rate of output of consumer goods might well push some persons below subsistence levels and make it impossible for others to meet fixed commitments. Use of borrowing as a method of war finance makes the control of inflation more difficult. But there appears to be no escape from this policy.

c. When governmental activities require capital outlays far in excess of usual expenditures and of a nonrecurrent character, borrowing is not only virtually imperative if the outlays are to be made, but is entirely justifiable. This rule is of primary concern to the local governments because at the federal and state levels the ratio of nonrecurrent expenditures to total expenditures is such that tax financing is possible without undue fluctuation in tax rates or hardships to taxpayers in particular years. But local governments must often make expenditures far in excess of usual annual figures on projects that will last over a period of years. Failure to use the loan method will tend to reduce expenditures for such purposes below the optimum level because taxpayers will strongly fight such sharp increases in taxes, particularly when the capital outlay will benefit taxpayers in future years. The case is particularly strong for self-liquidating projects such as power or water system expansions, but is valid even when the outlays are to be paid off out of tax revenues. It must be emphasized that the characteristic feature justifying the use of borrowing is the nonrecurrent element; the mere fact that the object of a particular expenditure will last a number of years is not in itself a justification if roughly the same amounts will be spent each year. If a city is to repave 20 blocks of streets annually, there is no need for borrowing, and a good case can be made against it, even if each particular repaved street may last 25 years.

A final justification for borrowing, relevant only to short-term loans, is a lack of exact correlation in the time when revenues are received and expenditures made. Unless a government is to build up a surplus, it must borrow occasionally to meet expenditures at a date earlier than the receipt of the tax revenue.

3. Debt Limitation Laws.—Although excessive borrowing should be regarded with some anxiety, no limitations are imposed in Great Britain on the borrowing powers of the central government. In the United States, however, fear of excessive government borrowing has resulted in placing restrictions on the amounts the executive and even the legislative branches of government can borrow. Many states found themselves in financial difficulties after they borrowed heavily to provide funds for canals and railroads in the middle of the 19th century, and as a consequence provisions were written into the constitutions of nearly all states to prevent or restrict further borrowing. The provisions limiting borrowing vary widely. In most states a maximum, usually expressed as an absolute dollar sum and relatively low in terms of present-day expenditure levels, is set. Either this figure cannot be exceeded at all (except by amending the constitution), or it can be exceeded only with approval of the voters at an election. In some states all bond issues require approval by popular vote and in some instances more than a bare majority is required. Purposes for which funds are borrowed and the duration of the issue are also frequently restricted. These constitutional restrictions have unquestionably lessened state borrowing; in so doing they have, perhaps, reduced waste but they have also sometimes prevented urgently needed improvements. The limits have likewise greatly increased the use of revenue bonds, which are normally not subject to the restrictions. Unfortunately, the interest rate on these bonds is higher than the rate on other bonds.

Restriction on local borrowing is almost universal in the United States. The restrictions, established either in the state constitutions or by state legislation, limit the total sum to be borrowed by any particular unit to a certain percentage (from 2 to over 20)

of the total assessed value of its property. The limits vary for different types of local units (city, county, school district, etc.). They usually do not apply to debts incurred for self-liquidating enterprises. In many states every bond issue must be approved by popular vote, in some instances by a two-third majority. In other states the limits established may be exceeded by popular vote, often with a requirement beyond a mere majority. Legislation also controls the maximum interest rate, duration of the issues, purposes of borrowing, establishment of means of retiring the bonds, etc. Several states exercise review over local bond issues, but only North Carolina requires specific state approval of all issues. Like the states, the local governments have found means of escaping the restrictions. Special districts with their own debt limits are often formed when a city has reached its limit. Revenue bonds are also employed. In some states, such as Pennsylvania, there has been widespread creation of special authorities.

A special school building authority, for example, is established with the power to finance the building of schools by issuing revenue bonds. In turn, the authority pays interest and principal on the bonds from rentals obtained from the school districts for the use of the buildings.

There are no constitutional limits on federal borrowing powers in the United States. But for many years congress has restricted borrowing by the treasury department. Before 1917 borrowing was permitted only upon specific authorization by congress. After 1917 maximum figures were set, at first for each type of loan, and then, after 1938, as an over-all total. The 1938 figure of $45,000,000,000 was gradually increased to a high of $300,000,000,000 in 1945, and reduced to $275,000,000,000 in 1946. The limit remained at this figure until 1954; there was strong pressure in congress against an increase, under the philosophy that failure to raise the limit would check growth in government spending. But eventually pressure on the limit became so great that various government activities were forced to borrow on their own at higher interest rates, and finally an increase was made, ultimately, to $295,000,000,000, the figure in effect in the early 1960s. Experts differ in their estimates of the usefulness of the federal limit. Some believe that it curtails government waste and unjustified increases in expenditures while others argue that it reduces flexibility in meeting emergencies, checks needed increases in various activities, prevents quick action to stave off a depression and leads to uneconomical forms of borrowing.

In Canada, the dominion and provincial governments are not subject to debt limitations. The local government limits are comparable to those in the United States, and in several provinces bond issues must receive approval of a provincial agency. In Great Britain, borrowing by local governments is subject to control, specifically by the ministry of health, and limits are usually established in terms of a ratio of debt to total ratable value (assessed value of property). After World War II much local borrowing was channeled through the Public Works Loan board, and thus was subject to additional control.

V. DEBT RETIREMENT POLICY

The question of the desirability of debt retirement must be considered separately for the national government and for the state and local governments.

1. National Debt.—Retirement of the national debt has the obvious advantage of eliminating the undesirable features noted in an earlier section: the adverse effects of the taxes necessary to pay interest; the redistribution of income resulting from interest payments of a nature often regarded as undesirable; the inflationary effects of the debt under certain circumstances; and the confidence-disturbing effects, which are of particular importance in a depression. Furthermore, the over-all program of a budget surplus and debt retirement tends to exert a deflationary influence on the economy and aids in checking inflationary pressures. It is true that a program of accumulating a budget surplus without retirement of debt, the surplus merely being held, would exercise still more anti-inflationary pressure, but such a policy is not usually regarded as feasible, politically or otherwise. Furthermore, the accumulation of surpluses without debt retirement tends to bring increases in government expenditures; it is politically difficult for a government to maintain an accumulated surplus for any length of time.

Debt retirement is also likely to increase the rate of capital formation in the country, that is, the rate of growth in investment in business expansion, so long as full employment of resources is maintained. The taxes necessary to provide the funds for retirement will tend to reduce consumption to some extent, while the sums paid out to the bondholders will be made available, in large measure, as money capital for business expansion. The net effect is to reduce the percentage of total national product used for consumption and increase the percentage used for expansion of the economy.

However, retirement of the national debt is subject to certain objections. Because of the deflationary effect of the over-all program, maintenance of a rigid program of retirement regardless of business conditions could easily produce a decline in business activity, which, in turn, would make further repayment virtually impossible for the duration of the depression. If the goal of economic stability is regarded as important, substantial retirement is possible only in years of inflationary pressures. Thus, as a rule, no systematic, year-by-year program of retirement is now attempted by national governments, although occasionally arguments are advanced for this approach. The other objection is that if taxes are kept high enough to ensure a budget surplus for debt retirement each year, current activities of government may be held down below what may be regarded as the optimum level. The strong popular resistance to tax increases beyond certain levels may result in the debt retirement program being carried on at the expense of urgently needed current activities of government, rather than through higher taxes. Certain other arguments are advanced against retirement. The bulk of the debt in the U.S. was incurred for the conduct of wars; since the benefits from these wars extend indefinitely into the future, it may be argued that no one generation of taxpayers should be made to shoulder the burden of debt retirement. Closely related is the argument that continued expansion in the economy will gradually reduce the significance of the debt, and thus failure to retire it is no cause for alarm.

If a program of debt retirement is carried on as part of an anti-inflationary program, the net effectiveness of the program will be influenced by the nature of the debt retired. Maximum effect is obtained by retirement of debt held by the central banking system, since the repayment creates no inflationary influence at all and, by reducing reserves of the banks, will tend to check bank lending. Retirement of debt held by the commercial banks will produce the next best results; while the banks' reserve positions are improved by the retirement, it is likely that they may not extend new loans to the extent of the debt retirement because other investments will be less liquid than the government bonds and the banks will feel obligated to hold greater reserves.

An alternative to debt retirement at the national level is monetization of the debt; that is, payment of the debt by new monetary issues. This policy would, of course, seriously aggravate inflation in a period in which there is a tendency toward inflation. In a period of depression, however, business activity would be stimulated and the burdens created by the debt would be lessened. Such a policy is rarely endorsed for the same reasons that this alternative is not favoured as an initial source of revenue in lieu of borrowing noted in the preceding section. If there were complete assurance that governments would not overissue money and the policy of monetization would not cause general loss in confidence, this alternative would be worthy of consideration.

A final alternative for the national debt is direct repudiation. Since a sovereign government cannot be sued without its permission, it can cancel outstanding debt without legal interference if it wishes. Such a policy has, in fact, usually been followed only when a government has been overthrown by revolution and the new government has disavowed the debt of the old, as occurred after the fall of the tsarist regime in Russia. Under ordinary circumstances such a policy is not seriously contemplated, because of the injustice to the bondholders that would result, the loss of

prestige by the government, and the difficulty of selling bonds in the event of need for borrowing in the future.

2. State-Local Debt Retirement.—The question of retirement of the debt of units of government subordinate to the national level, such as the states and local governments, must be considered in light of somewhat different factors, and the case for retirement in a systematic fashion is much stronger. These debts are incurred primarily for the financing of capital improvements with a limited life. If they are not retired over the period of use of the improvements, burden will rest upon generations of taxpayers who no longer enjoy the benefits of the improvements. Furthermore, failure to retire debt will soon get a state or local government into a position where it cannot borrow for new improvements because the total amount of debt has reached levels beyond the capacity of the government, at tolerable tax rates, to meet interest payments. The point may be reached at which actual default occurs. These levels of government are not faced with the same degree of responsibility for maintaining economic stability as is the national government.

In view of these factors, state and local bond issues normally provide for a systematic program of retirement; state law generally requires that the local governments take this action. The length of life of the bonds is limited to the expected life of the improvements. There are two systems for retirement. The older, the sinking fund system, requires that during each year of the life of the issue the government make payments into a sinking fund; the interest on the accumulating sums, plus the original payments, will be sufficient when the bond issue matures to pay it off in full. But unfortunately sinking funds are sometimes tapped for other purposes, and payments into them are not always made. As a consequence, governments have tended to shift to the alternative, the serial bond system. The maturity dates of serial bonds are spread over a period of years, a certain amount falling due each year. The issue is thus redeemed gradually, without the establishment of a sinking fund. Originally investors were inclined to resist this approach, but by the 1960s it had become more or less standard in the United States and other countries.

The states of the United States have the power to repudiate debts if they wish, since they have inherent sovereign powers. On two occasions, the most significant being in the south after the ousting of the carpetbagger governments following the American Civil War, states have repudiated debts outright. The local governments, however, being technically corporations and not sovereign governments, have no sovereign powers and thus can be sued and cannot repudiate debt. If they attempted to do so, legal action could be taken to enforce payment.

Distinct from the question of outright repudiation is that of unintended default. In the 1830s and again in the 1930s, several states of the U.S. and provinces of Canada and large numbers of municipalities were unable to meet their obligations at tax rates that were politically acceptable. In 1935 in the United States over 3,000 municipalities were in default. So far as the states and the Canadian provinces were concerned, the bondholders could not take legal action and simply had to wait until tax collections improved. At the municipal level, legal action was possible, as provided by state law; in some instances bondholders could obtain a court order requiring the levying of additional taxes. In other instances this was either impossible or futile, given the depressed conditions of the period. In four states provision was made for a state agency to assume administrative receivership of municipalities in default to straighten out their finances. In 1934 congress enacted a Municipal Bankruptcy act that provided for a revision of local government debts under court supervision, with concurrence of various percentages of the debt holders. The original law was held unconstitutional but a new law enacted in 1936 was upheld.

Government bondholders can never foreclose on government-owned property in the event of default and normally cannot proceed against the property of taxpayers or municipal officials, except to a limited extent in the New England states. It is significant that in Great Britain in the 1930s, where the depression caused acute distress, no local authority defaulted.

VI. DEBT MANAGEMENT

Distinct from the question of the desirability of borrowing or of debt retirement is that of debt management, or the choice of policies relating to the composition and nature of the debt, as contrasted to the amount of the debt. Debt management involves two separate but related aspects. The first is that of the nature of new security issues; the second deals with conversion or refunding of existing securities.

1. Policies on New Borrowing.—Governments are confronted with a number of alternative courses of action when undertaking new borrowing. The basic general rule for subordinate governments is that of adjusting the borrowing in such a manner as to minimize interest and other costs. National governments must strike a balance between low interest costs and attainment of the goals of economic stability. The precise policies that must be followed in light of this objective will depend on the relative importance attached to the interest and economic stability goals, the relative effectiveness of monetary policy and other methods of attaining economic stability, and the state of business conditions. Policies appropriate for depressions are clearly different from those suitable for inflationary periods. While the principles themselves are widely accepted, there are serious problems of interpretation of them in specific cases.

One question, of concern only during a severe emergency such as a major war, is the choice between voluntary and compulsory loans. Canada, Great Britain and other countries used a compulsory lending program to some extent during World War II; the United States considered it but relied on the voluntary approach. The compulsory system is undoubtedly more deflationary, per dollar obtained, since a greater amount of the money comes from persons who would otherwise spend it. But it is much less acceptable politically.

Compulsory lending offers several advantages over tax increases of equivalent amounts. Because the sums will eventually be paid back, the political opposition to the program and the possible adverse effects on incentives will be less than with tax increases. The program may be more equitable than a tax increase for the lower income groups because the over-all final burden may be distributed to a greater extent on the higher income level than would be possible with the tax increase. The return of the funds might cushion a postwar depression. However, in neither Great Britain nor Canada was the wartime experience very satisfactory, largely because the taxpayers regarded the payments essentially as another tax, not as savings which they would ultimately get back, and therefore the hoped-for advantages were largely lost.

Compulsory lending must be distinguished from a true compulsory savings program. The former method requires persons to place a certain amount of money (usually related to income) in government bonds each year. The latter method requires persons to save a certain amount during the year and place it in government bonds. A compulsory savings plan has not been attempted because of problems of enforcement. Liquidation of existing assets to offset the new saving and thus defeat the intent of the program would be very difficult to detect. But if the program could be made effective it would be much more anti-inflationary than even a compulsory lending system.

If borrowing is to be voluntary, is it desirable, in a period in which borrowing is necessitated by war or high defense spending, to appeal to persons to buy bonds on patriotic grounds? During and after World War II, the U.S. government followed this program extensively, particularly to get the bonds into the hands of individuals rather than banks and thus to minimize inflationary pressures. In a severe emergency such a program may have merit, but it is difficult to maintain the "crisis" atmosphere indefinitely. If, however, persons can be induced to commit themselves to buy bonds on a payroll deduction basis, the forces of inertia are placed on the side of recurrent bond purchases and the net effect may be to increase materially the total purchase of bonds by the lower-income groups, and reduce consumer spending.

The national government can influence to a considerable degree the extent to which the bonds are acquired by different types of purchasers. It may borrow directly from the central bank if it

wishes and the law permits; it may borrow from the commercial banks by direct sales of bonds to them, and can in fact exert strong pressure on them to buy if it wishes; it may sell to individuals, even restricting bank purchases of the issues. The choice of lender depends in large measure of the state of economic activity. In a period of depression, the goal is that of obtaining the funds with the least possible contractionary effect on individual and business spending. Thus sale of bonds to the central banking system is the most advantageous, although governments have been somewhat reluctant to follow this practice because it so closely resembles the issuance of paper money, and might cause loss of confidence in the government. Sale to commercial banks, which usually have excess reserves in depressions, is almost as good, but gives rise to greater interest cost and places the banks in a highly liquid position when prosperity returns. This result makes control of their lending policies by the central bank difficult.

In a period of full employment and inflationary tendencies, the goal is the reverse—to borrow in such a manner as to restrict private spending to the maximum extent. Thus during World War II governments stressed their savings bond programs. Since it was impossible to obtain adequate funds from these sources, some reliance on other sources was necessary. Sale to the banks tends to reduce their lending power to private business under conditions of tight money and thus has some influence in reducing total spending. Sale of bonds to the central bank is in some ways the most objectionable since it not only does not reduce spending at all but actually increases commercial bank lending powers. Despite this effect, however, some persons have argued that this source of funds is preferable to sale of bonds to the commercial banks, because it avoids the heavy interest cost. Most of the profits of the central banking system revert to the government, and thus the net interest cost is minimized. In Great Britain substantial amounts of government bonds are held by some of the central government departments. These provide a further instrument for the control of the money market generally.

For subordinate units of government it is not usually possible to borrow substantial sums on a short-term basis, and thus borrowing is confined to the issuance of bonds, usually running for 10, 20 or more years. The only exception is a small amount of short-term borrowing in anticipation of tax revenue. But a national government has a much greater choice between the two methods. Traditionally, short-term borrowing was regarded as indicative of financial irresponsibility. However, beginning in the 1930s, the U.S. government and other national governments began to make increased use of this form of credit, primarily because of the much lower rate of interest. There is available, especially in depression periods, a substantial volume of loanable funds whose owners are willing to invest it only on a short-term basis, with maximum liquidity and minimum risk. Thus the amounts are available at substantially lower rates than those at which bonds can be sold.

The primary disadvantage of the short-term loan from the standpoint of economic stability is the greater degree of liquidity to the investor. In inflationary periods borrowing of this sort is less effective in reducing liquidity than is long-term borrowing. Short-term borrowing also creates a continuous problem of refunding the issues as they mature, increases the danger that large amounts of debt might come due in a period of financial stringency and embarrass the government, and renders the government's interest burden highly vulnerable to changes in the market interest rate. Short-term borrowing is particularly disadvantageous if interest rates are expected to rise in the near future.

When inflation continues for a period of time, many persons become reluctant to buy any type of fixed-money-return security. Accordingly, suggestions have been made for the issuance in such periods of bonds with fixed purchasing power; that is, interest and principal payments would be adjusted in terms of changes in the price level so that the holder would be protected from the effects of inflation. At least one city in the United States (Carlsbad, N.M.) has issued bonds of this type. But such a policy is not without difficulties if adopted by a national government. If there were strong fear of inflation, a great shifting from existing securities to the new ones would occur and would disorganize the bond markets. The change would serve as notice that the government expected inflation to continue; that in itself would be a spur to increased purchasing, which stimulates inflation. Payment of interest and principal on the basis of the higher prices would feed the inflationary pressures and increase the future financial problems of the government. One more "escalator" would be added to the economy, and inflationary pressures increased.

Most government bonds are salable and therefore may be transferred on the market and have a market price. On the other hand, they are not usually redeemable until maturity. However, in the United States, Canada, Great Britain and some other countries, at the outbreak of World War II (and to some extent in World War I), special issues known as savings bonds or savings certificates were placed on the market. They were issued in small denominations, down to $25, in order to attract the small investor. In addition, they were made nonsalable, primarily to insure the purchasers against any decline in market value such as occurred to the Liberty Loans after World War I. This feature also enabled the government to control the amounts individuals purchased and prevented a mass shift from regular issues to the higher-interest-rate savings bonds. But since they were nonsalable it was virtually imperative to make them redeemable at will in order to make them attractive to the purchaser. Persons were given an incentive to hold them, however, because the interest rate was higher the longer the bonds were held.

On most government bonds interest is paid on a periodic basis by check or by the cashing of the coupons attached to the bonds. With the savings bonds, however, the discount method was employed; the bonds were sold at less than maturity value and the interest was obtained when the bonds were redeemed. The original $25 bonds, for example, were sold for $18.75, and redeemed at $25 if held the full ten years. This technique avoided the need for making large numbers of very small payments, delayed the receipt of interest until after the major inflationary pressures were over, and facilitated the scheme of varying the rate according to the period the bonds were held in order to discourage persons from cashing them in.

Governments can borrow only at the market interest rates as determined by current demand and supply for loanable funds. A government will attempt to ascertain the rate at which a new issue can be sold by examining yields on existing issues and consulting investment banking firms. Normally an effort is made to set the rate at which the bonds will sell at par (maturity value). If the rate is set too low, the bonds will have to be sold at a discount and the effective rate will reflect the market figure; the net result of selling at a discount is often a net actual rate slightly higher than otherwise.

In a few instances governments deliberately set rates higher than the market in order to attract certain classes of investors. The primary example was the setting of an unnecessarily high rate on savings bonds during World War II in order to get as much of the debt as possible into the hands of individuals instead of the banks. Banks were not permitted to buy these issues.

In some instances the law sets a maximum interest rate that can be paid on bonds sold. If the market rate rises above this figure the sale of bonds becomes impossible and other types of borrowing must be relied upon. During World War I the maximum interest rate on federal bonds in the U.S. was set by congress at 4¼%. This caused no difficulty until the late 1950s when market rates exceeded this figure and sale of long-term bonds became virtually impossible. Congress was reluctant to make an increase because of dislike of the federal reserve policies that had driven the market rate up in an effort to control inflation. In countries with the parliamentary form of government, such as Canada and Great Britain, interest ceilings are either completely absent or are of no significance because they can be changed at the will of the government.

While the states and local governments are completely at the mercy of the money market so far as interest is concerned, a national government can affect the rate of interest through its influence over the central banking system. The national government

can thus reduce its interest burden if it wishes, or can prevent an increase. Unfortunately, however, if such a policy is followed in an inflationary period it will interfere with effective anti-inflationary policies of the central banking system. From 1945 to 1950 in the United States interest rates were kept lower than was probably desirable in terms of inflation control in order to keep the government's interest costs down. After 1951 the inflation control goal became dominant in federal reserve policy, but the interest goal was not completely lost sight of. Great Britain also permitted interest rate policy to dominate central bank action from World War II until after 1952. In periods of decline in business activity the interest-cost and stabilization goals coincide.

When the central banking system raises interest rates in periods of inflation, state and local borrowing is made more expensive. These governments then seek special assistance from the national government in obtaining funds more cheaply. Such aid was provided after World War II in Great Britain through the Public Works Loan board, which made loans to local authorities. There was extensive demand for this sort of assistance in Canada after 1955. The problem illustrates one of the basic difficulties of general credit control, namely, the nonselective restriction on borrowing.

A government can make its bonds more acceptable to the buyers, and thus obtain a lower rate of interest, by making the interest on the bonds tax-exempt. This was the practice by the U.S. federal government before 1941; after that date only state and local bond interest continued to be exempt from federal tax. Most other countries do not provide such an exemption.

For a particular level of government, if tax rates are progressive, the tax loss will exceed the gain from lower interest rates unless there is sufficient market among persons in the highest tax bracket to absorb all of the bonds. In this instance the interest rate savings would more or less offset the tax loss. But this is most unlikely to be the situation, and in all higher tax brackets than the one at which the two elements are in balance, the government will lose in tax more than it gains through lower interest, while persons in lower brackets will not, presumably, buy the bonds. The shift in federal policy in the United States in 1941 was therefore desirable.

However, when the units of government involved are different, as with exemption of state and local bond interest from federal tax in the United States, the units whose bonds are exempt experience a net gain from lower interest and thus will oppose any effort by the other government to make the interest taxable. The United States originally exempted interest on state and local bonds because the 1894 income tax law had been held invalid in part because the supreme court considered the inclusion of state and local bond interest to violate the constitutional division of powers between the federal and state governments (*see* INCOME TAX). As the attitude of the supreme court has changed materially on this general question (federal taxation of the salaries of state employees having been held valid in 1939), it is likely that the court would accept the taxation of interest on state and local bonds. But the strong opposition of the states and local governments has prevented action by congress, although it is obvious that these governments gain less than the federal government loses. Furthermore, the exemption provides a simple avenue of tax avoidance and encourages wealthy persons to put their money into these safe investments instead of into business expansion.

Governments may sell bonds through investment banking firms in the same way that corporations do—the purchasers bidding on the issue, paying a lump sum and then reselling the bonds to their customers. This is the usual procedure for larger bond issues of state and local governments. Bonds may be sold directly to individuals, banks and business firms. Local governments sometimes sell their issues directly to local banks. The federal government sells savings bonds and other issues directly to the public; the banks and other institutions merely serve as agents. These bonds are sold on a continuous basis, the amount issued being adjusted in terms of volume purchased. Other federal bonds are sold primarily to financial institutions and banks. Treasury bills are sold at auction, largely to institutional investors. Normally, new federal issues (other than savings bonds) are "oversubscribed" in the sense that the orders exceed the amount of the issue, and are then allocated among the various purchasers.

2. Management of Existing Debt.—A major aspect of debt management is that of adjustment in the nature and structure of the existing debt, as, for example, replacement of short-term securities by long-term securities, refunding of maturing issues, transfer of securities from one type of investor to another (banks to individuals, for example), conversion of issues, and the like. This is a problem rarely faced by local and state governments because their debt is retired on a systematic basis and there is little opportunity to change the form before the date of maturity. About the only possibility of change is that of repayment before maturity if surplus funds are available or if replacement of an old issue by a new (at lower interest rates) is feasible. To facilitate such action without the necessity of buying the securities in the market, the issues are sometimes made callable so they can be paid off at maturity value (or with some premium) at any time beyond a certain year.

National governments, with their much greater variety of issues and greater responsibility for economic stability, have much more leeway in management of the existing debt. The major aspects of the policy are summarized below:

The treasury department can, if it wishes, materially change the relative size of the short-term and long-term elements in the debt. Even in the United States, control of the form of the debt rests largely with the treasury rather than with congress. Short and intermediate issues, which are constantly maturing in large volume, can be replaced by long-term bonds, or long-term bonds can be replaced by short-term issues, either as they mature or through purchase or call.

Replacement of short-term by long-term issues, advocated by many persons in the period after 1945 and attempted by the government on several occasions during that period, offers several advantages in periods of inflationary tendencies. First, it reduces the over-all liquidity of the debt structure, making it more difficult for investors to use funds in government securities for spending on consumption or business expansion. Second, increased use of long-term securities lessens the nuisance and cost of constant refunding operations and makes less frequent the danger that extensive refunding may coincide with a stringency in the money market, thus necessitating central bank action to support the government's borrowing. This action may run directly counter to the action needed in the interests of economic stability.

Distinct from the advantages of long-range lengthening of the structure of maturity of government debt are those of the change itself in the direction of greater reliance on long-term borrowing. The net effect is a tendency to raise long-term interest rates relative to those on short-term loans. This change should lessen inflationary pressures. But the actual magnitude of the effect is doubtful; direct monetary policy of the central banking system may be far more effective and simpler.

The primary disadvantage of increased reliance on long-term securities is the higher interest rate that must usually be paid. On rare occasions short-term rates may exceed long-term rates, but normally the reverse is true. It is this consideration that discouraged the government from continuing its program of lengthening the maturities of the debt in the late 1950s. Part of the difficulty lay in the reduced competitive position of long-term government bonds compared with other securities. The rapid fluctuations in government bonds, as monetary policy was used more intensively, made them less attractive investments, while private securities became more attractive as business activity remained at a high level. The increased supply of government-guaranteed mortgages also lessened interest in government bonds. It is particularly unfortunate for the government to increase the volume of long-term securities in a period in which interest rates have reached relatively high levels and are likely to fall.

In terms of cost considerations alone, the appropriate time for shift toward long-term issues is in depressions. While short-term funds become very cheap in such periods, it is more advantageous for the government to take advantage of the low rate level by

TABLE VI.—*Estimated Ownership of United States Federal Securities*
(par values*—in $000,000,000)

Year and end of month	Total federal securities outstanding†	Held by banks			U.S. government investment accounts§	Held by nonbank investors						
		Total	Commercial banks‡	Federal reserve banks		Total	Individuals‖	Insurance companies	Mutual savings banks	Corporations¶	State and local governments♀	Miscellaneous investors♂
1939—December	47.6	18.4	15.9	2.5	6.5	22.7	10.1	6.3	3.1	2.2	.4	.7
1941—June	55.3	21.8	19.7	2.2	8.5	25.0	11.2	7.1	3.4	2.0	.6	.7
1946—February (peak)□	279.8	116.7	93.8	22.9	28.0	135.1	64.1	24.4	11.1	19.9	6.7	8.9
1949—June	252.8	82.4	63.0	19.3	38.3	132.2	66.6	20.5	11.6	15.8	8.0	9.6
1951—June	255.3	81.4	58.4	23.0	41.0	132.9	65.4	17.1	10.2	20.1	9.4	10.7
1956—June	270.0	80.8	57.1	23.8	53.5	135.6	66.4	13.3	8.4	17.4	15.7	14.5
1959—November	290.7	85.9	59.0	26.9	53.8	151.0	69.1	12.5	6.9	23.2	17.4	21.9

*United States savings bonds, Series A-F and J, are included at redemption value.
†Securities issued or guaranteed by U.S. government, excluding guaranteed securities held by the treasury.
‡Consists of commercial banks, trust companies and stock savings banks in U.S. and territories. Excludes securities held by trust departments.
§Holdings of federal land banks included under "miscellaneous investors" instead of "U.S. government investment accounts" after 1947, when the proprietary interest of the U.S. government in these banks ended.
‖Includes partnerships and personal trust accounts. Nonprofit institutions and corporate pension funds included under "miscellaneous investors."
¶Exclusive of banks and insurance companies.
♀Consists of trust, sinking and investment funds of state and local governments and their agencies, and territories and island possessions.
♂Includes savings and loan associations, nonprofit institutions, corporate pension trust funds, dealers and brokers, and investments of foreign balances and international accounts. From Dec. 1946 on includes investments of International Bank for Reconstruction and Development and the International Monetary fund in special noninterest-bearing notes issued by U.S. government.
□Immediate postwar peak. The all-time end of month peak prior to 1959 was $280,800,000 as of Dec. 1955.
Data taken from *U.S. Treasury Bulletin* (Sept. 1956, p. 34; Feb. 1960, p. 54) and *Annual Report of the Secretary of the Treasury on the State of the Finances*, p. 510 (1957).

obtaining funds at the low figures on long-term issues. On the other hand, the short-term borrowing keeps the lenders' investments highly liquid and facilitates their spending the sums for consumption or business expansion whenever they wish. Thus interest cost and stability considerations suggest opposite policies. The former requires shifting from short-term to long-term loans in depressions, while the former dictates this shift in periods of inflation. But the liquidity considerations are probably not very important in depression periods, nor is the gain from the shift toward long-term securities in inflationary periods. The much more important consideration is that the over-all length of issue be relatively long when inflation does arise. There is an increased trend toward a policy of relying on other policies than changes in debt maturity as a means of lessening economic stability, and of lengthening debt maturities in periods when interest rates are low.

The government may at times find it advantageous to shift the relative holdings of different types of investors. In periods of inflationary pressures, increased holdings of savings bonds and reduced holdings of the central bank and commercial banks would lessen spending in the economy and reduce the liquidity of individuals—the ability to increase spending sharply if they wish. It is for this reason that in inflationary years of the postwar period the U.S. government continued to push the savings bond program even when it was not doing any net borrowing. Table VI shows the changing ownership of the U.S. national debt between 1939 and 1959.

On the other hand, during a period of depression, the repayment of savings bonds through borrowing from the commercial banks and the central banking system would tend to increase total spending. Some of this effect will be attained automatically as persons cash in their savings bonds when they lose their jobs.

Government securities are held, apart from government trust funds and the central banking system, by three principal groups of investors—the commercial banks, other financial institutions and individual investors. In the United States, some tailoring of securities to the particular needs of the various investors has been undertaken through the use of the savings bonds, which have been restricted to individuals. Some authorities have suggested that much more of this should be done, in the interests of stability and cost to the government. Edward Nevin, for example, has proposed three general forms of national debt (*The Problem of the National Debt*, 1954). The first, confined to the commercial banks, would consist of certificates without fixed maturity dates, payable at par on the option of the holder on a month's notice or by the government at any time. All of the nuisance and cost of constant refunding of short-term issues would thus be avoided. The interest rate would be adjusted in terms of the operating costs of the banks. Second, institutional certificates would be provided for other financial institutions, with a higher interest rate, fixed maturity date and no redemption at will. Third, the securities for individuals would be roughly comparable to savings bonds and would pay a higher rate than the other two forms. These would be redeemable and nonsalable. In general the program would greatly reduce the volume of refunding and would thus free the central bank from constant concern with this problem to the neglect of credit control policy. The direct effect of debt management on stabilization would be increased through varying redemption and volumes of issues for various classes of investors.

Distinct from the question of adjustment in the structure of the debt is that of conversion designed simply to lower interest cost, without change in the nature of the debt involved. When the interest rate has fallen sharply, conversion may be highly advantageous. However, it is not possible unless the bonds are callable, except in the rare instance of forced conversion. This latter type of policy is in a sense partial repudiation and is not followed by democratic governments. If the bonds involved are callable, and conversion is decided upon, the government will give the bondholders notice of conversion and give them the choice of repayment in cash if they wish.

As the term debt management is usually employed, it does not include central bank policy designed to influence the general interest rate level, which is regarded as a distinct form of stabilization policy. The two are, of course, closely related. Central bank policy controls the interest rate that the government must pay; the interest costs of the national debt can always be reduced by central bank action which increases the supply of money capital through credit creation. But such a policy may interfere with central bank attainment of the goal of increased economic stabilization. *See* also EXCHEQUER BILLS; WAR FINANCE: *Cost of World Wars I and II.*

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DEBTOR AND CREDITOR LAW. The law of debtor and creditor is of narrower scope than the literal meanings of the key words might suggest. The first part of this article seeks primarily to generalize concerning the laws in the United States, but these rest on English practice to such an extent that the broad outlines are traceable throughout the Anglo-American world. The law of sales, negotiable interests, mortgages and suretyship largely has to do with the creation and delimitation of legal obligations that may be considered debts in a broad sense. Indeed, judgments for damages, *e.g.*, those arising out of automobile accidents, can produce judgment creditors and judgment debtors. The more specialized field of law discussed in this article relates primarily to the law of debt collection and the restraints imposed upon creditors from reaching the assets of debtors.

UNITED STATES

Appropriation.—Some special legal aspects of credit transactions are encountered where business is proceeding smoothly. When two parties have entered into a number of transactions with each other and one of them makes a payment, he is entitled to specify its application. Thus, if he owes a secured debt and an unsecured debt, he may elect to release the security. If the debtor does not specify the application at the time he makes the payment, the creditor is entitled to apply the payment to the unsecured debt. Indeed, it has been held that, failing instructions to the contrary by a debtor, a creditor may change his mind after having improvidently applied a payment to a secured debt and apply the payment to the unsecured debt. If neither the debtor nor the creditor appropriates a payment to any particular debt, the usual implication of law is that a payment will be applied to the oldest debt or debts outstanding.

Setoff.—Another aspect of the debtor-creditor relationship is the practice of offsetting debits and credits so as to leave a net balance, due from one party to the other. This point often fails to operate until litigation arises. The individual practice between two traders or the established custom of the market may determine whether they make numerous remittances back and forth or whether they simply have periodic accountings settled by remission of the net balances. If controversy arises, however, accounting procedures must be subordinated to legal precepts and the rules of court. A tenant, for instance, indebted to his landlord for rent may not be safe under the law of some jurisdictions in withholding rent to protect himself by reason of the landlord's breach of a covenant to repair. His action of damages for nonrepair, if he has one, may have to be handled separately, and may not be available as a setoff in a suit for rent or as a defense in eviction proceedings.

The law, however, commonly takes notice of business understanding that when parties have cross claims the debtor-creditor relationship may frequently be dealt with in terms of net balances. If one party goes into insolvent liquidation and equal cross claims are setoff, the other party suffers no loss. If setoff is disallowed, however, the solvent party will be liable to pay his debt in full and will be allowed to rank as a creditor for a dividend from the insolvent estate. Since 1898 the federal Bankruptcy act of the United States has provided for a setoff of mutual debts and credits between the estate of a bankrupt and a creditor having a provable claim. The statute also provides against the manipulation of setoffs by debtors of the bankrupt buying up claims against him, although there is no parallel provision by which creditors are prevented from becoming debtors. Similar but somewhat different rules of setoff apply in other liquidation proceedings. Claims can be mutual in a sense to permit setoff even though they arise out of different kinds of transactions, but both parties must be acting in the same capacity on both claims. If a party with one claim is dealing in a representative or fiduciary capacity, a cross claim in his personal capacity is not available for setoff.

Collection Law.—The law outlined here is brought into active operation only in relation to the relatively small minority of credit transactions where payment is not forthcoming within commercially tolerable limits of time. After routine efforts at debt collection have proved fruitless, a claim will commonly be put into the hands of an attorney for collection. In some states of the U.S. his task will be much impeded by exemption laws.

Exemptions.—In the 19th century the pattern of exemption laws in the United States was comparatively logical and simple. Exemptions were low in the northeast and high in the south and west. The pattern has become more confusing, partly because of shifts in wealth and partly because many southern and western states which introduced exemptions with high monetary limits have failed to keep up with inflation. Few exemptions with a monetary limit dating from the 19th century constitute serious impediments to the collection of debts. Pennsylvania has no homestead exemption, while that of Illinois is limited to $1,000. The constitution of Florida exempts ½ ac. of urban property and 160 ac. of rural property, including improvements without monetary limit. The Kansas constitution extends these limits to a full acre of urban property, and part of the homestead may be rented out without losing its homestead character. Texas recognizes a "business homestead," a place used by the head of a family for business purposes. California is an example of a state that has retained monetary limits, but has frequently raised them and added new categories of exempt property. Exemptions of life insurance have been expanding broadly, even to shield the surrender values of insurance policies within the reach of the insured through reservation of power to change the beneficiary.

Creditors' Remedies.—A creditor, as such, has no rights in the debtor's property or in his earnings. Legal action to collect debts is ordinarily directed to acquiring such rights. It is sometimes possible to attach a debtor's property or to garnish his wages, bank account or other intangible rights against third persons ("on mesne process") at the outset of a suit. In the original 13 states, or most of them, such practice was routine, and still commonly exists in some, with the result that a plaintiff can sometimes tie up the resources that a defendant needs to conduct his defense. The modern trend is to limit attachment on mesne process to proceedings against the property of a nonresident or to complaints alleging various statutory types of fraud, evasion of process or actual or threatened absconding or concealment of property. The influence of the frontier upon the law of the new states was opposed to strengthening the creditor's hand, and attachments against other than nonresidents became strictly limited there. Garnishment is like attachment, except that the term is confined to proceedings against intangible assets, while an attachment on mesne process may issue against land or chattels. All collection process is statutory, although some of the interpretations of U.S. courts trace back to "common law statutes," adopted in England before the colonization of the country and woven into American legal concepts when not rejected as inapplicable to local conditions. Garnishment, particularly, is often treated as a formal matter not sufficiently flexible to meet various collection needs, so the creditor may have to rely upon other statutory or equitable remedies.

Liens by Legal Proceedings.—Apart from cases in which an alleged debtor contests and defeats an alleged creditor's claim, the effect of a judgment for a creditor may be considered here. The judgment itself may automatically constitute a lien (*q.v.*) upon any real estate of the defendant within the "bailiwick," which for trial courts of record is typically countywide. In some states further ministerial action such as docketing or recording is necessary. In others, a lien upon land can be obtained only by attachment or execution, and some further process is necessary everywhere to reach personal property. A common method is by issuing a writ of execution, whereby the clerk of the court attests an order directed to the sheriff to make of the goods and chattels of the defendant the amount of the plaintiff's judgment with interest and

costs. This is done by sale at public auction, but the creditor is often the only bidder, and he makes his purchase by setting off all or part of his claim against the purchase. He seldom bids more than his debt, interest and costs. To levy an execution it will frequently be necessary for a representative of the plaintiff, or his attorney, to accompany a deputy sheriff and point out property of the defendant. The sheriff is likely to exact indemnity from the creditor against liability on his official bond for a wrongful levy. Until a statute of 29 Charles II (1676), an execution created a lien on property in the bailiwick from the date of the official authorization of the writ, but the critical time was then made the delivery of the writ to the sheriff. Both rules have following in the United States. In some states there is no lien prior to levy. Any lien may become vulnerable as in fraud of other creditors or may be otherwise lost by undue delay in enforcement.

Executions have tended to become less effective than they were in the days of smaller populations, simpler business and less intangible property. An execution returned unsatisfied is sometimes a legal condition precedent to other forms of relief, but in many situations this has become merely a formal requirement met by the sheriff at the request of the creditor's attorney without any attempt to locate property. Garnishment or attachments may issue in aid of execution as well as upon mesne process.

Creditors' Bills.—Courts of equity several centuries ago developed the precept that equity would not suffer a right to be without a remedy, and the so-called concurrent jurisdiction was developed to operate where a complainant could show a legal right and a lack of adequate remedy of law. Two types of creditors' bills developed. A special creditors' bill was like an equitable execution in reaching assets which could not be reached at law. Upon a prayer for discovery a defendant could be compelled to disclose the nature and location of hidden or intangible assets, subject to the sanctions of perjury and contempt. A general creditors' bill was developed commonly in connection with receiverships to administer all the assets of an insolvent debtor for the various classes of creditors as their interests might appear. The modern trend has been along lines by which law and equity are applied in a single court. A concurrent development has been statutory "supplementary process," where the power of the court to coerce debtors can be summarily applied in appropriate cases.

Fraudulent Conveyances.—Debtors have frequently tried to put their property into friendly hands for their benefit, or to be generous to their family and friends at their creditors' expense. Creditors may frustrate such attempts as fraudulent conveyances. The law on this topic was developed under the Statute of 13 Elizabeth I, c. 5 (1570). Such transfers can be valid between the parties (although a transfer with actual fraudulent intent upon a secret trust for the grantor may disqualify the parties from obtaining help of the court in carrying out their intent). In any case, if a debtor seeks to cover up his property by transfers or to be generous to donees rather than just to his creditors, the creditors may either levy upon the transferred property as if it still belonged to the debtor or bring a bill in equity to have the transfer set aside. Although some courts have held to the contrary, the clear language and intent of the Statute of Elizabeth and of most state statutes in the same tradition permit the character of the alleged fraudulent conveyance to be tried in an action to obtain possession after the property has been sold under an execution. At common law it was necessary for the creditor to obtain judgment and have his execution returned unsatisfied before he could bring a bill in equity, but the Uniform Fraudulent Conveyance act, in force in 20 states, and the Rules of Federal Procedure for the District Court of the United States permit a creditor to establish his claim and attack a fraudulent conveyance in a single proceeding.

Forced sales generally destroy going-concern values. When a business has such value, it may be advantageous to creditors to conserve it by working out some friendly adjustment under which the debtor can get an opportunity to discharge his debts at least in part. His creditors may agree to extend time, and while the promise of one creditor to accept less than full satisfaction of an undisputed claim would be legally unenforceable for want of consideration, the agreement of several creditors to settle on like terms without secret advantage to any will be upheld as an enforceable composition at common law. Creditors' committees are often formed to supervise a debtor's business during the performance of an extension or a composition agreement. Such arrangements do not bind nonassenting creditors at common law, but the U.S. Bankruptcy act provides in ch. xi a procedure for binding minority creditors under arrangements approved by the court.

Receiverships.—Sometimes creditors initiate a general creditors' bill for the appointment of a receiver (*q.v.*) with a view to sheltering the business from destructive levies while a creditor's arrangement is being worked out. Receivers are sometimes authorized to carry on business under the protection of a court order and subject to general supervision by the court. Such a receivership may result in a reorganization of the debtor's business, with some readjustment of the proprietary interests as well as the debts. If the business does not prosper under the receiver's direction, it will probably have to be liquidated. If it can be sold as a going concern to another enterprise, however, it may produce a better price than piecemeal sales of assets.

Assignments for the Benefit of Creditors.—If a debtor finds it necessary to liquidate his business without the intervention of a bankruptcy court, he may try conveying all his nonexempt assets to assignees for the benefit of creditors, who will be responsible as trustees for distributing the assets. This may not achieve the purpose of avoiding bankruptcy, because such as assignment is an act of bankruptcy and, in the United States, any one of 11 creditors or less, or any three of 12 or more creditors "who have provable claims liquidated as to amount and not contingent as to liability . . . which amount in the aggregate in excess of the value of securities held by them, if any, to $500 or over," may upset the assignment by a petition in bankruptcy. Nevertheless, such assignments are sometimes achieved when the creditors trust the integrity of the debtor and the assignees, particularly in states where statutory regulations are not unduly burdensome. During the long periods when there was no bankruptcy act in force in the United States, assignments for the benefit of creditors regulated by state insolvency laws were frequently the best available means of liquidation.

Bankruptcy.—The entire subject of bankruptcy (*q.v.*) has an important bearing on the law of debtor and creditor. Security transactions must be conducted so as to withstand attack on possible bankruptcy proceedings. Since receiverships as well as assignments for the benefit of creditors are acts of bankruptcy, they are conducted under comparable limitations and may be short-lived. Liens by legal or equitable proceedings are voidable if the debtor's assets at a fair valuation are less than his liabilities and if bankruptcy proceedings ensue within four months. The trustee in bankruptcy may set aside any payments made or security given in respect of a debt that is wholly or partly unsecured when the purpose was to give one creditor an advantage over other creditors, at a time when the debtor was insolvent and the creditor had reasonable grounds for being aware of it. These possibilities must be weighed when credit is extended and again when the race for collection is on. The shadow cast by the Bankruptcy act may in some instances promote caution in the extension of credit. It may also serve to warn the aggressive creditor that if he destroys the debtor's going-concern value by a levy, he may not be permitted to retain the fruits of his diligence. Parties entering into friendly adjustments are well advised to take into account the potential operation of the Bankruptcy act.

(J. A. MacL.)

GREAT BRITAIN

In British law a debt exists when a sum of money is due from one person, a debtor, to another, a creditor. Not only is the debtor required to pay but the creditor has the right, which he can legally enforce, to receive payment.

Debts may arise in various ways, but by far the greatest number come into being under contract, either as specialty or simple contracts. The former may consist of a deed or other instrument

under seal such as a mortgage; but although a specialty debt at one time had the advantage of prior allocation of assets over debts created under a simple contract, this advantage no longer exists. Specialty debts do, however, possess an advantage as regards the right of action; the Limitations act, 1939, gave a time limit of 12 years for the settlement of a specialty debt as compared with 6 years under a simple contract.

A simple contract debt is one not provided for by deed or record. It is probable that the bulk of debts arising from the intricate ramifications of daily business life are simple contract debts.

Debts may also arise under statute, like those created by the Companies' act, 1948, dealing with calls on shares. They may be debts of record, the proofs of which are the records of a court. Judgment debts, which are among the most important of this class, are debts which come into being following a judgment or decree of a court of record. A simple example is the award of damages against a tort-feasor. Liability in damages is not a debt, but if there is a failure to meet it, a successful action to recover would result in a judgment constituting a judgment debt.

Debts due to the crown are known as crown debts. The crown holds a specially privileged position in Britain; thus, on the death of a debtor, crown debts have priority in repayment. Again, if a debtor becomes bankrupt but later receives his discharge from bankruptcy, liability for crown debts continues.

In law, debts may be assigned, and such assignment is valid if absolute and in writing. A bill of sale (*q.v.*) is the term usually applied to the act of assignment, which differs from pledging or pawning in that the creditor does not take possession of the goods assigned. A number of statutes under the general title Bills of Sale acts have been passed, of which only those of 1878 and 1882 need be mentioned. Both have as their aim the prevention of fraudulent bills of sale, the former being designed to protect the creditor, the latter the debtor.

Debts are sometimes referred to as secured debts and, as the term implies, the creditor has some measure of security over and above mere liability on the part of the debtor to pay. Such debts are by no means uncommon. Thus a loan on a house may be secured by a mortgage, loans by banks to their customers may be secured by guarantee, while a judgment by a court of record is an added and valuable security.

Just as a debt is a sum of money due, a debtor is the party who owes the debt; but curiously, he is difficult to define. The Bankruptcy act, 1914, has a somewhat complex reference to debtors, but essentially it embraces all persons who are resident in or transact business in Britain. This, however, does not restrict the term debtor to British subjects only, for an alien carrying on business in Britain is a debtor within the meaning of the statute when an act of bankruptcy is committed. This approach is not entirely satisfactory. The position might be considered from the angle of the creditor whose urgent problem is the ability to recover a debt. The relation of banker and customer has been held in Britain to be that of debtor and creditor, coupled of course with the obligation on the part of the banker to honour a customer's checks when the account is in credit. If, however, a customer overdraws his account, this will be regarded as a tacit request for a loan. In the case of a partnership, common law deems every partner to be liable for partnership debts to the full extent of his personal property. As between partners, each must contribute to the debt liability in the same proportion as his share of the profits. In the case of a company, debts cannot be recovered if they were contracted for a purpose outside the company's powers. Debts contracted by infants can be recovered only if incurred for necessities, a loose term dependent on the facts of each case. It will be seen from these few examples that a person from whom a creditor can effectively recover, if this is applied as a test of the meaning of debtor, may vary considerably both as to class and capacity.

A creditor is one to whom a debt is due. He will be described legally in differing terms according to the way in which the debtor-creditor obligation was established.

By the law of bankruptcy, or when a debtor dies insolvent, creditors claiming a share of the available assets may be grouped as secured and unsecured. For some purposes, a creditor will be deemed to be secured only for the part of the debt due to him after deducting his security. As a creditor in such circumstances may well incline to undervalue his security, the bankruptcy rules authorize the trustee or other official to purchase the security at the creditor's valuation. A creditor who presents a petition for adjudication in bankruptcy is known as a petitionary creditor, and he may take this action only if the debt amounts to £50 or more. If there are several creditors, the aggregate debt must total £50.

Almost all persons may be made bankrupt. These include a married woman, who for this purpose will be treated as a feme sole, and a convict. Various disabilities are imposed on bankrupt persons, such as limitations on incurring further debts and the holding of public office.

A liability for debt incurred by two or more persons may be joint and several, thus giving the creditor the option of suing either one or more of the debtors separately, or all jointly. If one of the debtors alone has to pay, he has a right of contribution from the others according to their respective shares.

The doctrine of fraudulent preference was evolved to prevent the voluntary distribution of a debtor's property among his creditors so as to defeat the rules of distribution under the Bankruptcy act. Therefore every distribution will be void if made within three months of the act of bankruptcy.

The position of creditors of those dying insolvent is governed by the Administration of Estates act, 1925, which lays down rules determining the distribution of an insolvent estate. *See* also references under "Debtor and Creditor Law" in the Index.

(GA. S.)

DEBUSSY, (ACHILLE) CLAUDE (1862–1918), French composer who expressed the musical ideals to which the painters and writers of his time aspired, and who was one of the principal figures in the evolution of music between Wagner and the middle of the 20th century. Born at St. Germain-en-Laye, near Paris, on Aug. 22, 1862, he was the son of a former soldier in the marines who intended that he should become a sailor. The works of his mature years, *Sirènes*, *La Mer* and the sea music in *Pelléas et Mélisande* show his nostalgia for the sea, which he evoked with great imagination and poetry. His musical gifts were discovered by Antoinette Flore Mauté, mother-in-law of the poet Verlaine, and he entered the Paris conservatory in 1872; there he studied the piano with Antoine Marmontel and composition with Ernest Guiraud.

Though he lived in poverty, he cherished an innate sense of luxury, which he was able to satisfy, between 1879 and 1882, by engagements as chamber pianist at the Château de Chenonceaux and at the palatial residences in Switzerland, Italy and Russia of Nadezhda von Meck, the patroness of Tchaikovsky. In 1884 he won the Prix de Rome with the cantata *L'Enfant prodigue* and spent the following two years at the Villa Medici in Rome, where new horizons were opened by *Lohengrin* and the works of Orlando di Lasso and Palestrina, as revealed to him by Liszt.

From 1888 to 1892 Debussy developed under influences that ranged from *Tristan*, *Meistersinger* and *Parsifal*, all heard at Bayreuth, to Gregorian chant and the Javanese *gamelan* orchestra, introduced at the Paris exhibition of 1889. He was also attracted to the paintings of the Nabis, a group of Impressionists, and the many English associations of the *art nouveau* movement; this attraction was reflected in his setting of a French translation of D. G. Rossetti's *Blessed Damozel* (1887–89). Other early works were inspired by Edgar Allan Poe's "Fall of the House of Usher," left unfinished; Baudelaire's *Fleurs du mal;* and Henri de Regnier's *Scènes au Crépuscule*, later developed into the *Nocturnes* for orchestra (1892–99). The first concert of his works was given in Brussels on March 1, 1894, at the gallery of La Libre Esthétique, which was hung with the freshly painted canvases of Renoir, Gauguin, Sisley and other Impressionists. With the exception of the String Quartet (1893) and the late sonatas and piano studies, the whole of Debussy's work was enriched by pictorial or poetic themes. With his illustration of Mallarmé's *L'Après-midi d'un faune* (1894), he approached the realization of the ideal, common

to the poets of Mallarmé's circle, of the fusion of the arts.

In 1893 he was present with Mallarmé at the first performance of Maeterlinck's *Pelléas et Mélisande*, an allegory of innocence and guilt plunging far into the dream world. Over the following nine years, when the psychological theories of the dream, as expounded by Wagner, Poe and Freud, were increasingly taking root in the arts, Debussy gradually evolved an original musical style that enhanced the symbolism of Maeterlinck's allegory and established opera as an imaginary theatre of the mind. The first performance of *Pelléas et Mélisande* (Opéra Comique, April 30, 1902) met with some hostility; the adverse feeling was soon overcome, however, though by its nature this entirely poetic conception of opera was to remain unique.

The composition of *Pelléas* liberated Debussy's imagination on another plane, and he further developed his style in the orchestral triptych *La Mer* (1905), followed by the largest of his orchestral works, the *Images* (1906–09). These and other works of this period, which are largely parallel expressions of the aesthetics of Marcel Proust, consist of finely drawn musical images that arouse innumerable sensations and half-forgotten memories.

In 1904 he had abandoned his first wife, Rosalie Texier, for Emma Bardac, to whom his daughter, Claude Emma, was born in 1905, and whom he married in 1908. In the same year he dedicated to his daughter a group of piano pieces called *Children's Corner*. Afflicted with cancer and unable to meet his debts, he undertook concert tours throughout Europe and Russia from 1909 until 1913; his works of this period include the 24 *Préludes* for piano, incidental music for the mystery play *Le Martyre de Saint-Sébastien* by Gabriele d'Annunzio, and the ballet *Jeux* (1913). During World War I, he wrote some of his finest works, the twelve *Études* for piano and three sonatas for various instruments. He died in Paris, March 25, 1918.

In form, harmony and instrumentation Debussy greatly enriched the musical language. His free structures are in the form of sophisticated improvisations since his ideal was music "that should seem not to have been written down." In his orchestral works he explored little-used registers of instruments, sought novel combinations and gave to each instrument, even the divided strings, a role of its own in the manner of a vast chamber orchestra. In his piano works he created the most original style since Chopin by experimenting with new sonorities, contrasts of register and effects obtained by a subtle use of the pedals. His vocal music is in the form of a supple recitative alive to the inflections of French speech.

The significance of his work is twofold. First, by his use of the pentatonic and Gregorian modes and his development of the whole-tone scale, he enlarged the musical horizon to embrace the musical civilizations of the middle ages and of the orient. On the other hand, the distinctions that he challenged between consonance and dissonance became the basis of many new harmonic developments. He expressed the quintessential sensibility of the generation before World War I and also was a Janus-headed figure who faced both the remote musical past, which he was able to revive, and the stylistic eclecticism of later generations.

See L. Vallas, *Claude Debussy et son temps*, 2nd ed. (1958); E. Lockspeiser, *Debussy: his Life and Mind*, vol. i (1962). (E. Lr.)

DEBYE (Debije), **PETER JOSEPH WILLEM** (1884–), Dutch physical chemist who received the Nobel prize for chemistry in 1936 for his contributions to the study of molecular structure, was born at Maastricht, Neth., on March 24, 1884. He was educated at the Technische Hochschule at Aachen (1900–05) and at the University of Munich, where he obtained his doctorate in 1910. After occupying chairs of physics successively in Zürich, Utrecht, Göttingen and Leipzig, he was appointed director of the Kaiser Wilhelm institute for theoretical physics in Berlin in 1935, leaving there in 1940 for Cornell university, Ithaca, N.Y. His researches included the theory of salt solution, polar molecules, dipole moments and molecular structure, and he showed that substances could be used in powder form for X-ray crystallography, thus obviating the necessity of preparing good crystals. He successfully extended to the crystalline solid state S. A. Arrhenius' idea of the ionization of salts in solution; and in the previously anomalous cases of concentrated solutions he studied quantitatively the association of the solute with the molecules of the solvent. Debye's work on electrical polarity in molecules led to an increased knowledge of the arrangement of the atoms in the molecule and to the measurement of the distances between them.

See also references under "Debye, Peter Joseph Willem" in the Index volume. (D. McK.)

DECALOGUE (Ten Commandments; Heb. *'aseret ha-devarim*, Gr. *deka logoi*, "ten words"), a list of religious obligations divinely revealed to Moses on Mt. Sinai and engraved on two stone tables. The term is applied to two different collections, that of Ex. xx, 2–17 (= Deut. v, 6–21), sometimes called the "ethical decalogue," and that of Ex. xxxiv, 14–26, called the "ritual decalogue." The latter prescribes ritual and cultic observances only and is probably to be assigned to the time of Solomon, though the practices themselves are much older.

The date of the Ten Commandments depends upon the view held of its purpose. If it is simply a brief summary of the legal and priestly traditions, it would have to be of relatively late date. It has been regarded as an epitome of prophetic teachings, and therefore placed after Amos and Hosea (*i.e.*, after 750 B.C.). In Hos. iv, 2 and Jer. vii, 9 there are lists of some crimes prohibited in the Decalogue.

On the other hand, it is also possible to argue for a very early date, even pre-Mosaic times. The traditions of Exodus and Deuteronomy connect the Decalogue with Moses and the Sinai covenant between Yahweh and Israel, and this becomes plausible in the light of the formal characteristics of international covenants in pre-Mosaic times. These covenants, known from Hittite and Canaanite and even Egyptian sources, were usually suzerainty treaties in which a "great king" bound to himself the king of a smaller state as a vassal. The written text of the covenant began with an identification of the king who "gave" the covenant, continued with a historical prologue in which the great king described his benevolent deeds in behalf of the vassal, and then stipulated the obligations which the vassal bound himself to obey. Thus far, the Decalogue has exactly the same structure, though in far briefer extent. It is generally admitted that the commandments themselves have been considerably expanded; originally all of them were short, concise statements only two to four words in length (in Hebrew).

The Decalogue can thus be regarded as the text of a covenant between Yahweh and Israel that reflects Late Bronze Age covenant forms (1500–1200 B.C.). The purpose was to establish a lasting relationship between the two parties to the covenant, in which Israel was bound to obey the stipulations defined in the commandments and Yahweh became its suzerain and protector. Other parts of the old covenant form appear elsewhere in the historical and legal traditions as well. Covenants of this type were deposited in a sanctuary, just as the tables of stone were placed in the Ark of the Covenant (a portable sanctuary), and were supposed to be read publicly at stated periodic intervals. The covenant had witnesses, as did most legal forms in antiquity; the Hittite-Canaanite covenants were witnessed by a list of gods. The Israelite traditions know of heaps of stones (Josh. xxiv, 27) or the people themselves (Josh. xxiv, 22) acting as witnesses. Sanctions for the covenant were blessings and curses, which were exclusively acts of the gods in the form of material and social well-being or calamity respectively. Disease, war, famine, drought and destruction were especially connected with breach of covenant, as in Deut. xxvii–xxviii.

The commandments themselves contain little that was new to the ancient world. Prohibition of other gods is parallel to the stipulation of the Hittite treaties that the vassal commits breach of covenant if he enters into relationships with other kings. The prohibition of images of Yahweh may possibly be a later addition, but no image of Yahweh has been found in Palestinian excavations and no certain reference to such an image is found in the Old Testament. The "vain" use of the name of Yahweh is certainly a prohibition of false oaths. This, like the rest of the commandments, was common morality throughout the ancient near east. Disrespect for parents, murder, theft, adultery, false accusation

were in at least some respects punishable in most legal systems of which we have knowledge. The meaning and purpose of the Sabbath at this early date is unknown, though there are possible similarities to Old Babylonian customs.

From this point of view the Decalogue is not law strictly speaking. It is simply the description of the conditions accepted by the community in its relationship to Yahweh. The law collections such as Exod. xxi–xxiii provide the death penalty for violation of nearly every one of the Ten Commandments, for such violation endangered the relationship of the entire community to God, but the Decalogue itself makes no provision for punishment other than the presumed blessings and curses which probably were originally a part of the covenant itself.

The expansions of the original short stipulations and the differences between the Exodus and Deuteronomy versions of the Decalogue show that it was being reinterpreted in the process of transmission from generation to generation during the Old Testament period. The particularly sacred nature of the Decalogue to postbiblical Judaism is indicated by the Nash papyrus from Egypt, written about a century before the time of Christ, which consists of a single leaf containing the Ten Commandments, in a form identical to neither the Exodus nor the Deuteronomy version, and the Shema (the Jewish confession of faith; Deut. vi, 4–5). The purpose of this single sheet of writing is unknown.

The Decalogue was of no particular importance in Christian tradition until A.D. 1246 when it was for the first time incorporated into a manual of instruction for those coming to confession. The traditional division of the commandments into two "tables of duties" toward God and toward man made it possible to regard the second table as a succinct statement of the "law of nature" within the framework of medieval Christian theology. With the rise of Protestant churches new manuals for instruction in the faith were soon made available, and the Decalogue was incorporated into various catechisms as a fundamental part of religious training especially of the young.

There is no agreement concerning the enumeration of the ten commands. Jewish tradition makes the prologue, "I am the Lord your God" the first command and the prohibition of other gods and images the second. Medieval Roman tradition, followed also by Luther, regarded all this as the first command and divided the prohibition of coveting into two commands. The Greek Orthodox and Protestant Reformed traditions treat the prologue and prohibition of other gods as the first and prohibition of images as the second command.

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DECAMPS, ALEXANDRE GABRIEL (1803–1860), one of the first French painters of the 19th century to turn from neoclassicism to romanticism, was born in Paris on March 3, 1803. In 1827 he traveled in Asia Minor and reproduced oriental life and scenery with a bold fidelity to nature, using a technique that brought out new effects of light and colour and made his works the puzzle of conventional critics. He was probably the first of European painters to represent scenes from Scripture history with their true and natural local background. Of this class were his "Joseph Sold by His Brethren," "Moses Taken From the Nile" and his scenes from the life of Samson, nine vigorous sketches in charcoal and white.

Decamps also produced a number of genre pictures, chiefly of scenes from French and Algerian domestic life. Probably the best known of all his works is "The Monkey Connoisseurs," a clever satire of the jury of the French Academy of Painting, which had rejected several of his earlier works because of their divergence from any known standard. He died at Barbizon on Aug. 22, 1860, in consequence of being thrown from a horse while hunting at Fontainebleau.

DECAPOLIS, a league of ten Greek cities of Coele Syria, probably established by Pompey as part of his eastern settlement in 63 B.C., from which year most of them date their civic eras. Most of the cities—Scythopolis (Beisan, *q.v.*), Hippos, Gadara (*q.v.*), Abila (or Raphana, in the list of the elder Pliny), Dium, Pella, Gerasa (*q.v.*, now Jerash) and Philadelphia (Amman, *q.v.*) formed a continuous block of territory bounding the Jewish principality on the east. Canatha lay detached to the northeast in Auranitis (the modern Hauran in Syria) and Damascus (*q.v.*), which was its capital, lay even further to the north. Capitolias, founded in A.D. 97 or 98, may have been a later accession, or was perhaps Pliny's Raphana under a new name. The league, which was probably religious in character, survived to the 2nd century. The cities were all originally in the Roman province of Syria, but some were later annexed to the kingdom of the Herods, and some later still transferred to the province of Arabia in A.D. 106. *See* also SYRIA: *Hellenistic and Roman Syria.* (A. H. M. J.)

DECATHLON, an athletic competition lasting two days in which contestants are required to take part in ten track and field events. It was introduced as a one-day event at the Olympic games in 1912 and the first U.S. championship was held in 1915.

Decathlon events are: (first day) 100-m. dash, broad jump, shot-put, high jump and 400-m. run; (second day) 110-m. hurdles, discus throw, pole vault, javelin throw and 1,500-m. run. Competitors are scored for their performance in each event according to a table established by the International Amateur Athletic federation. The table is changed periodically in order to keep pace with progress in individual events. The first table lasted from 1912 to 1936, at which time the decathlon became a two-day competition. Another adjustment to the table was made in 1950.

Hans Sievert of Germany set the world's record under the original table at 8,790.46 points in 1934. Fractional scoring was eliminated in 1936 and the first record holder under the new table was Glenn Morris of the U.S. with 7,900 points. Robert Mathias of the U.S. raised this mark to 8,042 in 1950 and then set the first record under the 1950 table at 7,887 points in 1952. By 1963 scores above 8,000 had been registered by Rafer Johnson, Dave Edstrom and Phil Mulkey of the U.S., Vasily Kuznetsov of the U.S.S.R. and C. K. Yang of the Republic of China. In 1963 Yang became the first to score more than 9,000 points with 9,121. (For Olympic decathlon winners *see* OLYMPIC GAMES.)

All-Around.—Similar to the decathlon is the all-around championship of the U.S. Amateur Athletic Union. It is a one-day competition with no more than a five-minute interval between each of the events—100-yd. dash, 16-lb. shot-put, high jump, 880-yd. walk, 16-lb. hammer throw, pole vault, 120-yd. high hurdles, 56-lb. weight throw, broad jump and one-mile run. (E. J. G.)

DECATUR, STEPHEN (1779–1820), U.S. naval officer who held important commands during the War of 1812, was born at Sinnepuxent, Md., on Jan. 5, 1779. He entered the U.S. navy as midshipman in 1798, was promoted lieutenant and saw service in the short naval war with France (1798–1800). In 1803 he served in Commodore Edward Preble's squadron in the Mediterranean, and in Feb. 1804 led an expedition into the harbour of Tripoli to burn the U.S. frigate "Philadelphia," which had fallen into Tripolitan hands. He succeeded and made his escape under battery fire with only one man wounded. This exploit earned him his captain's commission and a sword of honour from congress. He was engaged in all the attacks on Tripoli during 1804 and 1805.

In the War of 1812 his ship the "United States" captured H.M.S. "Macedonian." In 1813 he was appointed commodore to command a squadron in New York harbour, soon blockaded by the British. In an attempt to break out in Jan. 1815 his flagship the "President" was forced to surrender to a superior force. Subsequently he commanded in the Mediterranean against the corsairs of Algiers, Tunis and Tripoli with great success. He was made a Navy commissioner (Nov. 1815), an office which he held until killed in a duel with Commodore James Barron at Bladensburg, Md., on March 22, 1820. A toast of his has become famous—"Our country! In her intercourse with foreign nations may she always be in the right; but our country, right or wrong."

DECATUR, a city of northern Alabama, U.S., 85 mi. N. of Birmingham, is the seat and trade centre of Morgan county. Stimulated by the Tennessee Valley authority (TVA) program, its location on the navigable Tennessee river has led to growing port traffic, recreational development and diversified manufactures.

Chief products are man-made fibre (Acrilan), air-conditioning equipment, copper and aluminum tubing, steel barges and boats and food and feed items. Incorporated in 1820 as Rhodes Ferry, it was chartered and named for Stephen Decatur in 1826. In 1832 it became a terminal for Alabama's first railroad from Tuscumbia. Occupied by both armies and practically destroyed during the Civil War, it was rebuilt in the 1870s and 1880s. The present city was formed in 1927 by the amalgamation of Decatur and Albany (formerly New Decatur). Several ante-bellum buildings in and near the city have much appeal to visitors: the Old State bank building (*c.* 1832), the McEntire house (1824), Rocky Hill castle (1820s) and Gen. Joseph Wheeler's home. For comparative population figures *see* table in ALABAMA: *Population.* (J. A. TR.)

DECATUR, seat of De Kalb county, Ga., U.S., and a residential suburb of Atlanta (*q.v.*). Originally it was a trade centre for small farmers with few slaves. Its urban growth was tied to the transportation hub 6 mi. W. of the town which became Atlanta. Decatur was incorporated as a town in 1823 and named for Stephen Decatur. It adopted a city-manager form of local government in 1921 and was chartered in 1922. With the declining importance of agriculture in the area, industry assumed some importance. Manufactures include foods, cameras and paints. Industrial plants and warehouses are zoned. The residential area is attractive in a wooded setting. Agnes Scott college, for women (Presbyterian, chartered 1889), and Columbia Theological seminary (also Presbyterian) are in Decatur. Stone Mountain memorial (*q.v.*), the largest mass of exposed granite in North America, is in De Kalb county. For comparative population figures *see* table in GEORGIA: *Population.* (Js. C. B.)

DECATUR, a city in central Illinois, U.S., seat of Macon county, is located 37 mi. E. of Springfield on a bend in the Sangamon river which was dammed in 1922–23 (and improved in 1956) to form Lake Decatur. In addition to providing an adequate water supply for home users and industry the lake has become a centre of recreational activity for the surrounding region.

The city, an important communication centre, has large corn and soybean processing plants and is also significant in the manufacturing of tractors and motor-driven graders, structural and sheet steel, iron castings, automatic transmissions and carburetor parts, plastic products and gas and water main equipment. The principal shops of the Wabash railroad and a U.S. army signal corps depot are located there.

The city was not incorporated until 1839 although it was named after Stephen Decatur and located at the time of the creation of Macon county in 1829. The Lincoln family settled 9 mi. S.W. of Decatur on the Sangamon river in 1830 and Abraham Lincoln was well known in the area. The old log courthouse (erected 1829), where he often transacted legal business, stands in Fairview park. It was at Wigwam Convention hall (now marked by a plaque) that Lincoln on May 9, 1860, received his first endorsement as presidential candidate. Following the Civil War the Grand Army of the Republic was organized in Decatur on April 6, 1866.

Decatur's 1,300 ac. of public parks and playgrounds represent nearly 18 ac. per 1,000 population, almost double the standard recommended by the National Recreation association. Millikin university (Presbyterian, founded 1901) is an important factor in the cultural life of the community. In addition to its conservatory of music, it offers training in liberal arts and science, education, commerce and several vocational fields. Graduate study is offered in music and education. Pop. (1960) city 78,004; standard metropolitan statistical area (Macon county) 118,257. For comparative population figures *see* table in ILLINOIS: *Population.* (R. M. SU.)

DECAZES, ÉLIE, DUC (1780–1860), French statesman remarkable for his liberal policy in the early years of the Restoration, was born at St. Martin-de-Laye, in Guienne, on Sept. 28, 1780. He studied law, became a judge in the tribunal of the Seine in 1806 and was made a judge of appeal at Paris in 1811. After the abdication of Napoleon (1814), he declared himself a supporter of Louis XVIII, to whom he remained faithful during the Hundred Days. Appointed prefect of the Paris police by Louis XVIII in July 1815, he succeeded Joseph Fouché as minister of police in September. His resolute measures to stop the excesses of the royalist reaction earned him the hatred of the Ultras. Elected deputy for the Seine in Aug. 1815, he became the leader of the Constitutionalists (moderate royalists) and, in Aug. 1816, persuaded the king (whose personal friend he had become) to dissolve the chamber of deputies, in which the Ultras had a majority. His skilful manipulation of the elections of Oct. 1816 gave the Constitutionalists a majority, and the new electoral law voted in Feb. 1817 further strengthened their control.

On the resignation of the duc de Richelieu (Dec. 1818), a new ministry was formed, nominally under Gen. J. J. P. A. Dessolle, but in fact under Decazes, the minister of the interior. His projects for reform met with the hostility of the chamber of peers, where the Ultras were in a majority. To overcome this, he persuaded the king, in March 1819, to create 60 new peers. The government then secured the enactment of its very liberal press laws, which included the abolition of the censorship. Further measures, including the reorganization of finances, the protection of industry and the carrying out of large-scale public works brought renewed economic prosperity to the country.

The other European powers, however, viewed the growth of liberalism in France with anxiety. Their alarm was increased when Henri Grégoire (*q.v.*), who had been a bishop under the Revolution's civil constitution of the clergy, was elected to the chamber of deputies. The threat of foreign intervention rather than the attacks of the Ultras forced Louis XVIII to urge a change in the electoral law which would make an election such as Grégoire's impossible in the future. Refusing to consider such a policy, Dessolle resigned. Decazes then became head of the new ministry (Nov. 19, 1819).

The exclusion of Grégoire from the chamber and the projected changes in the franchise embittered the left without conciliating the Ultras. When on Feb. 13, 1820, the duc de Berry (*q.v.*) was murdered, Decazes was loudly accused by the Ultras of being responsible for the crime. He offered his resignation and, under pressure from the royal family, the king reluctantly accepted it (Feb. 18).

Raised to ducal rank in the French peerage on Feb. 20 (he had already been granted the Danish title of duke of Glücksbjerg in 1818), Decazes was appointed ambassador to Great Britain, but returned to France in 1821 to sit in the house of peers. After 1830 he gave his support to the July monarchy. In 1826 he had organized a society to develop the coal and iron of Aveyron, and in 1829 the name of Decazeville was given to the principal centre of the industry. He died at Decazeville on Oct. 24, 1860.

His son and successor as duc Decazes, LOUIS CHARLES ÉLIE (1819–1886), who used the title of duc de Glucksberg in his father's lifetime, was born in Paris on May 9, 1819. Entering the diplomatic service, he was minister plenipotentiary at Madrid and at Lisbon under the July monarchy. He retired to private life in 1848, but was elected a deputy to the national assembly by the Gironde *département* in 1871 and was minister of foreign affairs from 1873 to 1877. He died at the Château de Graves (Gironde) on Sept. 16, 1886.

For the elder Decazes *see* E. Daudet, *Louis XVIII et le duc Decazes* (1899) and *L'Ambassade du duc Decazes en Angleterre* (1910); R. Langeron, *Decazes, ministre du roi* (1960). (G. DE B. DE S.)

DECCAN (Sanskrit DAKSHINA, "the South") signifies strictly not the entire Indian peninsula south of the Narmada river, but only the high and relatively cool land of the Deccan plateau between the Narmada and the Tungabhadra-Krishna river, although it is sometimes also taken to include the Mysore plateau. From the Godavari southward it corresponds to the ancient subdivision of India, Kuntala. From Nov. 1, 1956, the region corresponding to the Deccan was divided, upon the dismemberment of the former Hyderabad (*q.v.*) state, primarily on a linguistic basis between the states of Mysore, Andhra Pradesh and Maharashtra (*q.v.*).

The early history of the region is obscure. Paleolithic remains and Neolithic settlements abound, and in the south there are many stone cist and cairn burials of the south Indian Iron Age. While the coastal plains were always rich in paddy and thickly populated, the plateau, though climatically favourable to vigorous endeavour,

is less well watered and has arid regions. Until large-scale irrigation works were made in historical times, cultivation must have been arduous and uncertain, especially once the land had been deforested. Consequently, Deccan dynasties attempted to acquire more fertile land in the Konkan, Gujarat, Vengi (in Andhra Pradesh) and the Cauvery valley and near Kancheepuram in Madras. While the plains were rich in food, the Deccan was and remains rich in minerals. Ancient mines explain why such rulers of the plains as the Pallavas were eager to rule the Deccan and Mysore. Similarly explicable are the interests taken by Asoka and later Samudra Gupta in what were then geographically and culturally "border regions."

The Yadavas of Deogiri acquired, as successors of the Chalukyas (*see* CHALUKYA), a great part of the Carnatic in which, as Marathas, they were aliens; their contemporaries, the Kakatiyas of Warangal, resisted their westward movement. Like the Hoysalas these families accumulated riches and tempted the sultans of Delhi. Expeditions to loot and, if possible, to make converts culminated by 1333 in the political subjugation of the Yadava and Kakatiya empires, the Hoysala becoming a nominal tributary. Almost simultaneously, about 1347, Vijayanagar (*q.v.*) succeeded in the south and the Muslim Bahmani dynasty in the central Deccan. The prize attracted Muslim adventurers from overseas, rivalries developed and the five Muslim sultanates of Golconda, Bijapur, Ahmednagar, Bidar and Berar emerged from Bahmani territories and accretions thereto between 1482 and 1518. The defeat of the Vijayanagar army by the sultans at Rakshasi-Tangadi (Talikota) in 1565 prevented the revival of Hindu rule from the south. The emperors of Delhi reasserted a title over the Deccan from 1656, but were compelled to yield to the Marathas under Sivaji, whose power grew steadily from 1706, when they acquired nominal rights of sovereignty over all the Deccan. When Nizam ul-Mulk (Mir Qamr ud-Din) became independent in 1724, laying the foundations of Hyderabad state, they were faced by a rival whose hostility, exploited by Mysore and the European powers, led gradually to the absorption of the Deccan by the British, either by subsidiary alliance, conquest, cession or failure of heirs.

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DECEBALUS (late 1st and early 2nd century A.D.), king of Dacia (*q.v.*) during the wars under the Roman emperors Domitian and Trajan, a leader of considerable ability who unified his country after a long period of weakness. One tradition says the legal king Duras resigned in his favour in 85. Decebalus was certainly responsible for annihilating a Roman army in 86 or 87, and it was with him that Domitian made terms soon after a Roman victory at Tapae in 88. His capital, Sarmisegetusa or Sarmizigethusa, was occupied by Trajan in 102. He is accused by Roman historians of having violated the treaty then made and thus of bringing on himself the final catastrophic war of 105–106, after which he committed suicide. (G. E. F. C.)

DECELEA, in ancient Greece, a deme (township) in Attica, on the pass which led over the east end of Mt. Parnes toward Oropus and Chalcis (Khalkis), commanding the Athenian plain. Its eponymous hero, Decelus, was said in legend to have indicated to Castor and Pollux (*q.v.*) where Theseus had hidden their sister Helen at Aphidnae; hence there was a traditional friendship between the Deceleans and the Spartans. This, together with the advice of Alcibiades, led the Spartans to build a fort at Decelea as a base for permanent occupation in Attica during the later years of the Peloponnesian War, from 413 to 404 B.C. Its position enabled them to harass the Athenians frequently, encourage sedition and cut them off from the port of Oropus and their silver mines at Laurium. The royal palace of Tatoi was built on the site.

See A. Milchhöfer in Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, 2425 (1901).

DECEMBER, the 12th month of the modern calendar, has 31 days. As the name shows (from Lat. *decem*, "ten"), it was the tenth month of the early Roman calendar, which began with March. The Romans celebrated the Saturnalia in December, and the ancient Teutonic peoples had at this season a great mid-winter festival, yule; some features of both survive in the traditional observances connected with Christmas. Christmas itself seems not to have been recognized as a festival by the early Christian church, nor was there at first agreement as to the date of the nativity of Christ, Jan. 6 being generally preferred in the east (*see* CHRISTMAS). The winter solstice occurs about Dec. 21. *See* also CALENDAR. (F. R. WN.)

DECEMVIRI, "ten men," the name applied by the Romans to any official commission of ten, followed by a statement of the purpose for which the commission was appointed; *e.g.*, *decemviri* (or *X viri*) *stlitibus judicandis, sacris faciundis*, etc. (*see* below).

Usually, it signified the temporary commission which superseded all the ordinary magistrates from 451 to 449 B.C., in order to draw up a code of laws. In 452 B.C. at the demand of the plebs, *decemviri* were appointed to draw up a code; during their tenure of office all other magistracies were in abeyance, but they were bound to maintain the rights of the plebs. The first board of decemvirs (all patricians) held office during 451 B.C.; the chief man among them was Appius Claudius (*see* CLAUDIUS). The decemvirs ruled with singular moderation, and submitted to the *comitia centuriata* a code of laws in ten headings. So popular were the decemvirs that another board of ten was appointed in 450 B.C., some of whom may have been plebeians (some scholars however reject the second board as a later invention). These added two more laws less favourable to the plebeians, thus completing the Laws of the Twelve Tables (*see* ROMAN LAW). But their rule then became violent and tyrannical and they were forced to abdicate (449 B.C.).

The judicial board of *decemviri stlitibus judicandis* formed a civil court concerned mainly with the free status of individuals. They were originally a body of jurors under the presidency of the praetor (*q.v.*), but eventually became minor magistrates, part of the college of 26 (*vigintisexviri*) reduced to 20 (*vigintiviri*) by Augustus, who also made the *decemviri* presidents of the centumviral courts (*see* CENTUMVIRI).

The priestly board of *decemviri sacris faciundis* was half patrician and half plebeian. They were first appointed in 367 B.C., instead of the patrician *duumviri* who had hitherto performed religious duties. Their number was increased to 15 (*quindecimviri*) in the 1st century B.C. Their chief function was the care of the Sibylline books (*see* SIBYL) and the celebration of the games of Apollo and of the Secular games.

Decemviri agris dandis adsignandis were also appointed occasionally to control the distribution of public land.

See A. H. J. Greenidge, *Legal Procedure of Cicero's Time* (1901); H. F. Jolowicz, *Historical Introduction to the Study of Roman Law*, 2nd ed. (1952).

DÉCHELETTE, JOSEPH (1862–1914), French archaeologist best known for his *Manuel d'archéologie*, was born in Roanne, Loire, Jan. 8, 1862. Educated at Saint Chamond (Loire), he was at first associated with the textile factory of his family, but in 1899 he retired from business to devote himself to archaeology. His special interest was the Celtic and Gallo-Roman periods. He collaborated with his uncle, J. G. Bulliot, in the excavations of Mont Beuvray (anc. Bibracte; *q.v.*) and after his uncle's death he took over the exploration of the site. Author of about 120 books and articles, he was a constant contributor to *L'Anthropologie, Revue Archéologique* and other periodicals. Among his publications are: *L'Oppidum de Bibracte* (1903), *Les Vases céramiques ornés de la Gaule romaine* (1904) and *La collection Millon* (1913). *Le Manuel d'archéologie préhistorique, celtique et gallo-romaine* (1908–13) is an indispensable work which covers the entire field of French prehistory from the Paleolithic to the end of the Iron Age. Profusely illustrated, its bibliography, practically complete up to the dates of publication, is one of its most important features. Déchelette was curator of the Musée de Roanne, renamed the Musée Joseph Déchelette, and was killed in the Aisne action on Oct. 8, 1914. (H. KE.)

DECIMAL: *see* ARITHMETIC; FRACTION; NUMERALS AND NUMERAL SYSTEMS.

DECIMAL COINAGE. A country using a decimal coinage system issues its metallic and paper currency in denominations that are multiples of ten of the standard unit. The U.S. dollar, for example, is divided into 100 cents and the French franc into 100 centimes. These countries also issue intermediate denominations such as the U.S. 25-cent and 50-cent pieces and the $5 note because the gaps in the decimal progression are inconveniently large.

The United States was the first country to adopt the modern decimal system. The Articles of Confederation in 1781 gave to congress the sole and exclusive power of regulating the alloy and value of coin of the United States and of the individual states. The coinage plan adopted under this provision in 1785 was a decimal system based on the Spanish dollar. Gouverneur Morris (*q.v.*) and Thomas Jefferson were mainly responsible for its provisions. When the second congress under the constitution met, one of the famous reports it received from Alexander Hamilton dealt, among other things, with coinage. He recommended much the same system as had Jefferson. Actual coinage began in 1792 with denominations of $10, $5, $2.50, $1, $.50, $.25, $.10, $.05, $.01, $.005. Both gold and silver money was coined (*see* BIMETALLISM).

France was the first European country to adopt the decimal system. The rationalism of the French Revolution led to the adoption not only of decimal coinage but also a metric system of weights and measures and the 10-month calendar. The livre of the *ancien régime* was replaced by a decimal system based on the franc. The French system was extended to the countries of the Latin Monetary union formed in 1865 with France, Belgium, Italy, Switzerland and later Greece as members. The decimal system of coinage was also adopted by Germany (1873), the Scandinavian states (1875), Austria-Hungary (1870, developed in 1892) and Russia (1875). The Latin-American countries and Japan (1871) also adopted it.

The British system of pounds, shillings and pence is the only important exception to the general predominance of the decimal system. In addition to the United Kingdom it is in use in the British colonies and in some of the countries of the commonwealth. A number of countries of the middle east follow the British in designating their standard monetary unit as a pound but use a decimal system for their subsidiary coins. In Great Britain there have been numerous proposals for adoption of a decimal monetary system but the difficulties of the change-over and the multiplicity of proposals have prevented the reform.

There are two main advantages of a decimal monetary system: (1) the ease with which the relationship of the value of various coins can be computed, and more importantly, (2) the convenience for arithmetic manipulation of stating sums of money as multiples, tenths, hundredths and thousandths of the unit of account.

For the general question of monetary scales *see* MONEY, and for the decimal system in reference to weights and measures *see* WEIGHTS AND MEASURES: *The Metric System.* (R. R. E.)

DECIN (Ger. TETSCHEN), an ancient city of Czechoslovakia, lies in the gorge of the Elbe river near the Czechoslovak-East German frontier, 18 km. (11 mi.) N.N.E. of Usti nad Labem. Pop. (1957 est.) 34,802. The Elbe flows between steep cliffs with a thick ribbon of settlement on either bank and Decin lies at its confluence with the Ploucnice on the east bank opposite Podmokly (Ger. Bodenbach). The two towns are connected by a suspension bridge. To the south are the volcanic rocks of the Stredohori highlands and to the north, great reddish cliffs of Cretaceous sandstone. Decin was founded in the 12th century and has been for centuries one of the most active ports of this part of the Elbe. Up to the time of World War II it was the headquarters of the boatmen's syndicate on the Elbe, which protected the interests of small-scale shipping, and from there in the early 20th century the *Decin Scale* was issued, the guide to navigational conditions on the Elbe throughout the year. Decin was almost wholly German up to the end of World War II, after which the towns and villages of the valley were almost emptied. The population is engaged partly in river trade and partly in metal, chemical, paper and textile industries.

DECISION PROCEDURE. In mathematics and logic, a decision procedure or algorithm for a class of questions is a method which enables one, after choosing any question of the class, to find the answer "yes" or "no" to that question by performing successively a finite number of steps determined by preassigned rules. In particular, the term is used of such procedures for finding whether a given formula is provable in a certain symbolic logic or formal mathematical system. *See* MATHEMATICS, FOUNDATIONS OF. (S. C. K.)

DECIUS, GAIUS MESSIUS QUINTUS TRAIANUS (*c.* A.D. 201–251), Roman emperor 249–251, was born at Budalia near Sirmium (Sremska Mitrovica, Yugos.) in lower Pannonia about 201. His parentage and his social origin are not known, but he was certainly a senator and a consular before his accession. It is likely that his brother was also a consular, and his wife Herennia Cupressenia Etruscilla, who bore the names of consular families of the previous century, was honoured—apparently on her own estates—in Etruria. Thus Decius probably came from a senatorial background. About 245 the emperor Philip the Arabian entrusted him with a command on the Danube, where in 249 (or the end of 248) he was proclaimed emperor, allegedly against his will. Philip advanced against him and was killed near Verona. Decius had to take the field against the Goths, who crossed the Danube and overran Moesia and Thrace. The details of the campaign are obscure. The final engagement took place on swampy ground in the Dobruja in June 251 and ended in the defeat and death of Decius and his son.

Decius was the first Roman emperor to institute an organized persecution of the Christians throughout the empire, previous persecutions having been sporadic and local in character. About the beginning of Jan. 250 an imperial edict ordered all citizens to perform a religious sacrifice in the presence of duly appointed commissioners, who were to issue a certificate (*libellus*) that they had done so. Several such certificates, written on papyrus and dated June or July 250, survive from Egypt. Many Christians obeyed the edict and were termed by Christian writers, such as Cyprian, "lapsed" (*lapsi*). Others forebore to sacrifice, but bribed the commissioners to issue a certificate; they were called "certificated" (*libellatici*). But a significant majority defied the government, and action was taken principally against the leaders of the Christians. The bishops of Rome, Jerusalem and Antioch lost their lives; the theologian Origen and many others were arrested. The effect was to strengthen rather than weaken the Christians, for public opinion condemned the government's violence and applauded the passive disobedience of the martyrs. Events justified the Christian boast that every martyr made ten converts, and persecution failed.

Early in 251, a few months before Decius' death, the commissioners seem to have ceased their activities. It appears that while absent from Rome, Decius selected the future emperor Valerian to direct the government in Rome, possibly with the title of censor or subcensor. He was succeeded by Gallus (*q.v.*).

DECKEN, KARL KLAUS, BARON VON DER (1833–1865), German explorer who, with the geologist R. Thornton (who had previously accompanied Livingstone), was the first European to climb Kilimanjaro up to 8,000 ft. and establish that it was glacier covered. Born on Aug. 8, 1833, at Kotzen, Brandenburg, he spent ten years in the military service of Hanover, but left in 1860 to explore east Africa. On his fourth expedition he and three other European members of the party were murdered by the Somalis near Bardera in late Sept. or early Oct. 1865, while attempting to navigate the Juba river. Only 11 members were able to escape to Zanzibar. Decken's collections went to the Berlin museums. The journal of his explorations was published posthumously.

See O. Kersten, *Baron K. C. v. der Decken's Reisen in Ost-Afrika* 3 vol. (1869–79); a biographical sketch in *Proc. R. Geogr. Soc.*, vol. x, pp. 206–209 (1865–66). (K. A. S.)

DECKER, SIR MATTHEW, BART. (1679–1749), British merchant and writer on trade and commerce, who can be considered one of the forerunners of Adam Smith, was born in Amsterdam in 1679. In 1702 he went to London and established himself

there as a merchant. He was a director of the East India company for 30 years and a member of the house of commons for 4 years. Decker was the author of two important tracts: *Serious Considerations on the several High Duties which the Nation in general, as well as Trade in particular, labours under* (1743), and *An Essay on the Causes of the Decline of the Foreign Trade . . .* (1744). In these essays he took a strong stand against any restriction of trade and industry whether in the form of tariffs or monopolies. Decker also proposed tax reforms, basing his arguments on the tax canons of justice, convenience and economy. He died on March 18, 1749. (L. N.)

DECKS, SHIPS', serve purposes similar to those served by the floors and roof of a building; they provide working surfaces, impart strength to the ship's structure and form a cover to exclude water from the hull. Decks may be assigned numbers or letters of the alphabet, or may be given names derived from an associated function. On a passenger liner, for example, deck nomenclature includes the following (from highest to lowest): house top, sports deck, sun deck, promenade deck, upper deck, main deck, "A" deck, "B" deck, and so on down to the lowest deck, usually called the tank top. In a cargo ship there is the bridge deck, boat deck, shelter deck, 2nd deck, 3rd deck and tank top. In naval vessels, decks above the main deck are termed levels, the first deck above the main deck being designated the 01 level, the next higher the 02 level and so on. Below the main deck, naval designations are 2nd deck, 3rd deck and so on, in descending order.

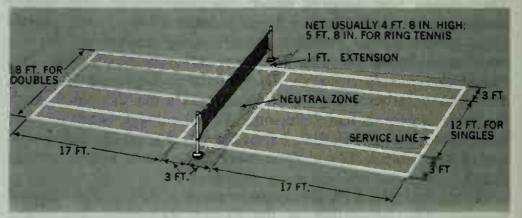
A deck may have several designations according to the functions it performs. For example, the main deck may also be the "strength deck," by virtue of its contribution to the ship's structure; in addition it may be the freeboard deck if it is the highest deck that can be made permanently watertight. The nomenclature and definitions of various decks are:

Awning deck, a complete deck on a light superstructure.
Berth deck, a deck with sleeping quarters for a ship's crew.
Boat deck, an upper deck on which lifeboats are carried.
Bridge deck, a partial deck approximately at a ship's midlength forming the top of a bridge house.
Bulkhead deck, the highest complete deck to which transverse watertight bulkheads are carried.
Damage control deck, in naval vessels, the lowest deck with access openings in the transverse watertight bulkheads.
Flight deck, on aircraft carriers, the deck where aircraft are launched or landed.
Forecastle deck, a partial deck above the main deck at the bow.
Freeboard deck, the highest complete deck having permanent means of closing all openings to the weather.
Gun deck, a deck on which guns are mounted.
Main deck, the principal deck on a ship having several decks; in a naval vessel, the highest complete deck contributing significantly to the strength of the ship.
Orlop deck, a partial deck in the lower part of a ship, or the lowest deck in a ship having four or more decks.
Platform deck, a partial deck below the lowest complete deck; when there are more than one, they are termed first, second, third, in descending order.
Poop deck, a partial deck above the main deck at the stern.
Promenade deck, an upper superstructure deck on passenger ships.
Protective deck, in naval vessels, a deck of extra thickness and special strength.
Quarter-deck, in sailing vessels, that portion of the upper deck between the mainmast and the stern; in naval vessels, an area of the weather deck reserved for officers.
Shelter deck, a complete deck on a light superstructure similar to an awning deck, but with at least one opening referred to as a "tonnage opening," not having permanent means for closure to the weather.
Strength deck, the highest complete deck contributing significantly to the strength of the ship; in naval vessels, the main deck.
Sun deck, the highest deck on large passenger liners.
Superstructure deck, a lightly constructed deck in the upper part of a ship, usually the first deck above the strength deck.
Tonnage deck, the deck from which a cargo ship's carrying capacity, or tonnage, is measured.
Upper deck, the highest complete deck having all openings fitted with permanent means for closure against sea and weather.
Watertight deck, any deck constructed to prevent water passing through it.
Weather deck, the highest continuous deck exposed to the weather.
(Ed. C. T.)

DECK TENNIS is a recreation designed for the limited space on shipboard and has proved popular enough to have been translated to land use as a garden game, the principle being that a ring or quoit is thrown across a net and must be caught single-handed before it falls to the ground, and be returned immediately.

The size of the court and of the rubber (formerly rope) ring used and the rules of play are not standardized. The following practice seems to be widely acceptable.

The game can be singles (two players) or doubles (four players). The server, as in lawn tennis, serves first from behind the right-hand court into the court diagonally opposite. A point is gained by that side whose opponents fail to return the ring into the first side's ground. If the ring lands in the neutral zone (*see* fig.) or outside the court, the thrower loses the point.



DECK TENNIS COURT: DIMENSIONS MAY BE ADAPTED TO SPACE AVAILABLE

As in tennis points are scored only in service or, by agreement, the server may continue to score until he loses a point, when his opponent may either take the point for himself and allow the server to continue or forgo the point and take over the service. The first player (or side) to score 15 points wins a set—a match can be over the best of three or five sets. In the event of the score's becoming 14–14 it is necessary to win 2 successive points to take the set.

The game sometimes is known as ring tennis when played indoors or when the higher net (5 ft. 8 in. instead of 4 ft. 8 in. or 5 ft.) is used. (N. D. McW.)

DECLARATION OF INDEPENDENCE, in the history of the United States, the famous document approved by the continental congress on July 4, 1776, which announced the separation of the 13 colonies from Great Britain and offered a justification therefor. It explained why the congress on July 2 "unanimously" by the votes of twelve colonies, with New York abstaining, resolved that "these United Colonies are, and of right ought to be Free and Independent States." Accordingly, the day on which final separation was officially voted was July 2, although the 4th, the day on which the Declaration of Independence was adopted, has always been celebrated in the United States as the great national holiday—the Fourth of July or Independence Day (*q.v.*).

When armed conflict began between the colonies and Britain on April 19, 1775 (*see* AMERICAN REVOLUTION), the American patriots claimed they sought only their rights within the British empire. At that time few of the colonists consciously desired to separate from Britain. It is apparent, however, that they were determined to secure their rights—which they were then describing as those of mankind as well as of Englishmen—whether within or without the empire. As the War of Independence proceeded during 1775 and Britain undertook to assert her sovereignty by means of large armed forces, making only a gesture toward conciliation, the patriots increasingly came to believe that they must secure their rights outside the empire. The losses and suffering that came from the war greatly widened the breach between the colonies and the mother country; moreover, it was necessary to assert independence in order to secure as much French aid as possible.

A royal proclamation of Aug. 23, 1775, declaring the colonies to be in rebellion, and the Prohibitory act of the following November, which withdrew from them the royal protection, spurred on the patriots. Before the end of that year George Washington and other high officers of the American army investing Boston were converted to independence. Early in 1776 Thomas Paine's *Common Sense* with its forthright denunciation both of Britain

and monarchy began to exercise a potent influence. On April 12 the Revolutionary convention of North Carolina specifically authorized the delegates of that colony in congress to vote for independence; and on May 15 the Virginia convention instructed its deputies to offer the motion which was finally adopted on July 2. It was brought forward in the congress by Richard Henry Lee on June 7. By that time the congress had already taken long steps toward severing ties with Britain. It had denied parliamentary sovereignty over the colonies as early as Dec. 6, 1775; and it had declared on May 10, 1776, that the authority of the king ought to be "totally suppressed," advising all the several colonies to establish governments of their own choice.

The passage of Lee's resolution was delayed for several reasons. Some of the delegates had not yet received authorization to vote for separation; a few were opposed to taking the final step; and several men, among them John Dickinson, believed that the formation of a central government, together with attempts to secure foreign aid, should precede it. However, a committee consisting of Thomas Jefferson, John Adams, Benjamin Franklin, Roger Sherman and Robert R. Livingston was promptly chosen on June 11 to prepare a statement justifying the decision to assert independence, should it be taken. On July 1 nine delegations voted for separation, despite warm opposition on the part of Dickinson. On the following day, with the New York delegation abstaining only because it lacked permission to act, the Lee resolution was adopted. (The convention of New York gave its consent on July 9, and the New York delegates voted affirmatively on July 15.)

The Declaration of Independence was largely written by Jefferson, who had displayed talent as a political philosopher and polemicist in his *A Summary View of the Rights of British America,* published in 1774. At the request of his fellow committee members he wrote the first draft. The members of the committee made a number of merely verbal changes, and they also expanded somewhat a list of charges against the king which Jefferson had prepared. The congress made more substantial changes, deleting a condemnation of the British people, a reference to "Scotch & foreign mercenaries" (there were Scots in the congress) and a denunciation of the African slave trade (this being offensive to some southern and New England delegates). The result was an extraordinarily appealing document couched in melodious language superbly fitted to its purpose.

It can be said, as John Adams did, that the declaration contained nothing really novel in its political philosophy, which was derived from Locke, Sidney and other English theorists. It may also be asserted that the argument offered was not without flaws in history and logic. Substantially abandoning contention on the basis of the rights of Englishmen, the declaration put forth the more fundamental doctrines of natural rights and of government under contract. Claiming that parliament never truly possessed sovereignty over the colonies and that the crown of right exercised it only under contract, it contended that George III, with the support of a "pretended" legislature, had persistently violated the agreement between himself as governor and the Americans as the governed. A long list of accusations was offered toward proving this contention. The right and duty of revolution were then invoked, the delegates pledging their lives, honour and fortunes to the cause of independence.

Few will now claim that government arose among men as Locke and Jefferson said it did, and the contract theory has lost vogue among political scientists. It is likewise true from a British viewpoint that parliament and crown could not be separated, and that the history of the colonies after 1607 was not entirely consistent with the assertion that parliament had never as of right possessed sovereignty over them. Furthermore, the specific charges brought against the king were partisan and not uniformly defensible, and the general accusation that he intended to establish an "absolute Despotism" is hardly warranted. It should be added that several of the heaviest specific complaints condemned actions of the British government taken after the beginning of hostilities.

The defects in the Declaration of Independence are by no means sufficient to force the conclusion that the document is unsound. On the contrary, it was in essence morally just and politically valid. If the right of revolution cannot be established on historical grounds, it nevertheless rests solidly upon ethical ones. The right of the colonists to government ultimately of their own choice is hardly deniable. Moreover, close scrutiny of the behaviour of the British government and of the colonists after 1763 must persuade that the grievances of the Americans were neither trifling nor transient.

Announcing to a "candid world" why it severed the bonds between America and Britain, the congress raised a noble standard to which the Americans could rally in the War of Independence and afterward. Some of the phrases of the declaration have steadily exerted profound influence in the United States, especially the proclamation that, "We

The Signers of the Declaration of Independence

Name	Birth-Death	National origin	Religion	Occupation	State represented
John Hancock	1737–93	English	Congregational	Merchant	Mass.
Button Gwinnett	*c.*1735–77	English	Episcopal	Merchant	Ga.
Lyman Hall	1725–90	English	Congregational	Physician	Ga.
George Walton	*c.*1740–1804	English	Episcopal	Mechanic-Lawyer	Ga.
William Hooper	1742–90	English	Congregational	Lawyer	N.C.
Joseph Hewes	1730–79	English	Episcopal	Merchant	N.C.
John Penn	1741–88	English	Episcopal	Lawyer	N.C.
Edward Rutledge	1749–1800	English	Episcopal	Planter-Lawyer	S.C.
Thomas Heyward, Jr.	1746–1809	English	Episcopal	Lawyer	S.C.
Thomas Lynch, Jr.	1749–79	Irish-Dutch-English	Episcopal	Lawyer	S.C.
Arthur Middleton	1742–87	English	Episcopal	Planter	S.C.
Samuel Chase	1741–1811	English	Episcopal	Lawyer	Md.
William Paca	1740–99	Italian-English	Episcopal	Lawyer	Md.
Thomas Stone	1743–87	English	Episcopal	Lawyer	Md.
Charles Carroll of Carrollton	1737–1832	Irish	Roman Catholic	Planter	Md.
George Wythe	1726–1806	English	Episcopal	Lawyer	Va.
Richard Henry Lee	1732–94	English	Episcopal	Planter	Va.
Thomas Jefferson	1743–1826	English	Unitarian	Planter-Lawyer	Va.
Benjamin Harrison	1726–91	English	Episcopal	Planter	Va.
Thomas Nelson, Jr.	1738–89	Scottish-English	Episcopal	Merchant-Planter	Va.
Francis Lightfoot Lee	1734–97	English	Episcopal	Planter	Va.
Carter Braxton	1736–97	English	Episcopal	Planter	Va.
Robert Morris	1734–1806	English	Episcopal	Merchant	Pa.
Benjamin Rush	1745–1813	English	Episcopal, Presbyterian	Physician	Pa.
Benjamin Franklin	1706–90	English	Deist	Printer	Pa.
John Morton	1724–77	Swedish-English	Episcopal	Farmer	Pa.
George Clymer	1739–1813	English	Episcopal	Merchant	Pa.
James Smith	*c.*1719–1806	Scotch-Irish	Presbyterian or Episcopal	Lawyer	Pa.
George Taylor	1716–81	Scotch-Irish	Episcopal	Ironmaster	Pa.
James Wilson	1742–98	Scottish	Presbyterian	Lawyer	Pa.
George Ross	1730–79	Scottish	Episcopal	Lawyer	Pa.
Caesar Rodney	1728–84	English	Episcopal	Planter	Del.
George Read	1733–98	Irish-Welsh	Episcopal	Lawyer	Del.
Thomas McKean	1734–1817	Scotch-Irish	Presbyterian	Lawyer	Del.
William Floyd	1734–1821	Welsh-English	Presbyterian	Landowner	N.Y.
Philip Livingston	1716–78	Dutch-Scottish	Presbyterian	Merchant	N.Y.
Francis Lewis	1713–1803	Welsh	Episcopal	Merchant	N.Y.
Lewis Morris	1726–98	English-Dutch	Episcopal	Landowner	N.Y.
Richard Stockton	1730–81	English	Presbyterian	Lawyer	N.J.
John Witherspoon	1723–94	Scottish	Presbyterian	Clergyman	N.J.
Francis Hopkinson	1737–91	English	Episcopal	Lawyer-Writer	N.J.
John Hart	*c.*1711–79	English	Baptist	Farmer	N.J.
Abraham Clark	1726–94	English	Presbyterian	Surveyor	N.J.
Josiah Bartlett	1729–95	English	Congregational	Physician-Judge	N.H.
William Whipple	1730–85	English	Congregational	Merchant-Judge	N.H.
Matthew Thornton	1714–1803	Scotch-Irish	Congregational	Physician	N.H.
Samuel Adams	1722–1803	English	Congregational	Politician	Mass.
John Adams	1735–1826	English	Unitarian	Lawyer	Mass.
Robert Treat Paine	1731–1814	English	Unitarian	Lawyer	Mass.
Elbridge Gerry	1744–1814	English	Episcopal	Merchant	Mass.
Stephen Hopkins	1707–85	English	Quaker	Surveyor-Merchant	R.I.
William Ellery	1727–1820	English	Congregational	Lawyer	R.I.
Roger Sherman	1721–93	English	Congregational	Cobbler-Lawyer	Conn.
Samuel Huntington	1731–96	English	Congregational	Lawyer	Conn.
William Williams	1731–1811	English	Congregational	Merchant	Conn.
Oliver Wolcott	1726–97	English	Congregational	Lawyer	Conn.

IN CONGRESS, JULY 4, 1776.

The unanimous Declaration of the thirteen united States of America,

When in the course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation. ——— We hold these truths to be self-evident, that all men are created equal, that they are endowed by their creator with certain unalienable Rights, that among these are life, liberty and the pursuit of Happiness. ——— That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed, ——— That whenever any form of government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their safety and Happiness. Prudence, indeed, will dictate that Governments long established should not be changed for light and transient causes; and accordingly all experience hath shewn, that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, pursuing invariably the same Object evinces a design to reduce them under absolute Despotism, it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future security. ——— Such has been the patient sufferance of these Colonies; and such is now the necessity which constrains them to alter their former Systems of Government. ——— The history of the present King of Great Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States. To prove this, let Facts be submitted to a candid world. ——— He has refused his Assent to Laws, the most wholesome and necessary for the public good. ——— He has forbidden his Governors to pass Laws of immediate and pressing importance, unless suspended in their operation till his Assent should be obtained; and when so suspended, he has utterly neglected to attend to them. ——— He has refused to pass other Laws for the accommodation of large districts of people, unless those people would relinquish the right of Representation in the Legislature, a right inestimable to them and formidable to tyrants only. ——— He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records, for the sole purpose of fatiguing them into compliance with his measures. ——— He has dissolved Representative Houses repeatedly, for opposing with manly firmness his invasions on the rights of the people. ——— He has refused for long time, after such dissolutions, to cause others to be elected; whereby the Legislative powers, incapable of Annihilation, have returned to the People at large for their exercise; the State remaining in the mean time exposed to all the dangers of invasion from without, and convulsions within. ——— He has endeavoured to prevent the population of these States; for that purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass others to encourage their migrations hither, and raising the conditions of new Appropriations of lands. ——— He has obstructed the Administration of Justice, by refusing his Assent to Laws for establishing Judiciary powers. ——— He has made Judges dependent on his Will alone, for the tenure of their offices, and the amount and payment of their salaries. ——— He has erected a multitude of New Offices, and sent hither swarms of Officers to harass our people, and eat out their substance. ——— He has kept among us, in times of peace, Standing Armies without the Consent of our legislatures. ——— He has affected to render the Military independent of and superior to the Civil power. ——— He has combined with others to subject us to a jurisdiction foreign to our constitution, and unacknowledged by our laws; giving his Assent to their Acts of pretended Legislation: ——— For quartering large bodies of armed troops among us: ——— For protecting them, by a mock Trial, from punishment for any Murders which they should commit on the Inhabitants of these states: ——— For cutting off our Trade with all parts of the world: ——— For imposing Taxes on us without our Consent: ——— For depriving us in many cases, of the benefits of Trial by jury: ——— For transporting us beyond Seas to be tried for pretended offences: ——— For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit instrument for introducing the same absolute rule into these Colonies: ——— For taking away our Charters, abolishing our most valuable Laws, and altering fundamentally the Forms of our Governments: ——— For suspending our own Legislatures, and declaring themselves invested with Power to legislate for us in all cases whatsoever. ——— He has abdicated Government here, by declaring us out of his Protection and waging War against us. ——— He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives of our people. ——— He is at this time transporting large Armies of foreign Mercenaries to compleat the works of death, desolation and tyranny, already begun with circumstances of Cruelty & perfidy scarcely paralleled in the most barbarous ages, and totally unworthy the Head of a civilized nation. ——— He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against their Country, to become the executioners of their friends and Brethren, or to fall themselves by their Hands. ——— He has excited domestic insurrections amongst us, and has endeavoured to bring on the inhabitants of our frontiers, the merciless Indian Savages, whose known rule of warfare, is an undistinguished destruction of all ages, sexes and conditions. ——— In every stage of these Oppressions We have Petitioned for Redress in the most humble terms: Our repeated Petitions have been answered by repeated injury. A Prince, whose character is thus marked by every act which may define a Tyrant, is unfit to be the ruler of a free people. ——— Nor have We been wanting in attentions to our British brethren. We have warned them from time to time of attempts by their legislature to extend an unwarrantable jurisdiction over us. We have reminded them of the circumstances of our emigration and settlement here. We have appealed to their native justice and magnanimity, and we have conjured them by the ties of our common kindred to disavow these usurpations, which, would inevitably interrupt our connections and correspondence. They too have been deaf to the voice of justice and of consanguinity. ——— We must, therefore, acquiesce in the necessity, which denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in War, in Peace Friends. ———

We, therefore, the Representatives of the united States of America, in General Congress, Assembled, appealing to the Supreme Judge of the world for the rectitude of our intentions, do, in the Name, and by authority of the good People of these Colonies, solemnly publish and declare, That these United Colonies are, and of Right ought to be Free and Independent States; that they are Absolved from all Allegiance to the British Crown, and that all political connection between them and the State of Great Britain, is and ought to be totally dissolved; and that as Free and Independent States, they have full Power to levy War, conclude Peace, contract Alliances, establish Commerce, and to do all other Acts and Things which Independent States may of right do. ——— And for the support of this Declaration, with a firm reliance on the protection of divine Providence, we mutually pledge to each other our lives, our fortunes and our sacred Honor.

Button Gwinnett
Lyman Hall
Geo Walton

Wm Hooper
Joseph Hewes
John Penn

John Hancock

Edward Rutledge

Thos Heyward Junr
Thomas Lynch Junr
Arthur Middleton

Samuel Chase
Wm Paca
Thos Stone
Charles Carroll of Carrollton

George Wythe
Richard Henry Lee
Th Jefferson
Benj Harrison
Thos Nelson Jr
Francis Lightfoot Lee
Carter Braxton

Robt Morris
Benjamin Rush
Benj Franklin
John Morton
Geo Clymer
Jas Smith
Geo Taylor
James Wilson
Geo Ross

Caesar Rodney
Geo Read
Tho M:Kean

Wm Floyd
Phil Livingston
Frans Lewis
Lewis Morris

Richd Stockton
Jno Witherspoon
Fras Hopkinson
John Hart
Abra Clark

Josiah Bartlett
Wm Whipple

Saml Adams
John Adams
Robt Treat Paine
Elbridge Gerry

Step Hopkins
William Ellery

Roger Sherman
Sam'el Huntington
Wm Williams
Oliver Wolcott

Matthew Thornton

THE DECLARATION OF INDEPENDENCE OF THE UNITED STATES

A facsimile reproduction of the DECLARATION OF INDEPENDENCE. The printed text appears on the facing page

IN CONGRESS, JULY 4, 1776

THE UNANIMOUS DECLARATION of the thirteen united STATES OF AMERICA.

WHEN in the Course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.—We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness.—That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed,—That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness. Prudence, indeed, will dictate that Governments long established should not be changed for light and transient causes; and accordingly all experience hath shewn that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, pursuing invariably the same Object evinces a design to reduce them under absolute Despotism, it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future security.—Such has been the patient sufferance of these Colonies; and such is now the necessity which constrains them to alter their former Systems of Government. The history of the present King of Great Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States. To prove this, let Facts be submitted to a candid world.—He has refused his Assent to Laws, the most wholesome and necessary for the public good.—He has forbidden his Governors to pass Laws of immediate and pressing importance, unless suspended in their operation till his Assent should be obtained; and when so suspended, he has utterly neglected to attend to them.—He has refused to pass other Laws for the accommodation of large districts of people, unless those people would relinquish the right of Representation in the Legislature, a right inestimable to them and formidable to tyrants only.—He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records, for the sole purpose of fatiguing them into compliance with his measures.—He has dissolved Representative Houses repeatedly, for opposing with manly firmness his invasions on the rights of the people.—He has refused for a long time, after such dissolutions, to cause others to be elected; whereby the Legislative powers, incapable of Annihilation, have returned to the People at large for their exercise; the State remaining in the mean time exposed to all the dangers of invasion from without, and convulsions within.—He has endeavoured to prevent the population of these States; for that purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass others to encourage their migrations hither, and raising the conditions of new Appropriations of Lands.—He has obstructed the Administration of Justice, by refusing his Assent to Laws for establishing Judiciary powers.—He has made Judges dependent on his Will alone, for the tenure of their offices, and the amount and payment of their salaries.—He has erected a multitude of New Offices, and sent hither swarms of Officers to harass our people, and eat out their substance. He has kept among us, in times of peace, Standing Armies without the Consent of our legislatures.—He has affected to render the Military independent of and superior to the Civil power.—He has combined with others to subject us to a jurisdiction foreign to our constitution, and unacknowledged by our laws; giving his Assent to their Acts of pretended Legislation:—For quartering large bodies of armed troops among us:—For protecting them, by a mock Trial, from punishment for any Murders which they should commit on the Inhabitants of these States:—For cutting off our Trade with all parts of the world:—For imposing Taxes on us without our Consent:—For depriving us in many cases, of the benefits of Trial by Jury:—For transporting us beyond Seas to be tried for pretended offences:—For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit instrument for introducing the same absolute rule into these Colonies:—For taking away our Charters, abolishing our most valuable Laws and altering fundamentally the Forms of our Governments:—For suspending our own Legislatures, and declaring themselves invested with power to legislate for us in all cases whatsoever.—He has abdicated Government here, by declaring us out of his Protection and waging War against us.—He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives of our people.—He is at this time transporting large Armies of foreign Mercenaries to compleat the works of death, desolation and tyranny, already begun with circumstances of Cruelty & perfidy scarcely paralleled in the most barbarous ages, and totally unworthy the Head of a civilized nation.—He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against their Country, to become the executioners of their friends and Brethren, or to fall themselves by their Hands.—He has excited domestic insurrections amongst us, and has endeavoured to bring on the inhabitants of our frontiers, the merciless Indian Savages, whose known rule of warfare, is an undistinguished destruction of all ages, sexes and conditions. In every stage of these Oppressions We have Petitioned for Redress in the most humble terms: Our repeated Petitions have been answered only by repeated injury. A Prince, whose character is thus marked by every act which may define a Tyrant, is unfit to be the ruler of a free people. Nor have We been wanting in attentions to our Brittish brethren. We have warned them from time to time of attempts by their legislature to extend an unwarrantable jurisdiction over us. We have reminded them of the circumstances of our emigration and settlement here. We have appealed to their native justice and magnanimity, and we have conjured them by the ties of our common kindred to disavow these usurpations, which would inevitably interrupt our connections and correspondence. They too have been deaf to the voice of justice and of consanguinity. We must, therefore, acquiesce in the necessity, which denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in War, in Peace Friends.—

WE, THEREFORE, the Representatives of the UNITED STATES OF AMERICA, in General Congress, Assembled, appealing to the Supreme Judge of the world for the rectitude of our intentions, do, in the Name, and by Authority of the good People of these Colonies, solemnly publish and declare, That these United Colonies are, and of Right ought to be FREE AND INDEPENDENT STATES; that they are Absolved from all Allegiance to the British Crown, and that all political connection between them and the State of Great Britain, is and ought to be totally dissolved; and that as Free and Independent States, they have full Power to levy War, conclude Peace, contract Alliances, establish Commerce, and to do all other Acts and Things which Independent States may of right do.—And for the support of this Declaration, with a firm reliance on the protection of divine Providence, we mutually pledge to each other our Lives, our Fortunes and our sacred Honor.

John Hancock
Button Gwinnett
Lyman Hall
Geo. Walton
Wm. Hooper
Joseph Hewes
John Penn
Edward Rutledge
Thos. Heyward, Jr.
Thomas Lynch, Jr.
Arthur Middleton
Samuel Chase
Wm. Paca
Thos. Stone
Charles Carroll of Carrollton
George Wythe
Richard Henry Lee
Th. Jefferson
Benj. Harrison
Thos. Nelson, Jr.
Francis Lightfoot Lee
Carter Braxton
Robt. Morris
Benjamin Rush
Benj. Franklin
John Morton
Geo. Clymer
Jas. Smith
Geo. Taylor
James Wilson
Geo. Ross
Caesar Rodney
Geo. Read
Tho. M:Kean
Wm. Floyd
Phil. Livingston
Frans. Lewis
Lewis Morris
Richd. Stockton
Jno. Witherspoon
Fras. Hopkinson
John Hart
Abra. Clark
Josiah Bartlett
Wm. Whipple
Saml. Adams
John Adams
Robt. Treat Paine
Elbridge Gerry
Step. Hopkins
William Ellery
Roger Sherman
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THE DECLARATION OF INDEPENDENCE OF THE UNITED STATES

The text of the Declaration of Independence. The original document is shown in facsimile on the facing page

hold these truths to be self-evident that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness." While the meanings of these phrases, together with conclusions drawn from them, have been endlessly debated, the declaration has served to justify the extension of American political and social democracy. Appeals to it as "higher law" superior even to the federal constitution were frequent in the middle third of the 19th century and still continue. Abraham Lincoln emphatically asserted that his political philosophy was based upon it.

The Declaration of Independence has also been a source of inspiration outside the United States. It encouraged Antonio de Nariño and Francisco de Miranda to strive toward overthrowing the Spanish empire in South America, and was quoted with enthusiasm by the Marquis de Mirabeau during the French Revolution. It must remain a great historical landmark in that it contained the first formal assertion by a whole people of their right to a government of their own choice. What Locke had contended for as an individual, the patriots proclaimed as a body politic; moreover, they made good the argument by force of arms.

Contrary to the inference which has often been drawn from the form of the document, the declaration was not signed by the delegates on July 4. Adoption of the declaration was celebrated on July 8 in Philadelphia, among other ways by the ringing of all the church bells, and the declaration was read before Washington's army on July 9. On July 19 the congress ordered the document to be engrossed as "The Unanimous Declaration of the Thirteen United States of America." It was accordingly put on parchment, probably by Timothy Matlack of Philadelphia. Members of congress present on Aug. 2 affixed their signatures to this parchment copy on that day, and others later. The last signer was Thomas McKean of Delaware, whose name was not placed on the document before 1777.

Not all of those who voted for the declaration on July 4 were later present to sign it; on the other hand, men who were not in congress on July 4 did put their names upon it. Fifty-six men in all, including John Hancock, signed. Printed copies of the document were authorized by congress and circulated after Jan. 1777.

For 101 years after the declaration was proclaimed it had no permanent home. During its wanderings it found shelter in ten cities and five states, twice narrowly escaped destruction by fire and in both the American Revolution and the War of 1812 was nearly captured by the British. In 1894, when the text of the manuscript had been dimmed by exposure to light and its signatures had been damaged by too frequent rolling of the parchment, the document was placed in a safe in the library of the U.S. department of state. In 1921 it was removed to the Library of Congress, where it remained until 1952; it was then placed in the National Archives exhibition hall in Washington, D.C.

See also references under "Declaration of Independence" in the Index volume.

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(J. R. AL.)

DECLINATION, in terrestrial magnetism, is the angle between true north and magnetic north, *i.e.*, the variation between the true (geographic) meridian and the magnetic meridian. In 1596 at London the angle of declination was 11° E. of N., in 1652 magnetic north was true north, in 1815 the magnetic needle pointed 24½° W. of N., in 1891 18° W., in 1932 12° 3′ W., and in 1956 8° 37′ W. The angle is gradually diminishing and the declination will in time again be 0°, then it will slowly increase in an easterly direction, the north magnetic pole oscillating slowly around the north pole. Magnetic storms cause irregular variations sometimes of one or two degrees. (*See* GEOMAGNETISM.)

In astronomy, the declination of a star is its angular distance north or south of the celestial equator, measured along the hour circle passing through the star, from 0° at the equator to +90° or −90° at the north or south celestial pole, respectively. There is an analogy between the declination of a star measured from the celestial equator and the terrestrial latitude of a station measured from the earth's equator. *See* ASTRONOMY: *Stellar Positions and Names.*

(A. Po.)

DECOLORIZING, in practical chemistry and chemical technology, the removal of coloured impurities from a substance. Charcoal, sometimes made from blood, bones or sugar, but now usually made from wood, is frequently used. So-called "activated charcoal," which is especially effective as a decolorizing agent, is prepared by treating charcoal with superheated steam for several hours at 800°–1,000° C., or with air at 350°–400° C. When shaken with a coloured solution, charcoal often retains the coloured substances, leaving the solution colourless. Thus the red colour of wines may be removed by filtering the wine through charcoal; the dark-coloured impurities of crude sugar may be removed in the same way. Other decolorizers acting through purely chemical reactions are chlorine, sulfurous acid, permanganates and manganates, all of which have been used in the sugar industry. *See* CHARCOAL and ADSORPTION.

(G. W. WD.)

DECONGESTANT DRUGS are compounds used to relieve the nasal congestion accompanying such conditions as colds and hay fever. When administered in nasal sprays or drops, or in devices for inhalation, such drugs shrink the mucous membranes lining the nasal cavity by contracting the muscle of blood vessel walls, thus reducing blood flow to the inflamed areas. The constricting action is chiefly on the smallest arteries, the arterioles, although capillaries, veins and larger arteries respond to some degree. Decongestant drugs are classified pharmacologically as sympathomimetic agents; they mimic the effects of stimulation of the sympathetic division of the autonomic nervous system. One of the chief drugs of the group is epinephrine, also called adrenalin, a hormone of the adrenal gland and the chemical effector substance released at sympathetic nerve endings when the nerves are stimulated. The decongestant action resembles the blanching of the skin that occurs with anger or fright, in which epinephrine released from the adrenal gland constricts the blood vessels of the skin. (*See* also ADRENALINE AND NORADRENALINE.)

The epinephrinelike effects of the other decongestant drugs result from their chemical similarity to epinephrine; all are amines. Oldest and most important is ephedrine, an alkaloid originally obtained from a plant drug, *ma huang*, which has been used in Chinese medicine for more than 5,000 years, but now made by chemical synthesis. Except for epinephrine itself, the others are all synthetic compounds. They include phenylephrine hydrochloride, amphetamine and several derivatives, and naphazoline hydrochloride. To gain a sustained effect, they must be used repeatedly, but too frequent use results in absorption into the blood stream, causing nervousness, insomnia, dizziness, headache or palpitations.

(V. E.)

DECORATED PERIOD, in architecture, the name of the second of the three periods into which the English Gothic was usually divided, generally embracing the first three-quarters of the 14th century. It may itself be divided into two, the earlier half being known as the Geometric period, and the later as the Curvilinear, although no definite date separates these two parts. The Geometric Decorated style is characterized by window tracery based on the arch, the circle and the quatrefoil and trefoil, frequently much cusped. (*See* CUSP.) Windows of great width and height were thus treated, with two, four, six or even eight lights, or main subdivisions. In the later, or Curvilinear style, the ogee curve, or curve of double curvature, controls tracery design. Two main types thus developed; one in which the tracery bars form a net, the other in which flamelike or flowing forms predominate. (*See* TRACERY.) In the entire Decorated period molding profiles are heavy and complex; carved ornament is intricate and of great naturalism. The most famous examples are the east end of Lincoln cathedral and the crossing and western part of the choir of Ely. During the Decorated period, church vaulting

became much complicated and subdivided by the addition, first of tiercerons, which are additional vaulting ribs springing from the capital and rising to the ridge; toward the end of the period there also appeared liernes, which are smaller ribs of little structural value connecting the more important ribs and so forming star or network patterns. *See* also EARLY ENGLISH PERIOD; FLAMBOYANT STYLE. (T. F. H.)

DECORATION DAY: *see* MEMORIAL DAY.

DECORATIONS OF HONOUR: *see* MEDALS AND DECORATIONS.

DECORATIVE ART. The conception of a subsidiary category of art to cover the arts of design was a necessary consequence of the idea of a category of the fine arts (*q.v.*), with architecture as an ambivalent link between the two. The conception of decorative art, however, was arrived at just at the moment when the industrial revolution began to transform the "handmade" crafts; the first recorded use of the word "decorative" dates from 1791. It was soon extended from such productions as Josiah Wedgwood's Etrurian ware to cover the whole field of the mechanically produced minor arts of the 19th century. Gradually decoration came to be thought of as a kind of artistic varnish that could be transferred to any plain surface; at this stage the phrase "applied art" was commonly used. It then came to be considered as an element in the economical production of a salable product: a phase admirably represented by the phrase "industrial art." This view provoked a reaction in the arts and crafts movement (*q.v.*) inspired by William Morris. Between World Wars I and II it began to be realized that this element of acceptability by the buying public was of great commercial importance. It was named "design," but during the period of shortage in and after World War II the word came to mean the adaptation of an object to mass production. A certain ambiguity in its use has remained. *See* INDUSTRIAL DESIGN; DESIGN, 19TH-CENTURY; DESIGN, 20TH-CENTURY; DISPLAY DESIGN; FURNITURE DESIGN; PACKAGING; *see* also references under "Decorative Art" in the Index. (J. Ev.)

DECRETALS, FALSE, a 9th-century collection of partially forged documents, the object of the falsification being to free the church from interference by the state and to maintain the independence of the bishops against the encroachments of the archbishops, who were attempting to extend their power.

A party had been formed in the Frankish empire to combat the subjection of the church to the state. In synods and writings its members pleaded for the independence of the church and freedom from interference in its own field on the part of the state. Within this party was a group that became convinced that the use of legitimate means would never accomplish this purpose and determined to try to achieve it by illegitimate means. They conceived that a necessary positive legislation could be projected into the past by attributing it to popes and kings long dead. To this end they produced a number of falsifications of church law: the *Hispana* of Autun (*Augustodunensis*), which was a reworking of the *Hispana* collection widely used at the time; the *Capitula Angilramni;* the *Capitularia Benedicti Levitae;* and the best known of all, the False Decretals.

The False Decretals—also called the Decretals of Pseudo-Isidore because their compilers passed as St. Isidore of Seville, and sometimes the Collection of Isidore Mercator because they usually begin with the words *Isidorus Mercator, servus Christi lectori salutem* ("Isidore the merchant, a servant of Christ, salutes the reader")—purport to be a collection of decrees of councils and decretals of popes of the first seven centuries. The collection contains: (1) the letters of the ante-Nicene popes from Clement to Miltiades—all are forgeries, some of which antedate the collection; (2) a collection of the decrees of councils, most of which are genuine though the forged Donation of Constantine is included (*see* DONATION OF CONSTANTINE); (3) a large collection of letters of the popes from Silvester I (d. 335) to Gregory II (d. 731), among which there are more than 40 falsifications.

As a collection the False Decretals seem to have been used first at the Council of Soissons in 853. They were known at the end of the 9th century in Italy but had little influence there till the end of the 10th century. Thereafter they were generally accepted by canonists, theologians and councils as authentic. Petrus Comestor in the 12th, Marsiglio of Padua in the 14th and Nicholas of Cusa in the 15th century doubted their authenticity. In the 16th century they were rejected by Erasmus, Cesare Baronius and Robert Bellarmine as well as by the Centuriators of Magdeburg (compilers of a church history published 1559–74). When Francisco Torres defended their authenticity against the Centuriators, David Blondel refuted him in his *Pseudo-Isidorus et Turrianus Vapulantes* (Geneva, 1628), which ended the controversy. Since that time research has concentrated on the origin, extent and purpose of the falsification.

Modern scholars do not believe that they were produced in Rome. Their place of origin was somewhere in France (Reims, Le Mans, Tours) and the time was about 850. The object of the forgers was not to extend papal authority; rather, in seeking to effect the purpose mentioned above, they attributed laws and customs to earlier times and earlier popes than the facts permit. To this end they insist on the canonical election of bishops, on the exemption of clerics from trial in civil courts and condemn the alienation of ecclesiastical property. In order to stop the abuses of archiepiscopal power they maintained that the provincial council when summoned by the pope was the superior of the bishops. In so doing they put the centralization of the church in this matter further back in time than is acceptable.

It is untrue to say that the False Decretals revolutionized canon law by substituting a new code for the older one. But the forgers did have a considerable influence. They seem to have helped eliminate *chorepiscopi* (bishops in full orders who at this time were auxiliaries of diocesan bishops or administrators of dioceses), limit the power of archbishops, revive dormant privileges of the clergy, revive the right of appeal, etc. The False Decretals were also used extensively during the Gregorian reform in the 11th century.

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DECURIO, a Roman official title, meaning literally "the head of a group of ten," with two applications, one civil, the other military.

The term was applied to a member of the local council or senate (*ordo decurionum*) of colonies and *municipia* in the Roman municipal system in Italy and the western provinces. Their number was regularly 100, but varied with the size of the town and the provisions laid down in the charter of the town. Usually they were appointed from former magistrates by the chief magistrates (*duumviri*) at the quinquennial census, but instances occurred of co-optation and of election by the assembly. Qualifications were laid down regarding age (25 years), wealth, rank and character, but age was often waived for minors who were benefactors. New *decuriones* regularly paid a set sum for public purposes. They were convened by the chief magistrates as in Rome, and carried decrees by majority vote of a quorum. They had wide powers in local administration, authorized expenditure, carried out investigations, decided on petitions and deputations to Rome and to provincial governors, granted honours, statues and rewards, chose patrons, acted as an advisory board for magistrates in judicial proceedings, and heard appeals from magistrates' decisions. In the early empire the position was an honour and they contributed greatly to the development of the towns, but in the later empire, when prosperity declined and the demands of the central government increased, responsibility for tax collection and liability for deficits gradually made their position unbearable. It became a hereditary and compulsory service, at times assigned as a penalty, for the class that in the later empire became known as *curiales*.

In the army, *decurio* meant an officer in command of a squadron of cavalry (*turma*). In each cavalry division (*ala*) of the imperial army there were 24 or 16 squadrons according as its strength was 1,000 or 500, and similarly six or three in cohorts of mixed cavalry and infantry. They were also officers in the *equites singu-*

lares of the headquarters troops.

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DEDEKIND, JULIUS (WILHELM RICHARD) (1831–1916), German mathematician, renowned for his work on the theory of numbers, was born at Brunswick on Oct. 6, 1831, and died there Feb. 12, 1916.

He obtained his higher mathematical education at the University of Göttingen where he was the last pupil of K. F. Gauss, under whom he took his Ph.D. degree in 1852. He became professor at Zurich in 1858; in 1862 he returned to his native Brunswick as professor at the technical high school. He published much highly original work, including three classics: *Stetigkeit und irrationale Zahlen* (1872), *Was sind und was sollen die Zahlen?* (1888) and *Über die Theorie der ganzen algebraischen Zahlen* (1879, 1894). Each of these profoundly influenced current mathematics. In the first he defined and elaborated the "cuts" later named after him, which passed into the standard course in the real number system. In the third he created the modern theory of algebraic numbers in which unique factorization is restored to algebraic integers by means of the ideals (not to be confused with Ernst Kummer's earlier ideal numbers) which he invented. The concepts of this theory permeate modern algebra.

Indicative of Dedekind's flair for what was to increase in general interest after his time, his works of 1897 and 1900 on dual groups anticipated parts of the current theory of lattices developed after 1933. Dedekind's collected works were published in three volumes, 1930, 1931, 1932. *Essays on the Theory of Numbers* was published in English (1924).

See also E. T. Bell, *Men of Mathematics* (1937). (E. T. B.; O. Oe.)

DEDICATION, FEAST OF: *see* JEWISH HOLIDAYS.

DEDUCTION, a word commonly used to stand for the process of subtracting or withholding something (usually a sum of money), or for that which is subtracted or withheld (as in "tax deduction"). The corresponding verb is "deduct" (from Lat. *deducere*, "to lead out from"). The verb "deduce" now has the quite different meaning of "infer." Thus, "deduction," in this important sense, is an approximate synonym for "inference." (The latter word, however, carries a stronger suggestion that the conclusion in question is true.) A deduction may be some *conclusion* drawn by reasoning from facts or from premisses (as in "a false deduction from the evidence"); or "deduction" may stand for the general process of reasoning ("deduction requires premisses"); or it may mean a particular specimen of reasoning ("a notable deduction").

In logic, "deduction" is used more narrowly, in opposition to induction (*q.v.*). A deduction, in this sense, is a rigorous proof, or derivation, of one statement (the conclusion) from one or more statements (the premisses); *i.e.*, a chain of statements, each of which is either a premiss or *follows from* a statement occurring earlier in the proof. If A "follows from" B in the sense intended, the conjunction of B and the negation of A (in symbols. $B.\sim A$) must be self-contradictory—a condition that does not apply to induction. (But an adequate analysis of what is meant by "following from" or "being rigorously implied by" is a difficult technical problem.) This modern use of "deduction" is a generalization of what Aristotle, in his *Prior Analytics*, called "syllogism." But a syllogism (*q.v.*) is now recognized to be merely a special case of a deduction. Also the traditional view that deduction proceeds "from the general to the specific" or "from the universal to the particular" has been abandoned as incorrect by most logicians. Some experts regard all valid inference as deductive in form, and for this and other reasons reject the supposed contrast between deduction and induction. *See* also references under "Deduction" in the Index volume. (M. Bk.)

DEE, JOHN (1527–1608), English mathematician and astrologer, made considerable contributions to the scientific knowledge of his time, despite his dabblings in necromancy and alchemy, which drew the attention of royalty. He was born in London on July 13, 1527, educated at St. John's college, Cambridge, and made a foundation fellow of Trinity college in 1546. After lecturing and studying at Louvain, Brussels and Paris between 1547 and 1550. he returned to England in 1551 and was granted a pension by Edward VI. The great maritime expansion was just beginning and the next 30 years of Dee's life were spent in giving advice and instruction to pilots and navigators. He also collected a large mathematical and scientific library. He enjoyed the favour of Elizabeth I, was asked to name a propitious day for her coronation and gave her lessons in the mystical interpretation of his writings. His preface to the English Euclid, translated by Henry Billingsley (1570), pointed out the practical applications of geometry and, together with several of his other works, fostered the revival in England of the mathematical arts. Dee spent the years 1583–89 in Poland and Bohemia with the astrologer and alchemist Edward Kelly, and became warden of Manchester college in 1595. He died in poverty at Mortlake in Dec. 1608.

See *The Private Diary of Dr. John Dee*, ed. by J. O. Halliwell for the Camden society (1842); E. G. R. Taylor, *The Mathematical Practitioners of Tudor and Stuart England* (1954). (O. J. E.)

DEE, a river in southern Aberdeenshire, Scot., flowing generally eastward from its source in the west of the county till it reaches the North sea at Aberdeen. Its sources are in the Wells of Dee on Ben Braeriach, one of the Cairngorms, at a height of almost 4,000 ft., and on Ben Macdhui. With its tributaries the river drains an area of about 1,000 sq.mi. Rapid and turbulent during the first half of its 87-mi. course, it broadens below Aboyne. After flowing through Kincardineshire for a short distance, it forms the boundary between the two counties. The channel toward its mouth was artificially altered in order to provide increased dock accommodation at Aberdeen, but above this the stream is navigable only for a few miles. It runs through beautiful scenery, especially in Braemar. About 2 mi. above Inverey it forms the spectacular rapids and cascades of the Linn of Dee. The principal places on it are Braemar (Castleton of Braemar), Ballater, Aboyne, Kincardine O'Neil, Banchory, Culter and Cults. The British royal family's Highland residence, Balmoral castle, lies between Braemar and Ballater. The river is famed for its salmon.

"Dee" is a common river name; it is said to mean "goddess." (A. T. A. L.)

DEE (Welsh AFON DYFRDWY), a river of Wales and England. It rises below the peak of Dduallt, flows northeast for 7 mi. to Bala lake, Merioneth, Wales, and continues past Corwen, Llangollen and Overton. From there it meanders northward to Chester and thereafter through a great estuary into the Irish sea. In the Llangollen district the Dee crosses Denbighshire and then forms the boundary of that county with Shropshire, a detached part of Flint and Cheshire. From its source to Bala the river falls about 1,000 ft. and from Bala to Overton (35 mi.) about 330 ft. Its course then lies through a narrow, beautiful valley, enclosed on the south by the steep slopes of the Berwyn mountains and on the north by lesser ranges. The Vale of Llangollen, where an aqueduct (built in 1805 by Thomas Telford) of the Shropshire Union canal bestrides the valley, is especially famous. Below Chester the Dee follows a straight artificial channel to the estuary, and this is the only navigable portion. The estuary, which is 12 mi. long and $5\frac{1}{2}$ mi. wide at its mouth, between Hilbre point and Point of Air, is not a highway like the Mersey, for at low tide it becomes a vast expanse of sand and marsh through which the river meanders. The tide spreads with great speed over the sands, and their danger is illustrated in the ballad "The Sands of Dee" by Charles Kingsley. The Dee drains an area of 813 sq.mi.; its total length is about 70 mi.; and the total fall is 1,500 ft. The river is mentioned as Deoua by the geographer Ptolemy.

DEED, in law, a written instrument for the transfer of title to real estate. At common law, the deed was a contract or obligation under seal, and a seal is still required in England (even if only a wafer), though no longer necessary in most places in the United States. Although customarily recited in a deed, neither consideration (the giving of something of value), witnesses nor acknowledgment before a public official is generally necessary to transfer title. Delivery is required but may be complete without manual

transfer of the deed; acts or words of the grantor indicating his intention to make the deed presently operative are sufficient. A deed may also be handed over conditionally as an escrow (*q.v.*), in which case it will not take effect until the specified conditions are fulfilled. A deed indented, or indenture (*q.v.*), so called because of its indented counterparts that can be fitted together for identification, is one between two or more parties who contract mutually; a deed poll (with a polled or smooth-cut edge, not indented) is a deed in which one party binds himself, with no corresponding obligations undertaken by another.

See also Real Property and Conveyancing, Laws of: *Conveyancing;* Title to Land; Contract: *History.* (A. Dm.)

DEER, any member of the mammalian family Cervidae of the order Artiodactyla, suborder Ruminantia, infraorder Pecora, the latter subdivision including also cattle and giraffes. The feature most commonly associated with deer is the presence of antlers; those few species that lack them have instead the upper canine teeth much enlarged. Deer are widely distributed over Eurasia, the Americas, northern Africa and the East Indian archipelagos. They occur mainly in forests, but some dwell in open country (the caribou of the northern tundras, the pampas deer of the Argentinian grasslands) and some prefer marshy areas. All swim well and most species willingly enter water. They are hunted extensively wherever they occur and in North America are second only to the rabbit as the most hunted mammal (*see* Hunting: *Stag Hunting*). The flesh, or venison, of most deer is esteemed as food. The hides, when properly tanned, produce a soft leather. Native peoples in colder climates have used deer hides as a source of clothing for centuries. Some kinds, notably the Laplander's reindeer, have been domesticated and, although migratory, are managed much as domestic cattle; they produce a beeflike meat, leather and milk, and serve also as draft and riding animals. At least one species, Père David's deer, of China, survives only in domestication and is on the verge of extinction.

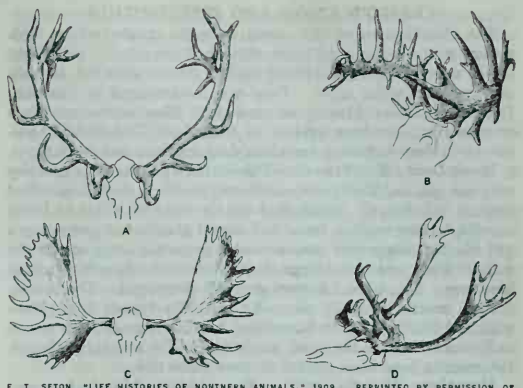
In certain areas of the world deer have occasionally become overabundant, with the result that they have spilled out of their natural habitats and have menaced crops. Earlier, when carnivores were more numerous—particularly coyotes, wolves, wild cats, bears—a natural check was kept on the deer population. Now, however, hunters are the check, and flexible game regulations tend to control the numbers of deer. Unless adequate numbers are harvested annually, disease and starvation often decimate local populations.

The terminology associated with the sexes of various cervids is an outgrowth of their importance as game: female deer are usually called does, but the female of the European red deer is a hind, and of the moose or elk a cow; males generally are called bucks, but the male of the red deer is a stag or, especially when mature, a hart, and of the moose or elk a bull. Several names are used for the fawns of various ages, *e.g.*, yearling, knobber, brocket, staggard, especially applied to male red deer; fawns of moose or elk are called calves.

GENERAL

Structure and Function.—Deer have lithe but compact bodies and short tails. The ears are large but usually slender. The legs are characteristically long and slender and are provided with paired hooves. In some deer lateral hooves are present but much reduced. Generally the fur is slightly harsh but has a smooth appearance. Some deer possess a shaggier coat, especially in the cold seasons, the longer, harsher fur tending to be more abundant on the foreparts. The colour is usually brownish to tawny, often with white on the chest and throat. In most kinds the coat of the young, or fawn, is spotted—a remarkably effective camouflage in the dappled lighting of forest glades—and in some, especially the smaller species, the spotting may be retained by the adult.

The antlers are solid bony outgrowths arising from the frontal bones. In most species they are borne only by the males, the caribou being an exception (*see* Reindeer). Antlers are shed and produced anew each year. The growth and shedding is under the control of the male sex hormones except in the caribou. The



E. T. SETON, "LIFE HISTORIES OF NORTHERN ANIMALS," 1909. REPRINTED BY PERMISSION OF THE ESTATE

FIG. 1.—ANTLERS OF CERVIDAE: (A) AMERICAN ELK OR WAPITI (CERVUS CANADENSIS); (B) WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS); (C) AMERICAN MOOSE OR EUROPEAN ELK (ALCES ALCES); (D) AMERICAN CARIBOU OR EURASIAN REINDEER (RANGIFER)

antlers originate as highly vascularized simple knobs covered with a soft, sensitive skin, the so-called velvet of the antlers. The growth of antlers is rapid, and ample calcium is required. As growth continues, a heavy deposit of bone at the base of the antler constricts the circulation, finally stops it entirely and the skin covering dries. The skin is then rubbed off and the hardened antler is fully developed as the rutting season begins.

The general form of the antler is characteristic of the various species. Some species have a main beam with one or more subsidiary tines; others show a dichotomous or even more complex branching. Maximum size and complexity of antlers is usually attained when the animal is in its prime; they tend to degenerate in older animals. Shedding of the antlers is caused by a resorption of bony material at their bases. This process of resorption, which irritates the animal, induces it to respond by rubbing the antlers against trees. When the base has been sufficiently weakened, the antler is shed.

In size, deer vary from that of a small dog (the pudu stands 13 in. at the withers) to that of a large horse (the American moose, known as the elk in Europe, stands about 90 in. at the withers and may weigh as much as 1,800 lb.). The cheek teeth have high crowns whose surfaces have sharp crescentic ridges—a type of tooth well suited to a varied vegetative diet. The upper incisors are absent or poorly developed except in the antlerless species. A gall bladder is usually absent. Most of the species have prominent facial glands below each eye, and some have tarsal, metatarsal or digital glands. The senses of sight, hearing and smell are very well developed.

Natural History.—Deer, like most browsing animals, are most active in early morning and late afternoon, resting at midday and at night. Most live in small bands comprising a family group although the males are prone to be solitary seasonally. In warm climates breeding takes place at any time of the year; in colder climates, in autumn or winter; and one or two (as many as seven in the water deer) young are born. The gestation period varies from 160 days (musk deer) to a year (marsh deer). Most deer are polygamous, the bucks collecting harems and battling other males for possession of the does. Occasionally the antlers of two fighting bucks become so firmly engaged that the struggle ends in both combatants dying of starvation.

Most deer are shy and furtive although the larger species are dangerous opponents and should not be approached closely even when tamed.

Especially in the rutting season deer are likely to be unpredictable. The American moose is justly known for its irascible disposition. Deer attack with either antlers or hooves, impaling with the former and slashing with the latter.

CLASSIFICATION AND DISTRIBUTION

The classification of the cervids is quite unsatisfactory. Although many fossils are known, they shed remarkably little light on the relationships of the living kinds, a matter on which scarcely any two authorities agree. They may be arranged in four subfamilies as follows: Moschinae, musk deer; Muntiacinae, muntjacs or muntjaks; Cervinae, typical, or true, deer; Odocoileinae, hollow-tooth deer including American deer, caribou and roebuck.

Musk Deer (Moschinae).—The subfamily Moschinae contains only one species, *Moschus moschiferus*, the musk deer (also called kastura or kabarga). Musk deer are the most primitive of living cervids, lacking antlers, facial and digital glands, but possessing a gall bladder, daggerlike canines and a preputial musk sac in the males. They resemble a large, dark-brown, stout hare with robust hind legs. The lateral hooves are well developed. The species occurs, usually solitarily, in rocky and hilly forests from Mongolia and Siberia to upper Burma and Assam. A small form occurs in Korea. Because the musk sac is sought for making perfumes, the animals have been hunted to near extinction.

Muntjacs (Muntiacinae).—The subfamily Muntiacinae contains only two genera, *Muntiacus* (muntjac, or barking deer) and *Elaphodus* (tufted deer, or Tibetan muntjac). These small deer lack a gall bladder, as do most cervids, and males possess small to tiny antlers. Unlike that of the typical deer, however, the antler arises from an extended bony basal stalk or pedicel. The upper canines are well developed.

Muntjacs.—The muntjacs have relatively large and conspicuous simple two-branched antlers with short tufts of hair at their bases. The coat of the several species varies from blackish to yellowish. They stand from 20 to 28 in. at the shoulders. Muntjacs are secretive animals, inhabiting wooded areas or thick underbrush from China and Formosa to many of the East Indian islands. The sharp cry remarkably resembles the bark of a dog.

Tufted Deer.—The tufted deer (*E. cephalophus*) has tiny antlers quite out of proportion to the length of the pedicels. Prominent tufts of hair between the ears are the origin of the common name. These dark-brown deer stand about 23 in. at the withers and weigh about 40 lb. They are found only in China.

True Deer (Cervinae).—The subfamily Cervinae includes the typical deer of which there are at least four genera, *Dama, Axis* (including *Hyelaphus*), *Cervus* (including *Rusa, Sika, Rucervus* and others) and *Elaphurus*. All possess well-developed antlers in the males and lack a gall bladder. The upper canines may be relatively well developed but are not tusklike.

Fallow Deer.—Two species of *Dama,* the fallow deer, are known: *D. dama,* originally occurring from southern Europe to Asia Minor but now established over most of Europe; and *D. mesopotamica,* occurring in Iran. The prominent antlers consist of a small brow tine and a main beam that branches at its end into short, stubby, fingerlike tines. The fallow deer stands 34 in. at the withers. The tan upper parts are marked with round whitish spots arranged more or less in longitudinal rows; the underparts are white. Fallow deer usually occur in small family groups. They eat a wide variety of vegetation. The rutting period occurs in early autumn and usually two spotted fawns are born the following spring.

Axis Deer.—The axis deer, also called chital or spotted deer, *Axis axis,* resembles the fallow deer in size and colour pattern, but the antlers are not palmated, the main beam terminating in two points. It is a jungle dweller of India and Ceylon.

Also often included in this genus as the reddish-brown hog deer is *Axis* (*Hyelaphus*) *porcinus* of southeastern Asia and the Philippines. Hog deer have long, slender simple antlers, and are small, only about 28 in. at the withers.

Red Deer, Wapiti and Allies.—The genus *Cervus,* in the broad sense, includes a great number of species. The following are among the better-known members of the genus. *Cervus elaphus,* the European red deer or stag and the maral, occurs over most of Europe eastward to Iran. It stands 4 to 4½ ft. at the shoulders and has a russet coat. The American elk or wapiti (*C. canadensis, C. merriami* and *C. nannodes*) formerly occurred over most of North America south of the tundra. They are among the largest of the deer, standing more than five feet at the shoulder and bearing massive antlers. The sambar (*C. unicolor* and others) includes small to large deer having three-tined antlers. The several species occur from China to the East Indian islands. The usual form is the size of the red deer, and lives mainly in jungle-covered mountains. The coat is uniformly dark brown, even, usually, in fawns. The sika (*C. nippon*) is a medium- to small-sized deer having four- or five-tined antlers. It occurs on the eastern coast and offshore islands of Asia.

Père David's Deer.—The genus *Elaphurus* contains only Père David's deer (*E. davidianus*), known only in the domesticated state. This large deer with slender antlers is thought to have originated in northern China.

Hollow-Toothed Deer.—The subfamily Odocoileinae contains at least ten genera. The following are among the better known kinds.

White-Tailed Deer.—Odocoileus virginianus (not *Dama* of some authors, a name properly ascribed to the Eurasian fallow deer), the Virginia, or white-tailed, deer, occurs over most of North and Central America and in parts of South America. The antlers have one main beam with side tines. The underside of the tail is white and forms a conspicuous flag when the tail is raised, as in alarm. Its run is quite unlike the stiff-legged bouncing gait of its relative, the big-eared western American mule deer, *O. hemionus.*

BOB ROSE FROM NATIONAL AUDUBON SOCIETY

FIG. 2.—MULE DEER (ODOCOILEUS HEMIONUS) WITH ANTLERS IN VELVET

Andean Deer.—The Andean deer, or guemal, *Hippocamelus antisiensis,* occurs uncommonly in the Andes. It is said to hide in rocky places in the day and to emerge in the evening to feed on mosses, lichens and other low vegetation. It is smaller than the Virginia deer and has a speckled brown and tawny coat.

Swamp Deer.—The swamp deer, *Blastocercus dichotomus,* is the largest South American deer, being about four feet high at the shoulders. The antlers are small and simple. This deer is a reddish species inhabiting the shore of streams and swamps in dense jungles.

Pampas Deer.—The pampas deer (*Ozotocerus bezoarticus*) is smaller, being the size of a European roe deer (*see* below). The antlers are small and delicate; the coat, light reddish brown. It inhabits dry, grassy plains from Brazil to northern Patagonia, occurring usually solitarily.

Pudus.—The pudu, smallest of the deer, and bearing the improbable name *Pudu mephistophiles,* has a very restricted range in Ecuador. Its over-all colouring is a rich dark-brown, with face and legs blackish.

Moose.—The American moose (*A. alces americana* and other subspecies) and the European elk (*A. alces alces*), both of which are sub-Arctic, circumpolar in distribution, extending southward to Poland and to the central Rockies. They are the largest-antlered animals known. (*See* Moose.)

Caribous and Reindeer.—The caribou of North America and the reindeer of Eurasia are probably subspecies of a single species, *Rangifer tarandus.* Unlike other deer, both sexes of most *Rangifer* bear antlers. The colour varies from nearly white to blackish-brown. The preferred food is lichens, but leaves, grass and sedges are also eaten.

Brockets.—The Central and South American brockets or cariacus, genus *Mazama,* comprize several species of squat-bodied, small, forest-dwelling deer distinguished by the antlers being short, simple spikes. The pygmy brocket of central Brazil is,

next to the pudu, probably the smallest deer, standing less than 20 in. at the withers.

Water Deer.—The Chinese water deer, *Hydropotes inermis*, is about 20 in. tall, and has a coarse yellowish coat. It is found in China and Korea, in both marshy and dry land areas.

Roe Deer.—The roe deer, or roebuck, *Capreolus capreolus*, is a graceful three-foot-tall deer of Europe and western Asia. The colour is brown; the antlers are small and simple. It is a forest dweller, monogamous (mates for life), and is much hunted for its tasty flesh.

See RUMINANT; separate articles on various cervids including ELK; FALLOW DEER; REINDEER; WAPITI; *see* also references under "Deer" in the Index.

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DEERE, JOHN (1804–1886), pioneer U.S. manufacturer of steel plows, was born at Rutland, Vt., on Feb. 7, 1804. After a public school education he became an apprentice to a blacksmith at the age of 17 and eventually set up his own smithy. In 1837 he moved to Grand Detour, Ill., where he opened a blacksmith shop in partnership with Maj. Leonard Andrus. In that year he and Andrus developed and manufactured a successful steel plow. He sold his interest to Andrus in 1847 and moved to Moline, Ill., where he founded his own firm, incorporated as Deere and Co. in 1868. He was active as president of this company until his death at Moline on May 17, 1886. (H. J. Sc.)

DEERFIELD, a town (township) of Franklin county, Mass., U.S., on the Connecticut and Deerfield rivers, 33 mi. N. of Springfield. The population, which numbers less than 5,000, is located principally in the villages of South Deerfield and Old Deerfield. The town is picturesquely situated amid broad meadows in the Connecticut valley. The surrounding region is primarily agricultural and the town is the site of several private schools, notably Deerfield academy, established in 1797.

Old Deerfield is celebrated for "The Street," a broad and tranquil thoroughfare lined with towering elms and charming restored homes dating from the early 18th century. Many of these are open to the public, as is a historical museum housing a collection of colonial and Indian relics.

Settled in 1669, Deerfield for years was the northwestern frontier outpost of New England and the target of several destructive Indian attacks. Scene of the famous Bloody Brook massacre in 1675, the town suffered its most devastating raid at the hands of the French and their Indian allies in 1704. From a forced march northward following this raid, the Rev. John Williams returned to write a harrowing account which has become a minor classic, *The Redeemed Captive Returning to Zion* (1707). (RI. H. B.)

DEER FLY, any of the banded-winged flies of the genus *Chrysops* of the family Tabanidae, order Diptera (*q.v.*). They are important because, in western North America, *C. discalis* is a painful biter which transmits tularemia (*q.v.*) to humans. In Africa *C. discalis* and *C. silacea* are vectors of the eye worm *Loa loa* (*see* FILARIASIS).

Deer fly is also a name applied to the parasitic deer botfly (*q.v.*) of western North America, claimed to be the speediest insect on earth. (C. H. CN.)

DEERING, WILLIAM (1826–1913), U.S. manufacturer and philanthropist, was born in South Paris, Maine, April 25, 1826. After commencing the study of medicine, circumstances forced him to assist his father in managing a woolen mill. Later he invested in Illinois and Iowa farm lands. Returning east, he cofounded the textile firm of Deering, Milliken and Co. Subsequently he manufactured the Marsh harvester as successor to the reaper and resided in Evanston, Ill. Utilizing J. F. Appleby's invention, he added the twine self-binder and in 1900 he exhibited the first self-propelled farm machine. In 1902 Deering Harvester company united with the McCormick company and others to form International Harvester Co., Deering's son Charles becoming chairman of the board. For many years Deering was president of the boards of Garrett Biblical institute and Northwestern university; Chicago Wesley Memorial hospital was dedicated in memory of him and his daughter. He died in Coconut Grove, Miami, Fla., on Dec. 9, 1913.

See Wayne Andrews, *Battle for Chicago* (1946). (R. McC.)

DEFAMATION, in law, is the offense of injuring a person's reputation and good name by communicating to others an imputation concerning him which tends to diminish the esteem in which he is held by his fellow men. The allegation may be calculated to bring him into "hatred, contempt or ridicule" or have the tendency merely to cause him to be shunned and avoided, as by imputing to him a misfortune rather than dishonourable conduct. Either can be sufficient, taking men as they are with their prejudices and conventional standards, to impair the respect and confidence which he enjoys. But the imputation must tend to injure his character or reputation; a falsehood otherwise prejudicial, such as an allegation that he has gone out of business, falls outside the purview of defamation except under special legislation (as in Australia). Likewise, mere vulgar abuse is not treated as defamatory when insulting rather than disparaging to reputation.

Whether an imputation is defamatory must be judged by reference to the reaction of the "ordinary decent citizen," though it is sufficient that the allegation is calculated to incite adverse feelings among a substantial and respectable group of the community. So, depending on time and place, it may be defamatory to call someone a German, a Communist, a Jew, a Jew-hater or a scab. It is immaterial whether the imputation is conveyed by words of assertion or suggestion, or whether couched in declaratory or interrogatory form. The effect, the tendency of the language used, not its form, is the criterion. Reputation cannot be traduced with impunity by dexterity of style or other stratagems, such as resort to pseudonyms or the common blurb that "the characters or incidents in this book (or film) are fictional."

No expression is necessarily defamatory in all circumstances. However disparaging at first sight, it may admit of an innocent interpretation if explained in the light of its context and the circumstances attending its publication. Particularly, the meaning of spoken words can never be divorced from the gesture, tone of voice or facial expression of the speaker. Conversely, words apparently innocent in themselves may, with reference to special circumstances and to persons knowing them, be shown to carry a secondary and highly defamatory meaning. For example, an erroneous description of a woman as the wife of Mr. X is defamatory of X's real wife in so far as it suggests, to those knowing her, that she has been living in adultery. In such cases, the plaintiff must make the defamatory sense clear by an averment in his pleadings called an "innuendo," and at the trial he must prove that the words were understood in the defamatory sense averred, though not necessarily believed to be true, by persons having the necessary background knowledge.

After much turbulent political debate culminating in Charles James Fox's Libel act of 1792, it has come to be recognized as a basic guarantee of democratic liberty that the issue of "libel or no libel" should be within the exclusive preserve of the jury; and significantly, in actions for defamation, jury trial remains a matter of right despite the virtual disappearance of juries from civil actions in England. It is accordingly for the jury, not the judge, to determine whether the offensive imputation is defamatory, subject to the judge's power to direct a verdict if he is of the opinion that the words are clearly incapable of defamatory meaning.

Any living person may be defamed, but no civil action lies for defamation of the dead, however much distress might be involved for relatives or friends. Indeed, reputation is so personal an attribute that a cause of action for defamation does not survive for the benefit of the defamed person's estate.

Publication.—No civil action lies unless the defamatory statement was communicated to a third person: it must have been "published," not in the sense of being addressed to a large audience but of being made known to someone other than the victim of the calumny. The wrong consists in injury to reputation, *i.e.*, the respect and esteem entertained toward him by his fellows, rather

than in affront to personal pride and self-respect, though the latter may be taken into account in assessing damages. Liability attaches to every participant in the publication, whether he be the writer, speaker, printer or merely concerned in the process of distribution. In some circumstances it may even be incumbent to remove defamatory matter which someone else has originated, such as a writing on one's wall affixed by a trespasser.

Every republication of defamatory matter gives rise to a new cause of action, and it is no defense to a republisher that what he transmitted was a true report of what he had heard or read. The existence of a defamatory rumour is no justification for repeating it; otherwise, newspapers would be almost wholly outside the reach of liability. On the other hand, one who publishes a defamatory allegation is not responsible for any mischief caused by its repetition unless he published it to a person who was under a legal or moral duty to repeat it, or the repetition was authorized or intended by him, or perhaps where circumstances were known to him at the time of publication which gave him reason to expect such a repetition.

In order to attract liability, the publication must have been intentional or negligent. One who writes a libelous letter to the person defamed or charges him with discreditable conduct in his presence will escape responsibility if he guarded against the possibility that the letter would be opened or the accusation overheard by strangers. It is negligent, however, to communicate a libel on a post card and, if sent through the mail, publication to post-office employees and the like will be presumed.

Yet, though there is no liability for intentionally defamatory matter published accidentally, there is for accidentally defamatory matter published intentionally. Liability does not depend on the intention of the defamer but on the fact of defamation. Thus a publisher is liable for a statement, harmless on its face, which by reason of extrinsic facts unknown to him happens to be defamatory of the plaintiff. Not only does he shoulder the risk of an unintended defamatory meaning, but also of an unintended reference to the person defamed. "The question is not who was aimed at but who was hit." This stringent common-law liability was attenuated in England and Scotland (also in New Zealand and Tasmania) after 1952, whence a person who has "innocently," *i.e.*, unintentionally and without negligence, defamed another in such circumstances may make an offer of amends in the form of a published correction and suitable apology. Whether accepted or not, such an offer constitutes a good defense to any publisher (provided he can prove, if the offer has not been accepted, that the words were written by the author without malice in case he was not the author himself).

Apart from this legislative measure of relief, it has long been recognized that the strict liability for unintended defamation attaches only to those who are primarily instrumental in the publication, such as the writer, newspaper proprietor and publisher, editors and printer. Persons who play the more subordinate role of mere distributors, like news agents, booksellers and librarians, escape responsibility even at common law on proof that they were ignorant of the defamatory content and that there was nothing to indicate to a reasonable man that the matter might be defamatory.

Libel and Slander.—Somewhat fortuitously, English law became committed to a division of the law of defamation into the twin wrongs of libel and slander. The distinction is of singular importance in so far as slander, unlike libel, is not actionable without proof of "special damage"; *i.e.*, loss of some material advantage other than mere prejudice to reputation, except where the words (1) impute a crime that is punishable corporally (*e.g.*, by imprisonment); (2) impute a contagious and loathsome disease, such as leprosy or syphilis; (3) impute unchastity or adultery to a woman or girl; (4) are calculated to disparage the plaintiff in any office, profession, calling, trade or business held or carried on by him. These exceptions are the outcome partly of historical accident and partly of judicial policy aided by legislative reform.

The distinction between libel and slander is essentially that between written and spoken defamation or, more precisely, between communications addressed to the eye and the ear. According to another view, it depends on the permanence or transience of the medium of communication. Each of these theories has been rationalized on the ground that the potentiality for mischief inherent in visible or permanent form is infinitely greater than that of slander because of the larger area of dissemination, facility for repetition and the tendency to evoke a higher degree of credence, particularly among the less erudite sections of the community. The advent of radio and television acutely raised the problem of classification because, though akin to slander according to the conventional tests, these media of mass communication are invested with a capacity for mischief which might seem to favour the more stringent safeguards of libel traditionally applied to the press. In Australia, radio defamation has been held to be slander, but decisions in the United States are sharply divided. By legislation, defamation that is broadcast by means of wireless telegraphy was deemed to be libel in the United Kingdom (1952), Australia (1956) and Ontario, Can. (1958), though the trend in the United States favours the opposite conclusion.

The recommendation by a select committee of the house of lords in 1843 to assimilate the law of slander to libel, while not adopted in England, was translated into the statute book of New Zealand, a majority of Australian states and several Canadian provinces. But the Australian legislation retains a safeguard against frivolous actions for oral defamation by allowing the defense that the publication was made under circumstances where the person defamed was not likely to be injured thereby. In the United States, by contrast, all jurisdictions except Louisiana still adhere to the traditional dichotomy.

Several defenses are open to a defendant in an action for libel or slander.

Justification.—In English law, truth is a complete answer to a civil action for defamation. Damages are due to a deserved reputation traduced, not a false reputation exposed. This viewpoint is open to the objection that it condones even wanton exposures of a person's past unbalanced by social utility, and aggravates the absence in English, as contrasted with U.S., law of any redress for invasion of privacy as a distinct wrong. A recommendation by a select committee of the house of lords in 1843, that truth be recognized as a defense only if the publication was for the public benefit, received legislative endorsement in England with respect to criminal, but not civil, actions. It was, however, fully adopted in the majority of Australian jurisdictions and corresponds with a widespread requirement in the United States that the publication be made for an honest motive.

To succeed in this defense the defendant must prove that the defamatory statement was substantially true. A slight inaccuracy is not fatal, provided the justification "meets the sting of the libel." But, at common law, the defense failed unless all of several distinct allegations were so justified, even if an unproved charge could not have materially injured the plaintiff's reputation in view of the truth of the rest. This technicality was abrogated by statute in 1952.

Fair Comment.—One of the most important safeguards of democratic liberty is the right of fair comment upon matters of public interest. But however ample the protection thus afforded to the press and critics, the defense is subject to important limitations.

First, it shields only defamatory expressions of opinion, not statements of fact. The distinction between these is not always easy to draw, and much must depend on the context of the impugned expression: if the facts are set out and an opinion is expressed about them, the latter is clearly comment, but bare inference or allegations will generally be treated as statements of fact. To say that a man's conduct was dishonourable is a statement of fact; to say that he did specific things and that his conduct was dishonourable is a statement of fact coupled with a comment. It is not absolutely necessary, however, that the opinion be based on facts actually presented to the reader or listener, since criticism of a literary work would otherwise be confined to passages actually set out in the review. It is accordingly sufficient if the facts necessary to support the comment can be implied from the terms of the impugned expression.

Secondly, comment cannot be fair if based on facts which are distorted or invented. Truth is therefore material, not only to

justify such allegations of facts as are defamatory, but also as an essential step in establishing that any defamatory comment is fair.

Thirdly, the subject commented on must be a matter of public interest, such as the public conduct of a person holding or seeking public office, or any work of art, literature or play performed or exhibited in public. The defense does not, therefore, significantly impair the claim to privacy by citizens content with an anonymous existence. Moreover, a person's moral character is not a permissible subject of defamatory comment even if he occupies a position which makes his character a matter of public interest, because it is feared that public affairs would not be conducted by men of honour if the law were to sanction such attacks without opportunity for redress.

Lastly, the comment must be both fair and honest. Fairness, however, does not demand either reasonableness or balanced judgment. For the sake of wide freedom of discussion, even the unreasonable critic deserves tolerance; still less should a jury be at liberty to substitute its own opinion for that of the critic. Rather, the question is: "Would any honest man, however prejudiced he may be, however exaggerated or obstinate his views, have expressed this opinion?" Comment distorted by malice is never fair.

Absolute Privilege.—There are certain occasions on which public policy requires the complete removal of all restrictions on freedom of expression, even at the risk of thereby exposing reputations to defamatory assaults known to be false and made with the express intent to injure. Such an exceptional privilege is accorded principally for the sake of ensuring the efficient functioning of governmental institutions. Foremost is the absolute immunity attaching to all statements made by members of parliament in the course of proceedings of either house, to statements made by any person when giving evidence before a parliamentary committee, to petitions addressed to parliament and to all parliamentary papers published by authority. The same protection extends to any defamatory statement made in the course of proceedings before a court of justice or a tribunal having similar attributes (like the Discipline committee of the Law society), whether by judges, juries, parties, witnesses or their legal representatives.

Lastly, absolute immunity attaches to communications made by "high officers of state" in the course of their official functions, for the sake of protecting the fearless discharge of duties within the executive department of government. In the United States, there has been a tendency to extend this privilege farther down the executive hierarchy and, instead of linking it to a basis of rank, to look rather to the duties which the officer is authorized to perform. Accordingly, absolute immunity has been conceded to official communications (including, under federal law, even statements to the press) by such lowly officers as building inspectors, internal revenue agents and law-enforcement officers.

Communications between husband and wife have also been traditionally invested with absolute immunity in recognition of their confidential relationship, but a like claim for professional communications between solicitor and client (except in relation to prospective or pending litigation) is in doubt.

Qualified Privilege.—In a much larger range of situations, the law attaches a qualified privilege to defamatory publications, in recognition of certain necessities of social intercourse. In these cases, the immunity is conditional in the sense that it will be forfeited if the communication is made from a dishonest motive or for an improper purpose, foreign to the interest for the protection of which the privilege is recognized; *e.g.*, to gratify spite or to cover up a previous misstatement. It is in this extended sense that qualified privilege is frequently said to be defeated by "malice." Absence of any genuine belief in the truth of the statement automatically defeats the privilege.

Privileged occasions cannot be catalogued exactly, but their range may be comprehensively described as including all those situations "where the person who makes [the] communication has an interest or a duty, legal, social or moral, to make it to the person to whom it is made, and the [latter] has a corresponding interest or duty to receive it." Statutory modifications apart (as under certain Australian codes), reciprocity of interest or duty in both publisher and recipient is essential, so that a stranger would not be privileged to make disclosures to a wife reflecting on her husband's morals, for, though she has a legitimate interest in hearing about it, he has no corresponding duty or interest to communicate such information.

A common illustration of privilege is that attaching to information given in answer to an inquiry concerning an employee's character or tradesman's credit. But the person making the inquiry must have a legitimate interest, not merely an interest springing from idle curiosity; and in England, unlike the United States, it is doubtful whether commercial credit agencies are entitled to this protection. Sometimes a duty to speak may arise, though the information is not requested. Certain relations, such as that of employer and employee or father and child, justify volunteered statements by one to the other relevant to their duties and interests.

Privilege also attaches to statements made by a man for the bona fide protection of his own legitimate interest; *e.g.*, in reply to attacks upon his own character in a manner relevant to the matter in hand. Sometimes the speaker and recipient are privileged by a bond of "common interest," as in the case of interchange of information among shareholders, candidates and electors, and members of professional associations.

But no privilege arises merely because the publication is concerned with a matter of public interest. If it were otherwise, newspapers would have altogether too free a hand. As already seen, the defense of fair comment protects the discussion of matters of public interest in the form of criticism and comment based on a foundation of true facts, but defamatory allegations of fact are actionable unless true or entitled to privilege on some other ground. Thus, it is but rarely permissible to resort to the press as the proper medium for communicating privileged information. For, while a man attacked in public may legitimately reply to the same large audience in order to rehabilitate himself, the range of persons having a proper interest in receiving privileged information is ordinarily more restricted, and the method of publication must be adjusted so as not to exceed what is reasonably appropriate for protecting the particular interest which the defendant is entitled to assert.

Privileged Reports.—Fair and accurate reports of parliamentary and judicial proceedings are clothed with qualified privilege at common law, whether published by a newspaper or anyone else, because it is considered in the public interest that full information be available concerning the administration of public affairs. (By statute, fair and accurate newspaper reports of judicial proceedings are probably entitled to absolute privilege in England and in some commonwealth countries.) The report need not be verbatim because the protection would otherwise be illusory; a condensed summary is sufficient, provided it gives a correct and fair account of what took place.

The range of privileged reports has been substantially augmented by legislation which, inevitably, differs materially from one jurisdiction to another. In England, fair and accurate reports in newspapers or broadcasts dealing with a very wide range of subjects enjoy immunity, provided they are published without malice, the matter in question is one of public concern and its publication is for the public benefit. The relevant reports fall into two categories, the second being privileged only if a reasonable explanation or contradiction has been published on request. The first includes reports of proceedings in any legislature of the commonwealth, in any international or commonwealth court, in any court martial held outside the United Kingdom, or proceedings at a public inquiry in one of the self-governing commonwealth countries. The second comprises reports of lawful public meetings: general meetings of a public company and proceedings of any local authority; justices not sitting in court; any commission duly appointed to hold an inquiry by the crown, by parliament or a local authority; or any other tribunal, board, etc., functioning under an act of parliament—all in the United Kingdom. Also protected are copies and reports of official "handouts" issued by a government department, officer of state, local authority or chief officer of police.

Apology.—Except as previously noted (*e.g.*, in relation to "in-

nocent" defamation), an apology does not furnish a defense to an action for defamation, but may be given in evidence in mitigation of damages. To be effectual, an apology should be made promptly, should be both unequivocal and unconditional and should be given a publicity equal to that of the libel.

Moreover, in any action for libel contained in a newspaper or periodical, the defendant may plead that it was inserted without actual malice and without gross negligence and that, before commencement of the action or at the earliest opportunity afterward, he inserted in the newspaper or periodical a full apology. The defense must be accompanied by a payment of money into court by way of amends. The policy behind this measure of relief for the press is to save the publisher the necessity of incurring litigation expenses in connection with an unintentionally defamatory article; but he should not estimate the amount of suitable recompense with overdue refinement because, if the money paid into court is not accepted and the jury independently awards a larger sum, the defense fails altogether.

Damages.—In actions for defamation, juries are entrusted with the widest discretion in assessing damages. In addition to recovery for special damage, *e.g.*, loss of customers or employment, a plaintiff is entitled to an award of general damages for loss of reputation and affront to his dignity. This may range from contemptuous damages, if in the jury's opinion the plaintiff's reputation was worthless, to an award of exemplary or punitive damages against a defendant guilty of malice, wantonness or insulting conduct.

English courts are prepared to issue injunctions to restrain the publication or repetition of defamation, though only in the clearest cases where any jury would say that the imputation was defamatory and where, if it did not so find, its verdict would be set aside as unreasonable. This drastic power is disclaimed by U.S. courts, which adhere to the view, once shared in England, that the use of the injunction amounts to advance censorship contrary to constitutional safeguards and usurps the jury function which, since Fox's Libel act of 1792, has been regarded as a basic guarantee of free speech.

Insurance.—It is lawful to insure against the risk of liability for defamation, unless at the time of the publication the insured knows that the matter is defamatory and does not reasonably believe that there is a good defense to any action brought upon it.

Criminal Law.—Defamation is not only an actionable wrong but, if libelous, also a criminal offense punishable by fine and imprisonment. Slander, however, is not a crime (except in some jurisdictions; *e.g.*, in Australia and the United States) unless the offensive words are blasphemous, seditious or obscene.

A prosecution should not be instituted where the libel is so trivial as to be unlikely to provoke a breach of the peace or seriously affect anyone's reputation. Moreover, as a further safeguard against abuse, a criminal prosecution may not be commenced against any proprietor, publisher, editor or person responsible for the publication of a newspaper without the order of a judge in chambers, whose decision is final.

While the civil and criminal law of libel are in most respects identical, the following major discrepancies call for comment. It is of the gist of civil liability that the libel be communicated to some third person, for the wrong consists in injury to reputation. In contrast, the criminal law dispenses with the requirement of "publication," being essentially concerned with the prevention of public disorder, which is as likely to be provoked by direct insults as by exposing a person to the disrespect of others. Again, no civil action lies for what may be described as "group defamation"; *i.e.*, imputations vilifying not identifiable individuals but a class of persons distinguishable by race, creed, colour or vocation. The only sanction for vicious and unfounded attacks on particular sections of the community is provided by the criminal law, especially by prosecutions for seditious libel. Again, no civil remedy is available against defamation of the dead, unless perchance it involves a slur on the living; but this concession (which affords invaluable protection to historians and biographers who would otherwise be seriously embarrassed by the rigorous burden of having to prove the truth of matters long past) is circumscribed by the existence of a criminal sanction in cases where the attack was made with intent to injure and bring contempt on the deceased's posterity. Lastly, while truth of a defamatory imputation continues to furnish a complete defense to a civil action in England, the criminal law directed its attention to the insult offered and acted on the axiom "the greater the truth, the greater the libel." This stringent approach was modified in 1843 when truth was admitted as a defense to criminal proceedings, provided it was for the public benefit that the matters charged should be published.

The publisher of a newspaper is civilly liable for any libel which appears in its columns, even though the libel was published in his absence, without his knowledge and contrary to his express orders. But a person is specifically exempted from criminal responsibility on proof that the publication was made without his authority, consent or knowledge and did not arise from want of due care or caution on his part.

Scotland.—Despite wholly disparate origins, the Scots law of defamation is in most respects identical with the English law. The only noteworthy differences of substance between the two systems are that in Scotland (1) no distinction is drawn between written and oral defamation, in other words, between libel and slander; (2) the term "slander" is reserved for statements, however published, which are calculated to injure the fame, reputation or honour of a person. In contrast, false statements which are prejudicial to the plaintiff in some other respect, *e.g.*, attributing to him unpopular sentiments so as to expose him to public hatred and contempt, constitute the distinct wrong of "verbal injury," which also includes what in England is known as slander of title or injurious falsehood. Unlike slander, "verbal injury" is not actionable without proof that the defendant intended to cause injury without lawful justification, that loss or damage was actually suffered (except when the words were calculated to cause pecuniary damage), and falsehood is not presumed but must be affirmatively established by the plaintiff; (3) publication to a third person is not essential, so that a defamatory letter sent to the person defamed or a slanderous statement made to him privately entitles him to reparation; (4) there is no criminal remedy for defamation though, as in England, slander may be enjoined in suitable cases by interdict.

United States.—Based on the heritage of the English common law, the modern law of defamation in the United States continues to adhere to the basic pattern formulated by English courts in the past. Deviations in matters of detail have inevitably emerged as the result of divergent legislation and, to a lesser extent, of judicial development. Besides, due to the legislative and judicial autonomy of the various states of the union, no less a measure of diversity is found within the United States itself—a factor which at once discourages a detailed summary of the law administered in the various jurisdictions and emphasizes the limitations inherent in any account of so-called U.S. law.

Most of the more significant trends in the United States have already been noted in the preceding account; and it will suffice here to recall the debate whether to classify radio defamation as libel or slander and the related question whether broadcasting or television stations are liable strictly or only for negligence with respect to defamatory utterances by outsiders who are permitted to use their facilities. On neither issue is there any clear preponderance of authority, save for an emerging legislative trend (opposed to that in the Commonwealth of Nations) which seems to reflect the industry's success in lobbying for protection rather than any policy choice based on more cogent criteria.

Perhaps the most notable departure from English precedent is a further refinement of the already complex and elusive distinction between libel and slander. A majority of U.S. courts treat as slander (and therefore not ordinarily actionable in the absence of "special damage") any libel which is not defamatory on its face and hence requiring proof of extrinsic facts to support an "innuendo." However dubious its origin, this development represents a considerable retreat from the rigours of the law of libel and undoubtedly owes its popularity to that fact.

A majority of U.S. courts have also broken with the English rule that the sale of each single copy of a libelous newspaper

constitutes a distinct publication and thus furnishes a separate cause of action. Important for such purposes as venue and the period of limitation within which action must be brought, most courts favour the "single publication rule," which treats the entire edition of a newspaper, magazine or book as one publication. There has, however, been a reluctance to apply that rule where it is most needed, viz., in relation to interstate publications, so as to avoid the possibility of numerous actions based on divergent laws of different jurisdictions.

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(J. G. F.)

DEFENDER OF THE FAITH (Lat. *Fidei Defensor*), a title belonging to the sovereign of England in the same way as *Christianissimus* (Most Christian) belonged to the king of France, and *Catholicus* (Catholic) to the ruler of Spain. It seems to have been suggested in 1516, and although certain charters were appealed to in proof of an earlier use of the title, it was first conferred by Pope Leo X on Henry VIII. The bull granting the title is dated Oct. 11, 1521, and was a reward for the king's treatise against Luther.

When Henry broke with the papacy Pope Paul III deprived him of his designation, but in 1544 the title of "Defender of the Faith" was confirmed to Henry by parliament, and is still used by his successors on the English throne.

DEFENSE, DEPARTMENT OF: *see* GOVERNMENT DEPARTMENTS.

DEFENSE MECHANISMS. The idea of "defensive" mechanisms being active in the mind is derived from the psychoanalytic theory of mental functioning and constitutes an integral part of that theory.

The Mental Apparatus.—Psychoanalysis (*q.v.*) assumes that mental life is the function of an apparatus which can be imagined as being made up of several agencies, each of whose processes is governed by different laws and serves different purposes. The oldest of these realms in development contains what is inherited by the individual (*i.e.,* the drives and impulses which originate in the body and make their claims felt in the mind by means of tensions) and, in view of its impersonal character, is called the id. Its sole purpose is the satisfaction of the organism's innate needs, and it pursues this aim blindly, oblivious of external conditions, influences or threats to the organism's existence. The mental processes in the id are different from those which are familiar through conscious self-observation. They are not subject to any logical restrictions and are governed by the search for immediate wish-fulfillment.

The agency which develops next constitutes what we acknowledge as ourselves, the so-called ego (*q.v.*). It represents a portion of the mind which has undergone special development under the influence of the external world. It is equipped with the ability to deal with stimulation arising from without and from within the organism and, therefore, to act as intermediary between the id and the external world. The ego does not abandon the pleasure principle as a dominant force but adapts it to the exigencies of reality (reality principle).

There is a third agency, the superego, formed gradually within the ego, which is differentiated from it and at times opposed to it. It owes its origin to the child's identification with his first, most important love-objects, the parents, whose influence it perpetuates, and it contains also the racial, national and family traditions. Its functions are the setting up of ideals and the limitation of satisfactions through the action of a newly developed conscience which behaves as a moral arbiter.

With the normal adult, action (and all motor activity) should not be governed by the blind impulses of the id but controlled by the perceptive and intelligent ego. Action by the ego is considered beyond reproach if it satisfies simultaneously the demands of id, superego and reality by reconciling their claims with each other. As regards external reality, this can be done only if the ego acquires certain abilities, such as awareness of stimuli from without, storing up experience as memory, avoiding excessive stimulation through flight, dealing with moderate stimuli through adaptation and, finally, ability to bring about favourable changes in the environment through appropriate action. As regards internal events in the id, the ego has to learn to gain control over the drives and to decide which of them shall be allowed to obtain immediate satisfaction; those for which satisfaction has to be postponed; and those for which recognition of the drive activity and the accompanying affects have to be suppressed altogether.

While acting as intermediary between the inner and outer world, the ego is threatened equally by the dangers in external reality which might annihilate the whole organism and the danger of excessive drive activity from within; and it is to ward off this latter danger that the ego develops the defense mechanisms.

To summarize the definition of the term: defense mechanisms are activities of the ego which come into play whenever the ego experiences a drive activity, or its accompanying affect, as a danger. They work automatically, not accompanied by consciousness. For the ego to adopt a defensive attitude, the precise nature of the threat is immaterial. On the other hand, the particular type of danger against which defense is directed is important for determining which of the available mechanisms the ego will select.

Description of Defense Mechanisms.—Compared with the wide range of dangers by which the ego is faced, the number of defensive methods at its disposal is small. Following is a list of the major defense mechanisms and their description:

Repression.—This consists of the withdrawal of consciousness from an idea, affect or drive derivative unwanted by the ego. Such withdrawal results in withholding of the repressed matter from the conscious ego, or its expulsion from it.

Reaction Formation.—To secure the result of repression, an idea, affect, or drive derivative of the opposite order is fixed in consciousness and firmly held in place by the ego as a valuable part of its contents.

Projection.—This is another form of expulsion of an idea, affect or drive derivative from the mind. Consciousness is not withdrawn, but the unwanted internal content is displaced outward onto another person, where it impresses the individual as a threat from the external world.

Introjection.—The mental property of another person, or part of it, is appropriated by the individual and becomes, or is treated as, part of his own internal world.

Regression.—When dangers or conflicts arise at one of the later stages of development, the ego can institute a return to earlier stages and abandoned forms of gratification belonging to them. Regression can affect either drive development or ego development and, usually, precedes neurotic symptom formation.

Sublimation.—Sublimation is the giving up of a purely instinctual gratification for a noninstinctual one in conformity with social values; *i.e.,* under pressure of the environment or of the superego representing the values of the environment.

Isolation.—In the attempt to render an experience harmless, the ego separates the event from the affect which accompanied it originally.

Undoing.—This is an attempt by the ego to treat an undesirable experience, impression or affect as if it had not occurred.

Reversal.—Reversal is an attempt by the ego to substitute for a dangerous drive derivative its opposite; *i.e.,* to turn an active drive into its passive counterpart or vice versa.

Turning Against the Self.—An id impulse, usually of the aggressive kind, is withdrawn from its aim in the external world and employed instead against the self.

Intellectualization.—In the effort to master overpowering inner (instinctual) dangers, the ego overemphasizes its attempts at conscious,

intellectual, rational and logical control.

Other.—Not listed here are some other, minor mechanisms, such as identification with the aggressor (taking into the self as protection the threatening aspects of another person) or the ego's devices to deal with unwanted stimulation from the outer world, such as denial.

The foregoing enumeration has the drawback that it includes under one heading a number of heterogenous processes. Mere techniques and devices used by the ego (isolation and undoing) are listed side by side with important vicissitudes of drive activity, set in motion only by the ego (regression, drive reversal, turning against self). Some mechanisms (repression) master large quantities of drive or affect, while others deal with small quantities only or only complete what repression has failed to accomplish.

The History of the Concept of Defense.—The term defense is the earliest representation of the dynamic and economic viewpoint in psychoanalysis. It expresses the hypothesis that there are forces in the mind, opposed to each other and battling with each other, and that the outcome of these conflicts is determined largely by quantitative elements; *i.e.*, by the superior strength of either the threatening, attacking id representative or the warding off, defending ego side. The term is used for the first time in Sigmund Freud's paper "The Defence Neuro-Psychoses" (1894), where conflicts of this nature are shown to be the pathogenic agents. In this and some following papers ("The Aetiology of Hysteria," 1896; "Further Remarks on the Defence Neuro-Psychoses," 1896) the term is employed to describe the ego's struggle against painful or intolerable ideas or affects. In Freud's subsequent writings the use of the term lapsed for more than 20 years; instead the concept of repression was used exclusively to cover all incidences of defense activity. It was only in an appendix to *Hemmung, Symptom und Angst* (1926; Eng. trans., *Inhibition, Symptoms and Anxiety,* 1936) that Freud reinstated the term defense, stating that it would be advantageous to use it "provided we employ it explicitly as a general designation for all the techniques which the ego makes use of in conflicts which may lead to neurosis, while we retain the word 'repression' for that special method of defence which the line taken by our investigation made us better acquainted with in the first instance." This new designation of repression as the first-described but not a unique method of defense opened up a general inquiry into the other methods which serve the ego as protection against instinctual demands and led to comparisons of their respective qualities and uses.

Since there are definite connections between special forms of defense and particular illnesses, the order of description of the various mechanisms followed the order in which the various clinical states came under study. It was the early investigation of hysteria (*q.v.;* 1895–96) which led to the theoretical preoccupation with repression, since repression of drive and affect (followed by conversion into bodily manifestations) is the main defense mechanism used in hysteria. The study of obsessional neurosis (1908–09; *see* NEUROSES), while confirming the importance of repression, threw light additionally on regression, which initiates symptom formation in such neuroses; isolation and undoing as techniques used by the ego; and reaction formations as means of stabilizing the neurotic structure and constructing what is known as the obsessional character. A study of the instincts (*see* INSTINCT) highlighted the processes of reversal and turning against the self (1915). Studies of pathological jealousy, paranoia and homosexuality (*see* PARANOID REACTIONS; HOMOSEXUALITY) yielded results for isolating the mechanism of projection (1911, 1922). Clinical investigations of the state of mourning and of melancholia clarified the working of introjection and identification (1916), while defenses such as sublimation and intellectualization were linked with the gradually accumulating insight into the processes of growth and development in infancy and adolescence.

Chronology of the Defense Mechanisms.—The order in which the various methods of defense made their appearance in the literature does not coincide with the chronology of their emergence in the development of the individual. The latter is a much debated point in psychoanalytic theory. Many accept the hypothesis that each defense mechanism is first evolved to master some specific situation and, thus, is associated with a particular phase of infantile development; another assumption states that before division into the three agencies (id, ego and superego) the mental apparatus uses different methods of defense from those which it employs after it has attained these levels of organization. In short, defense, as an activity of the ego, is inevitably corelated to the consecutive stages of ego and personality development. There are among the defense mechanisms enumerated above those regarded as primitive and others which bear the hallmark of complex higher organization. In fact, after some chronological orientation in the field has been established, the type of defense used by an individual at a given time of life can serve as a valuable diagnostic indication of the developmental level which has been reached, or to which the person in question has regressed.

Pre-Stages of Defense.—Before the ego has separated off from the id (or from the undifferentiated matter which forms the basis for id and ego development), the immature organism has no means of protecting itself from unpleasurable tensions and frustrations except by ineffective attempts at hallucinating absent satisfactions or by giving signs of distress which call for help from the external world. After motility has developed, the reactions of flight from and avoidance of external stimuli become protective measures. With the emergence of a primitive ego, denial (withdrawal of awareness, mental flight) becomes a major method of dealing with the unpleasant, painful or frustrating external world.

Stages of Defense.—The ability to protect the self against the inner world is tied to the next phase of ego maturation and development. In the period in which the infant makes first attempts to differentiate between its own self and the world around it (*i.e.*, in the first year of life), much of the mastery of tensions seems to be accomplished by means of projections and introjections, the infantile ego throwing out and ascribing to the environment whatever is painful and appropriating for itself whatever is pleasurable. In the period in which ego and id become decisively separated from each other (the second year of life), repression comes into use as the main defense, to safeguard this newly established, all-important division. The defense of intellectualization also has its origin in the second year, in the period when the development of speech and logical thought serve to lift mental activity to the higher level of performance and mastery of the id which, from then onward, remains characteristic of the processes in the ego (secondary processes), in contrast to the primitive forms of mental functioning which reign in the id (primary processes). Reaction formations and sublimations appear later (sometime between three and five years of age), since they depend on the child's internalization of an external system of values, a step which presupposes the division between ego and superego.

It is less possible to assign a place in this chronology to mechanisms such as regression, reversal of drive or turning drive activity toward the self. As mentioned above, these represent alterations and modifications of drive activity which are inherent in the drives themselves and merely made use of by the ego in periods of danger. As such they seem to be independent of the stage of ego development and as old as the drives themselves, or at least as old as any conflict which arises between id impulses and any hindrance which they may encounter on their way to gratification.

Defense in Normal and Abnormal Development.—*Defenses as a Means of Adaptation.*—Taken all together, the defensive activities of the ego add up to a massive interference with drive activity; *i.e.*, with the free play of sexual and aggressive impulses. The result of this for the adaptation of the individual to his environment can hardly be overrated. Without a properly functioning system of defenses, there would be no way for the organism to maintain a tolerable mental equilibrium or even to maintain itself in the surrounding world and escape the danger of being destroyed while engaging blindly in the search for instinctual gratification.

Apart from maintaining the existence of the organism, the defenses also play a major role in building up the personality: projection and introjection in their interaction with the environment establish the individual's sense of identity; repression safeguards the conscious personality against inroads from the unconscious id, thereby guaranteeing sanity; sublimations and reaction forma-

tions ensure socialization, etc. Altogether, it is the curtailing of gratification, brought about by the defense mechanisms, which is responsible for changing primitive, infantile human beings into responsible members of the civilized community. (*See* also ADJUSTMENT [IN PSYCHOLOGY]; PERSONALITY.)

The Danger of Defense Action.—Although defense is undertaken in the service of self-preservation, reason, mental equilibrium and social adaptation, such major interference with the natural forces in the human mind cannot fail to have serious consequences for the individual's health and happiness. The effort of maintaining a constant defense system is in itself a strain on the ego and may deplete it of energies needed for other, constructive purposes.

Further, each defense action is paid for heavily by the ego. Projection, while easing the "unpleasure" caused by unwanted inner impulses, falsifies the picture of the external world, thereby creating new threats. Reaction formations act as an armour to the ego, but also hinder free expansion of interest. Turning aggression against the self socializes the individual but simultaneously weakens his efficiency and creates a self-destructive, masochistic attitude to life. Regression may promise momentary safety from conflict but interferes severely with growth and development. Repression, above all, is justly held responsible for damage to the personality. Although indispensable for securing the border against the id, it also limits man's enjoyment of sex and aggressive activity and also restricts the ego's sphere of influence by leaving all repressed matter permanently outside its jurisdiction.

Defense and Mental Illness.—No neurosis maintains its structure by employing one defense mechanism only, but always a combination of several. Although defense mechanisms are an integral part of every neurotic structure, the presence of defensive activity in the mind is in itself no sign of pathology. In cases where defense is successful in controlling tensions, no symptomatology develops, although the effect may be crippling for the ego and impoverishing for instinctual life. Where the defense mechanisms fail to ward off anxiety and "unpleasure" and where repressed matter returns to consciousness, the ego is forced to multiply and overintensify its defensive efforts and to overstress the use of the various mechanisms. It is in these instances that, finally, the formation of neurotic symptoms is resorted to. Such symptoms are compromise formations which express and represent at the same time the defensive tendencies of the ego and the pleasure-seeking tendencies of the id. Psychoses signify a severe breakdown in the defense system, characterized also by the preponderance of primitive mechanisms.

See *The Standard Edition of the Complete Psychological Works of Sigmund Freud* (1953–), especially *Outline of Psychoanalysis* (Eng. trans. by J. Strachey, 1949); and A. Freud, *Das Ich und die Abwehrmechanismen* (1936; Eng. trans., *The Ego and the Mechanisms of Defence*, 1937). (A. FD.)

DEFFAND, MARIE DE VICHY-CHAMROND, MARQUISE DU (1679–1780), a leading figure in French society, famous for her letters to the duchesse de Choiseul, to Voltaire and to Horace Walpole, was born of a noble family at the château of Chamrond in Burgundy on Dec. 25, 1679, and educated at a convent in Paris. From the beginning she was an unbeliever, whose skepticism the great Massillon himself was unable to shake. When, at a later date, the cardinal Melchior de Polignac, in an unguarded moment, spoke of the miracle by which St. Denis is said to have walked two miles with his head in his hands, she interjected: "Je n'ai pas de peine à le croire, Monseigneur. Il n'y a que le premier pas qui coûte" (I can easily believe it, my lord. It is only the first step which costs). She was married at 21 to her kinsman, Jean Baptiste de La Lande, marquis du Deffand, from whom she separated in 1722. She was by that time taking part in the extremely dissipated life which characterized the entourage of the regent, Philippe, duc d'Orléans, whose mistress she became (*cf.* Walpole's letter to Thomas Gray, Jan. 25, 1766). She was frequently seen at Sceaux, where the duchesse du Maine held court amid a brilliant company, which included Fontenelle, Houdar de la Motte, the marquise de Lambert (Anne Thérèse de Marguenat de Courcelles), Voltaire and the president Charles Hénault (*q.v.*) with whom she lived on intimate if not always friendly terms till his death in 1770. When she set up her own salon, in the convent of St. Joseph, she attracted scientists, writers, wits and all that were of any consequence in the world of letters and in society. She was drawn to D'Alembert, but she never liked the *Encyclopédistes,* whom she seems to have tolerated only for his sake, and she spoke scathingly of Jean Jacques Rousseau, who did not spare her in his *Confessions.*

By 1754 Mme du Deffand had lost her sight and engaged Julie de Lespinasse (*q.v.*) to help her in entertaining. The wit and charm of the latter made some of the guests, D'Alembert among others, prefer her society to Mme du Deffand's, and she arranged to receive her friends for an hour before the appearance of her patron. When this was discovered, Mlle de Lespinasse was dismissed (1764), and as a result the salon was broken up, for she took with her D'Alembert, Turgot and the *littérateurs* generally. From this time, Mme du Deffand rarely received any literary men. The principal friendships of her later years were with the duchesse de Choiseul (Louise Honorine de Crozat) and with Horace Walpole (*q.v.*). Her letters to the duchesse are full of life and have great charm. Those to Voltaire, extending over 43 years, dazzle by their wit. Her last letters addressed to Walpole, for whom she developed a tardy passion, are among her best. Her prose developed qualities of style and eloquence of which her earlier writings had given little promise, and her chronicle of events at court and at home form a fascinating and valuable document. There is something pathetic in this aging rationalist, hard, cold and egocentric, becoming truly infatuated for the first time at the age of 68. Her last years were sad, and she died in Paris on Sept. 23, 1780, leaving her dog Tonton to the care of Walpole, who was also entrusted with her papers.

Editions of Mme du Deffand's letters are: *Correspondance inédite* . . . with D'Alembert, Hénault, Montesquieu and others, two volumes (1809); *Letters of the Marquise du Deffand to the Hon. Horace Walpole . . . 1766–1780,* edited by M. Berry, four volumes (1810); *Correspondance complète* . . . edited by M. de Lescure, two volumes (1865); *Correspondance inédite,* edited by the marquis de Sainte-Aulaire, three volumes (1866); *Lettres de Mme du Deffand à Horace Walpole,* with 18 of the supposedly lost letters of Walpole and nearly 500 previously unpublished, edited by Mrs. Paget Toynbee, three volumes (1912). There are also *Letters to and from Mme du Deffand and Julie de Lespinasse,* edited by W. Hunting Smith (1938); and *Horace Walpole's Correspondence,* vol. iii–viii, *With Madame du Deffand and Wiart,* edited by W. S. Lewis and W. H. Smith (1939).

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DEFINITION. *Nominal definition* is the act of stating, explaining or indicating the meaning or use of a *notation* (*i.e.*, word, phrase, symbol or expression); the act of introducing and fixing the meaning of a notation; or the sentence, in some language, by which such a statement or fixing of meaning is made. Under this broad head are included many things, not all closely related to one another, which are called or have been called definition. Here will be distinguished abbreviative definition, semantical definition, and ostensive definition.

In *abbreviative definition* a notation, the *definiendum,* is introduced as a mere abbreviation of another notation, the *definiens,* which it may be used to replace (the definiendum being ordinarily a shorter or otherwise more convenient notation than the definiens). The distinguishing feature is that an expression containing the definiendum must be understood as if it had the definiens in place of the definiendum—not only semantically, *i.e.*, in regard to its meaning, but also syntactically. For a fuller explanation and examples, *see* LOGIC.

In *semantical definition* a meaning is directly ascribed or assigned to a notation by a statement that mentions explicitly both the notation and the meaning; *e.g.*, "The word 'pentagon' means a polygon with five sides." In this example the definiendum is

"pentagon" and the definiens is "polygon with five sides."

In *ostensive definition* a proper name or a common name (*see* NAME [IN LOGIC]) is assigned to a concrete object by physically showing or pointing to the object and naming it. It is a common remark that without ostensive definition, and related methods of indicating rather than stating meanings, language cannot acquire objective reference at all. Yet, unlike other kinds of definition, the study of ostensive definition is not in the domain of logic; and objective reference, as acquired by ostensive procedures, is rather a presupposition for logic.

A familiar feature of natural language is the use of demonstrative words such as "you," "I," "here," "today," "yesterday," a part of whose meaning is reintroduced by an implicit ostensive definition on each new occasion of their use—and which have as what may be called their secondary meaning the manner in which this implicit ostensive definition is to be understood. For example, "Yesterday was a fine day" may be true when uttered at one time and false when uttered at another, because of the different meaning of the name "yesterday." Such demonstrative words are a linguistic convenience but, unlike ostensive definition generally, are dispensable in principle. For purposes of logic, they must either be eliminated altogether, or treated as used on one fixed occasion in such a way that the meaning remains unchanged.

Real definition is distinguished from nominal definition as being the definition of a thing rather than of a notation. For Aristotle a definition is of what a thing is and of its essential nature or essence. By many this Aristotelian notion of real definition has now been abandoned or modified because of the difficulty of a precise account of what is meant by the essence of a thing, as distinguished from the meaning of some name of that thing or an analysis of some concept of it. (*See* LOGIC, HISTORY OF.)

Another kind of real definition is obtained if (without attention to essence) a nominal definition is paralleled by a corresponding statement of identity or equivalence, in which the definiendum is used rather than mentioned. For example, the semantical definition of "pentagon" which is given above has the parallel real definition, "A pentagon is a polygon with five sides," which is not about the word "pentagon" but about pentagons. Or again, in the article LOGIC the notation $p \vee q$ is introduced by abbreviative definition as standing for $\sim p \supset q$; for a different formulation of propositional calculus in which the signs $\vee$ and $\supset$ are both taken as primitive, we might state instead the real definition, $p \vee q \equiv \cdot \sim p \supset q$. However, it is held by some that such real definitions are not suitably called definitions at all, but should rather be characterized merely as statements that are true by definition, or otherwise analytically true.

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DEFOE, DANIEL (1660–1731), English novelist and political pamphleteer, the author of *Robinson Crusoe*, was born in the parish of St. Giles, Cripplegate, London, probably in the latter half of 1660. His father, James Foe, was a tallow-chandler of Flemish descent and later became a member of the Butchers' company, as did (1688) Defoe himself. It is thought that the family name was originally "Du-foe" or some variant of it and from his middle thirties Daniel was calling himself Defoe. The family were Nonconformists but although the English universities were closed to dissenters Defoe received a good education, first at the Rev. James Fisher's school at Dorking and then (from about 1674 to 1679) at the Rev. Charles Morton's excellent academy at Newington Green, Stoke Newington. Morton (1627–98), who was an admirable teacher and later became first vice-president of Harvard college, may have influenced Defoe's literary style, though the Bible, Bunyan's writings and the pulpit oratory of the day also no doubt contributed.

Although intended for the Presbyterian ministry, Defoe decided against this and by 1683 had set up as a merchant. He called trade his "beloved subject" and it was one of the abiding interests of his life. He dealt in many commodities, traveled widely in Britain and on the continent and became an acute and intelligent economic theorist, in many respects ahead of his time; but misfortune, in one form or another, dogged him continually and in a couplet which, he says, sums up the scenes of his life, he wrote:

> No man has tasted differing fortunes more,
> And thirteen times I have been rich and poor.

As a result, mainly, of losses sustained in insuring ships during the war with France, Defoe went bankrupt in 1692, for £17,000. He dealt honestly with his creditors and in ten years had paid off all but £5,000; but he was never afterward entirely free from debt and much of his apparently equivocal political conduct in later years should be seen in the light of this. The existence of unsatisfied creditors was always a weapon that could be used against him by his enemies, while his political masters could use his need for protection to keep him toeing the line. Defoe suffered other severe losses in 1703, when his prosperous brick-and-tile works near Tilbury failed during his imprisonment for political offenses; his last years were clouded by legal controversies over allegedly unpaid bonds dating back a generation; and it is thought that he died in hiding from his creditors. His Moll Flanders, who was born in Newgate prison, speaks of poverty as "a frightful spectre," and it is a theme of many of his books.

With Defoe's interest in trade went an interest in politics, the first of his many political pamphlets appearing in 1683. As a dissenter he opposed the Catholic James II and joined the ill-fated Monmouth rebellion of 1685, managing to escape after Sedgemoor. In 1688 he rode to welcome the army of William of Orange—"*William*, the Glorious, Great, and Good, and Kind" as Defoe was to call him; and throughout William's reign Defoe supported him staunchly, becoming his leading pamphleteer. In 1701, in reply to attacks on the "foreign" king, Defoe published *The True-Born Englishman*, said to be the most widely sold poem that had appeared in English; vigorous and witty, it is still a valid and penetrating attack on the fallacies of racial prejudice. In the same year he wrote an outspoken tract, *The Succession to the Crown of England, Considered*, in which he asserts his belief that political power derives from the people, whose servants both king and parliament are.

Foreign politics also engaged Defoe's attention: since the treaty of Ryswick in 1697 it had become increasingly obvious to many observers that war would soon break out again over the Spanish succession; in 1701 five gentlemen of Kent presented a petition, demanding greater defense preparations, to the house of commons (now with a Tory majority) and were imprisoned. The following morning Defoe, "guarded with about 16 gentlemen of quality," presented the speaker, Robert Harley, with his *Legion's Memorial*. This famous document, containing such phrases as "Englishmen are no more to be slaves to Parliaments than to a King," was effective: the Kentish petitioners were released and Defoe was fêted by the citizens of London; but it undoubtedly branded him in the eyes of the extremer Tories as a dangerous man who must be brought down.

It is often difficult to separate religion from politics in this period. Both dissenters and low churchmen were mainly Whigs, and the high-church Tories—the "high-fliers"—were determined to undermine their working alliance by preventing the practice of "occasional conformity"—that is, the practice of receiving the sacraments according to the rites of the Church of England, in order to qualify for public office, and then attending dissenting worship services. This had long been a burning question and Defoe had written the first of his many pamphlets on it in 1698. With the change of government, pressure increased; violent attacks were made on the dissenters by such preachers as Dr. Sacheverell and in reply Defoe wrote perhaps the most famous of all his pamphlets, *The Shortest Way with the Dissenters* (1702). His method was ironic: to discredit the high-fliers by writing as if from their point of view, but reducing their arguments to violent absurdity. The pamphlet had a huge sale but the irony recoiled on Defoe, for dissenters and high churchmen alike took it seriously and alike were angry when the hoax became apparent. Defoe was prosecuted for seditious libel and arrested in May 1703 after a period of hiding. The advertisement offering a reward for his capture gives the only personal description we have of Defoe: "a

middle-sized spare man, about 40 years old, of a brown complexion, and dark-brown coloured hair, but wears a wig, a hooked nose, a sharp chin, grey eyes, and a large mole near his mouth." After being advised to plead guilty and rely on the court's mercy, Defoe was harshly sentenced: to a fine of 200 marks, to stand three times in the pillory and to find sureties for his good behaviour for seven years. It has been suggested that the prosecution was primarily political: that the earl of Nottingham, one of the two secretaries of state, had hoped to force Defoe into betraying certain Whig leaders who had supported William over the Second Partition treaty of 1699 (*see* ENGLISH HISTORY: *The Struggle Against Louis XIV*). While awaiting his ordeal, Defoe wrote his audacious *Hymn to the Pillory* (1703); and this helped to turn a punishment into something of a triumph, with the pillory garlanded and the mob drinking his health.

Triumph or not, Defoe remained in Newgate. Nineteen years previously, in 1684, Defoe had married Mary Tuffley, who bore him eight children (of whom one died in infancy and another young); while he was in prison his Tilbury business had failed and he was desperately concerned for the welfare of this already numerous family. He had appealed to Harley in May 1703, and by September Harley, appreciating Defoe's potential usefulness, set about securing his release, which finally took place in Nov. 1703. Thereafter Defoe was a pamphleteer in the cause of successive ministries, both Tory and Whig, until shortly before his death. He has, inevitably, been accused of "trimming," and there is little doubt that at times Defoe was able to equivocate successfully with his conscience; but a more sympathetic view may see him, as he always claimed to be, as an unswerving champion of moderation, skilfully helping those he advised and supported to steer a middle course.

Whatever his motives, Defoe was an energetic worker on behalf of the government. He traveled extensively, wrote reports, minutes of advice, pamphlets: "Intelligence," he told Harley, who employed him as a secret agent, "is the Soul of all Publick business," and Defoe was a valuable servant. He paid several visits to Scotland, especially at the time of the Union of 1707, and kept Harley closely in touch with public opinion. These trips bore fruit in a different way later: in 1724–27 the three volumes of his admirable *Tour Through the Whole Island of Great Britain* were published, for which he certainly drew on many of his observations of the earlier years.

Perhaps Defoe's most remarkable achievement during the reign of Queen Anne was his periodical, the *Review*. He wrote this, practically single-handed, as the main government organ from 1704 to 1713; at first a weekly, it became a thrice-weekly publication in 1705 and Defoe continued to produce it even when, for short periods in 1713, his political enemies managed to have him arrested and imprisoned again on various pretexts. The political line corresponded with that of the moderate Tories but, in addition to politics as such, Defoe discussed current affairs in general, religion, trade, contemporary manners and so on; some of this was presented through the medium of the "Scandalous Club," which probably influenced Addison and Steele. Defoe has been called "the father of modern journalism" and he was connected in one way or another with 26 periodicals.

With the accession of George I in 1714 the Tories fell; but the Whigs in their turn recognized Defoe's value and he continued to write for the government. He also served them in other ways, including the rather disreputable office of editing and toning down various Tory journals, such as the Jacobite *Mist's Weekly-Journal*. Again, Defoe defended himself by claiming to work only for the public good: the ethics might not be wholly admirable, but for him the end—the prevention of the bitterness of party and religious strife—justified the means.

But not all the writings so far mentioned, nor his long political poem of 1706, *Jure Divino* (an attack, in 12 books, on the theory of the divine right of kings), would have procured for Defoe his undoubted literary immortality. It was not until 1719 that he turned his talents to an extended work of prose fiction and produced *Robinson Crusoe*, one of the most famous books ever written. A German critic has called it a "world-book," a label justified by the number of translations, imitations and adaptations that appeared and continue to appear. It was popular from the first, not, perhaps, with the "polite" public, who usually affected to despise Defoe, but certainly with the middle and lower classes. He followed up its success with Crusoe's *Farther Adventures* (1719) and *Serious Reflections* (1720), though neither of these is comparable to the first of the trilogy. Having struck this vein, he produced *The Life and Adventures of Duncan Campbell, Memoirs of a Cavalier* and *The Life of Captain Singleton*, all in 1720. His *annus mirabilis*, however, was 1722, which saw the publication of *Moll Flanders, A Journal of the Plague Year* and *Colonel Jack*. In 1724 he published *Roxana*, his last major work of fiction.

In *History of the Pirates* (1724–28) Defoe wrote, "I am most entertained by those actions which give me a light into the nature of man," and the insight he shows into human nature is perhaps his greatest gift as a novelist. The men and women he writes about are, it is true, all placed in remarkable circumstances; they are all, in one sense or another, solitaries; they all struggle, in their different ways, through a life which is a constant scene of jungle warfare; they all become, to some extent, obsessives. But they are also all ordinary human beings of Defoe's own class and their creator, writing always in the first person, enters into their minds and analyzes their motives for behaving as they do. Defoe has been called the first social historian and, especially in the brilliant early chapters of *Moll Flanders* and *Colonel Jack*, he demonstrates unforgettably how the force of circumstances and the fear of poverty may drive one into a life of crime. *Robinson Crusoe* stands somewhat apart from the rest by reason of its subject and setting; but the same penetrating insight is at work and the book's success is largely due to the skill with which Defoe creates his hero, an ordinary man with whom his readers can identify themselves, and shows him overcoming the difficulties of life on his island—making things, planting crops, taming wild creatures, longing for human companionship, building his little "castle," experiencing spiritual doubt and physical fear—all the time seeking to preserve his integrity, all the time a living human being. The sense of fact is one of Defoe's great strengths, the vivid concreteness of detail with which he visualizes and presents his material. Where this material came from hardly matters: *Robinson Crusoe* was partly inspired by the adventures of Alexander Selkirk (*q.v.*), but many other mariners and castaways have been brought together in Crusoe. For his other novels Defoe almost certainly uses such things as his memories of Newgate or the interviews with condemned criminals he conducted for Applebee's *Journal* in the 1720s; but he draws upon a lifetime of observation, of talking to people of all kinds, of preoccupation with statistical and mercantile detail. It may seem at first as if the detail is unselective and undifferentiated, but this is not the case: whether the selection was made consciously or not, in every novel Defoe uses detail to build up a particular world. There are complaints to be made of him as a novelist: there is too much apparently extraneous moralizing for a modern taste, though fortunately the artist continually gets the better of the moralist; the novels are singularly shapeless, the attitudes sometimes naïve. His range is narrow; but within that range Defoe is a novelist of unquestioned power and his plain, direct style, as in all his writing, holds the reader's interest.

In the last decade of his life Defoe's health was failing, but he was still extremely active. Among his works of this period may be mentioned *The Complete English Tradesman* (1725–27), *Atlas Maritimus et Commercialis* (1728), *The Political History of the Devil* (1726) and *An Essay on . . . Apparitions* (1727). His last work was an expanded edition (1731) of *A Plan of the English Commerce*, first published in 1728. The total number of Defoe's writings is enormous: the canon must always, perhaps, remain uncertain, but in 1958 Professor J. R. Moore credited him with no fewer than 545 titles.

Defoe died in Ropemaker's Alley, Cripplegate, on April 24, 1731, and was buried two days later in Bunhill Fields. His wife, to whom he had been married 47 years, died in the following year.

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DE FOREST, ALFRED VICTOR (1888–1945), U.S. engineer who developed the magnaflux test, a method of discovering defects in steel, was born in New York city, April 7, 1888. He was educated at the Middlesex school in Concord, Mass.; the Massachusetts Institute of Technology, from which he received the B.S. degree in 1911; at Princeton and Columbia universities. While working for the American Chain company in Bridgeport, Conn., he specialized in magnetic analysis in its correlation with metallography as these studies reveal the physical properties of steel. The magnaflux test which he developed was based upon a discovery by W. E. Hoke in 1918 that tiny iron particles placed on the metal surface tend to accumulate along cracks in magnetized steel parts. De Forest made significant improvements in the methods and obtained several patents. In 1934 he founded the Magnaflux corporation. That same year he became a member of the faculty of the Massachusetts Institute of Technology, a position he held until his death at Marlboro, N.H., on April 5, 1945. He published a number of technical and scientific papers and received many honours. (W. E. Hp.)

DE FOREST, LEE (1873–1961), U.S. inventor of the audion, the elementary form of the modern radio tube, was born at Council Bluffs, Ia., Aug. 26, 1873, graduated from Yale Sheffield Scientific school in 1896 and received his Ph.D. in 1899. Almost immediately he started his career of invention and the promotion of radio communication, or wireless, as it was then called. The De Forest Wireless Telegraph company was organized but after several years it failed. Primarily an individualistic experimenter and inventor, De Forest spent several years on the important problem of devising a sensitive detector for the reception of radio waves. This work culminated in 1906 in the invention of the audion. Slowly the usefulness of these tubes as generators, amplifiers and detectors of radio waves was established. However, it was not until the radio communication needs of World War I arose that the audion, improved by the work of others, became an invaluable engineering device and was manufactured in large quantities.

In 1910 De Forest transmitted the singing voice of Enrico Caruso and thus was one of the pioneers of radio broadcasting. His many patents included the phonofilm, an early development in the field of talking motion pictures. He was honoured by medals and awards from several learned societies and served as president of the Institute of Radio Engineers. De Forest died at Hollywood, Calif., on June 30, 1961. (W. C. Wh.)

DEFREGGER, FRANZ VON (1835–1921), Austrian genre painter, whose representations of Tirolese life had a wide and popular appeal, was born in Dölsach, in Tirol, on April 30, 1835. He spent his youth amid the mountains as a farm labourer, and then went to Innsbruck to study drawing and carving. His teacher, Franz Stolz, took him to Munich in 1861. In 1863 he went to Paris, and then, returning to Munich, studied under Karl von Piloty for five years. His works, whose popularity was the result principally of their subject matter, depicted the rustic life of the Tirolese and the struggle of Tirol, under Andreas Hofer, for freedom from foreign domination. Defregger died in Munich on Jan. 2, 1921.

DEGAS, HILAIRE GERMAIN EDGAR (1834–1917), one of the greatest of 19th-century French artists and a master of the human figure in movement, was born in Paris on July 19, 1834. He came of the powerful upper *bourgeoisie*, his family having banking and business connections both in Italy and the United States, and he was intended for the law, which he studied for a time after leaving the Lycée Louis-le-Grand. In 1855, however, he enrolled at the École des Beaux-Arts and entered the studio of Louis Lamothe, a pupil of Ingres, whose long-established position as defender of academic orthodoxy in draftsmanship and subject matter was being challenged by the realism of Courbet as well as by the romanticism of Delacroix.

It seems likely that as a young man Degas wished to succeed along orthodox lines as a painter of historical subjects in the grand French tradition. To further his aim he augmented his studies by visiting Florence, Assisi, Rome and Naples and by closely observing and copying the work of Mantegna, Botticelli, Hans Holbein the Younger and Nicolas Poussin, all notable for their scrupulousness in figure draftsmanship. Before 1860 Degas had produced some splendid family portraits in which the effect of this discipline, though clear, is heightened by a taut, alert urbanity which belongs unmistakably to the mid-19th century. The "Duchess Morbilli" (Louvre, Paris, 1855–56) is typical of this group. It is broadly designed with large, simple surfaces rather flatly modeled in the manner of Ingres; the paint is solid, yet delicate, and the colours cool and restrained with many black and neutral passages. In 1860 Degas made his debut as a painter of classical subjects with his "Young Spartans Exercising" (Louvre); but here the nude figures, though arranged in balanced groups, are those of real adolescents in a natural landscape instead of idealized nudes in an Arcadian setting.

After 1861, when Degas painted "Semiramis Founding a City," again with academic intentions, he seems to have abandoned historical painting and begun to seek his subject matter in the fast-moving city life of Paris. In this he was probably inspired by contemporaries like Courbet and Manet (whom he met in 1862), by contemporary novelists and by the discovery, late in the 1850s, of the astonishing formal yet documentary quality of Japanese graphic art. Nor did he overlook the brilliant work of contemporary French graphic artists like Gavarni and Daumier. It is not surprising that by 1862 he was painting the riders, their mounts and the smart spectators at Longchamp racecourse, soon afterward beginning the portrait groups of musicians and stage subjects, which, like all subjects in which the sitters were absorbed in practised movement, fascinated him throughout his life. Among the first of the latter is the "Mlle. Fiocre in the Ballet 'La Source'" (Brooklyn museum, *c.* 1867). His portraits of the 1870s show greater ease and naturalism than the very first group, but are still based on a firm discipline traceable right back to Holbein and the great north Italian portraitists.

Degas served in the artillery during the Franco-German War of 1870–71. On his return, he began to undertake ambitious figure groups, seen informally and in movement, and continued his studies of stage and orchestral groups. From these he passed to instantaneous renderings both of outdoor and indoor scenes, using displaced figure grouping and unorthodox cutting and perspective rather in the manner of a cameraman. Yet his magnificent formal sense and skill is always present to provide an equilibrium, however momentary, to these exacting subjects. The "Place de La Concorde (Viscomte Lepic and His Daughters)" (*c.* 1873) is a fine example and an outdoor counterpart to the ballet subjects which gave Degas endless scope for multifigure groups seen in fast intercepted movement. Degas visited the United States in Oct. 1872, staying for five months and painting one of his best-known scenes of figures in absorbed "occupational" movement. This was the "New Orleans Cotton Office" of 1873, now in the museum at Pau, France; it shows that although Degas had completely abandoned his early ambition of historical figure painting, he had nevertheless put to full use the structural principles of the formal tradition.

During the 1870s most of Degas' figure groups are arranged against fairly extended background space, in which the figures themselves are given plenty of room. By the end of the decade, however, he was becoming interested in the pictorial possibilities of more closely juxtaposed and superimposed groups and giving more attention to the formal qualities of the voids between them. The famous "Repasseuses" ("Women Ironing," Louvre) of 1884 shows this tendency at an advanced stage, with an artificially shal-

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"ABSINTHE" BY EDGAR DEGAS, 1876. IN THE LOUVRE, PARIS

low picture space and a reconciliation of solid form and surface reminiscent of Venetian mid 16th-century art in method but here applied with a documentary eye to a casual workaday subject. By this time Degas had begun to work in pastel, sometimes using a mixed technique with volatile oil mediums, and his indoor series of women at their ablutions carries on the researches mentioned above. Some of the later ones reach an astonishing compromise between plasticity and surface pattern, the flesh colours being built up of strips of pure colour more closely knit than the *taches* of the impressionists, but like them merging at a certain distance to give the illusion of solid modeling. Though Degas was a consistent exhibitor with the impressionists, his position mainly as a painter of closely calculated indoor figure groups places him slightly apart from his colleagues. He was, however, very much concerned with depicting the fleeting and momentary, while his subjects are those of the school which followed Courbet, and his palette, moreover, becomes progressively more brilliant and divided, like that of the impressionists. After about 1880 Degas was practising occasionally as a sculptor, and the group of small bronzes deriving from his models of dancers, bathing women and horses again show his power of revealing the potentialities of the ordinary unobserved movements of human beings and animals. Degas, in fact, perhaps for the first time in history, viewed his animal and human models with the same dispassionate eye when making these studies. He was interested in photography, and there is an affinity between his vision and that of a high-speed camera. Degas' eyesight failed in later life; he eventually became completely blind in one eye and nearly so in the other. He died Sept. 26, 1917, leaving an extremely important collection of the drawings and paintings of his contemporaries. He also left a notebook of poetic compositions, mostly in the sonnet form.

See also references under "Degas, Hilaire Germain Edgar" in the Index volume.

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DE GASPERI, ALCIDE (1881–1954), Italian statesman and leader of the Christian Democratic party who was prime minister as head of eight successive governments from Dec. 1945 to Aug. 1953 and was also one of the builders of the western European economic and political community, was born on April 3, 1881, at Pieve Tesino, in the then Austrian Trentino. After studies at the University of Vienna, he was elected in 1911 to the Austrian *Reichsrat* (parliament) as an Italian irredentist representative. The Trentino having been united with Italy after World War I, he was elected in May 1921 to the Italian parliament as one of the founders of the Partito Popolare Italiano led by Don Luigi Sturzo. He opposed Mussolini's dictatorship, and in 1926 the Fascists suppressed the daily newspaper *Il Nuovo Trentino* that De Gasperi had edited for 20 years. He was arrested and sentenced to four years' imprisonment, but was released after 16 months through the intervention of Pope Pius XI and, in 1929, was appointed an assistant in the Vatican library.

During World War II De Gasperi took part in the resistance movement and in June 1944 joined Ivanoe Bonomi's first cabinet as minister without portfolio. Having been minister of foreign affairs in Bonomi's second cabinet (Dec. 1944) and under Ferruccio Parri (June–Nov. 1945), he became prime minister on Dec. 10, 1945. He was to remain in office for more than seven years. In the same period he was also foreign minister again from Dec. 1945 to July 1946 and from July 1951 to Aug. 1953.

Early in 1946 De Gasperi was elected leader of the Partito Democratico Cristiano or Christian Democratic party, as the reconstructed Partito Popolare was now called. In the general election of June 1946 his party won 207 seats out of 556, but in that of June 1948 it won an absolute majority of 305 out of 574. De Gasperi nevertheless remained faithful to his principle of government by a coalition of the truly democratic parties. At the election of June 1953, however, the Christian Democrats obtained only 262 seats out of 590, and they and their allies failed by a narrow margin to gain an absolute majority. Deserted by the Republicans and by the right-wing Social Democrats, De Gasperi had to form, on July 16, 1953, his eighth government as a single-party Christian Democratic ministry and 12 days later he failed to win a vote of confidence (obtaining only 263 votes against 282). He resigned his ministry on Aug. 2, 1953, but remained secretary-general of his party till June 1954.

De Gasperi played a major part in restoring—with U.S. aid—his country's economy after the Italian defeat in World War II. Under his guidance Italy became a member of the North Atlantic Treaty organization. In intimate collaboration with Robert Schuman (France) and Konrad Adenauer (German Federal Republic)—both Christian Democrats too—he contributed to the creation of the European Coal and Steel community (April 1951) and to the planning of the European Defense community (May 1952). The latter project, however, collapsed in Aug. 1954 because of the French opposition.

Faithful to his irredentist tradition, De Gasperi insisted on maintaining Italy's frontier on the Brenner pass and worked to retain Trieste for Italy. Yet he was never really popular among the Italians, who judged him to be too strict in applying his own moral values to politics. He was also a rather poor speaker. He himself, however, cared little for personal popularity, believing that the achievements of his policies were eloquent enough.

De Gasperi died of a heart attack at Sella di Valsugana, Trentino, on Aug. 19, 1954, shortly after a telephone call from Mario Scelba, the prime minister, informing him of the French opposition to the European Defense community.

See G. Petrocchi, *De Gasperi e la Democrazia Cristiana* (1946); "Adstans," *Alcide De Gasperi nella politica estera italiana* (1953).

DE GAULLE, CHARLES ANDRÉ JOSEPH MARIE (1890–), French army officer and statesman, was born at Lille on Nov. 22, 1890, son of a professor of philosophy and literature at a Jesuit college. He passed with distinction through the École Militaire of St. Cyr and in 1913 joined the 33rd infantry

regiment commanded by Col. Philippe Pétain. He fought in the early campaigns of World War I, culminating in the battle of Verdun in March 1916, in which he was disabled and taken prisoner for the rest of the war.

When the armistice brought his release De Gaulle rejoined his old regiment, soon to be detailed to the Polish army formed in France. He was recalled to lecture at St. Cyr in 1921. Having graduated from the École Supérieure de Guerre in 1924, he was summoned by Marshal Pétain, then vice-president of the Conseil Supérieur de la Guerre, to join his staff in 1925. In 1927, with the rank of major, he served at Trier in the army occupying the Rhineland. Two years later he was moved to the Lebanon, returning to Paris in 1931. His publications, *Le Fil de l'épée* (1931), *Vers l'armée de métier* (1934) and *La France et son armée* (1938), revealed him as a soldier of unusual intellectual powers and literary skill, and led him into conflict with orthodox military opinion. He urged a strategy of defense based on the mobility of tanks and aircraft rather than on the immobility of fortifications in depth, and pleaded for a highly mechanized professional army at a time when official opinion favoured reliance upon national conscription and the Maginot line.

When World War II began in 1939 De Gaulle, then colonel, commanded the brigade of tanks attached to the 5th army in Alsace. During the campaign of May 1940 Gen. Henri Giraud appointed him brigadier general in charge of the half-formed 4th armoured division, which fought effectively in desperate conditions. On June 6 the new premier, Paul Reynaud, appointed him to his first political post, undersecretary of state for war. In this capacity he visited London twice and met Winston Churchill. When Pétain, as Reynaud's successor, sought an armistice, Gen. de Gaulle returned to London and on June 18 broadcast his famous appeal to the people of France to continue the fight and put himself at the head of the new Free French movement. On July 7, 1940, at Toulouse, a French court-martial sentenced him to death.

As leader of the Free French and eventually president of the French Committee of National Liberation in Algiers, De Gaulle became at once the symbol of French resistance to occupation and an intransigent ally of the western powers. On Sept. 10, 1944, after the liberation of metropolitan France, he formed a provisional government. Two constituent assemblies were elected to draft a new constitution. But when this was at last put to referendum in Oct. 1946 De Gaulle—who resigned as prime minister on Jan. 20, 1946—campaigned against it as likely to produce weak and unstable government. In April 1947 he formed the Rassemblement du Peuple Français (R.P.F.) which expressed popular discontent with the weak parliamentary system and exploited fears of Communism. Although it made gains in local elections and the parliamentary elections of 1951, it then lost ground and by 1953 was disbanded as a party. De Gaulle then retired into private life and wrote two volumes of his *Mémoires de guerre* (1954–56).

On May 13, 1958, when army leaders in Algeria defied the government in Paris, and France was threatened with civil war, the general again emerged as the only personality in national life capable of inspiring popular confidence. On June 1 he formed a government pledged to solve the Algerian problem and to make drastic revision of the constitution.

In September the people of France and its overseas territories approved a new constitution supported by De Gaulle, and on Dec. 21 he was elected president of the fifth republic. Under his leadership elections were held in nearly all French overseas possessions to determine their status with regard to the new French community; a brief revolt by Europeans in Algeria was put down without bloodshed in Jan.–Feb. 1960, and on Feb. 13 France became a nuclear power by exploding its first atomic bomb. De Gaulle was host to the May 1960 summit conference in Paris which broke up in a dispute over violations of Soviet airspace by reconnaissance planes of the U.S.

In March 1962 De Gaulle won an important victory when a cease-fire agreement was signed with the Algerian provisional government ending a seven-year war. The Secret Army Organization (O.A.S.) in Algeria, however, announced its determination to carry on the fight against De Gaulle's Algerian independence plan and committed numerous acts of terrorism against the Muslims in Algeria. In April the peace accord was overwhelmingly approved by the voters in a French referendum. (D. Tn.; X.)

DE GEER, LOUIS GERARD, Baron (1818–1896), Swedish statesman and writer, was born on July 18, 1818, at Finspång castle. In 1855 he became president of the Göta *hovrätt*, or lord justice of one of the Swedish higher courts. From 1858 to 1870 he was minister of justice (*i.e.*, prime minister). His greatest achievement was the reform of the Swedish representative system, whereby he substituted a bicameral elective parliament, on modern lines, for the existing cumbersome representation by estates. This great measure was accepted by the *riksdag* in Dec. 1865 and received the royal sanction in 1866. He retired from the ministry in 1870, but took office again, as minister of justice, in 1875. From 1876 to 1880 he was minister of state (a new office) and from 1881 to 1888 chancellor of the universities.

De Geer wrote a few novels and biographies (*H. Järta*, 1874; *A. J. von Höpken*, 1882, *B. B. von Platen*, 1887). His own memoirs (*Minnen*, 1892) are a valuable historical document. A selection of his letters (*Ur Louis De Geers brevsamling*, 1929) was published by his son.

See Sven Eriksson, *Carl XV* (1954). (S. C. O. C.)

DEGGENDORF, a town of Germany which after partition of the nation following World War II was included in the *Land* of Bavaria, Federal Republic of Germany. It is situated on the Danube, 4 km. (2½ mi.) above its confluence with the Isar and 143 km. (89 mi.) E.N.E. of Munich by road. Pop. (1959 est.) 16,437. The Danube and the mountains of the Bavarian forest are there close together and form a beautiful setting for the town which retains its medieval pattern and part of its fortress. The town hall (1535) has a 14th-century tower. To the Grabkirche, built in 1337, a tall baroque tower was added in the 18th century; the church was built in atonement for an earlier violation of the Host and a pilgrimage to it takes place every year. The parish church, several times rebuilt, dates from 1748 and has a red and white marble altar in the baroque style. The history museum has a good prehistory collection. The Benedictine abbey of Metten (4 km. [2½ mi.] W.N.W.) was founded in 770 and that of Niederaltaich (10 km. [6 mi.] S.E.) in 731; both have rich art collections. Deggendorf is a market centre with textile industries, breweries and a small shipyard. Founded by Tekko about A.D. 750, Deggendorf came into possession of the dukes of Bavaria in 1242 and it was they who laid out the existing town. In World War II it fell to U.S. forces in April 1945. (Wi. Br.)

DEGREE, ACADEMIC, a title conferred by a college or university at the completion of a course of study. The hierarchy of academic degrees, which is as old as the 13th century, had its direct counterpart in the medieval guild system. In its original meaning the bachelor's degree represented the first stage of academic life in the university, enabling the holder to proceed to the degree of licentiate, which permitted him to teach, and to that of master or doctor (then interchangeable terms), which admitted him into the teachers' guild and was in effect a certificate of fitness to teach at a university. Degrees in law, medicine and theology still may carry with them a licence to practise the corresponding professions, but degrees in the arts are now no more than certificates of a certain measure of acquaintance with the subject. (*See* also Bachelor; Master; Doctor.)

In general two practices are followed in the awarding of degrees. The European and South American countries have as a rule retained the degrees of the five traditional faculties: law, medicine, theology, arts and philosophy; academic work in newer fields of study is recognized by the granting of the degree of the faculty to which the new field most nearly approximates. With some exceptions, intermediate degrees, such as those of bachelor and master, have been abandoned in the universities of continental Europe. In France the usual degrees are the *licence* and *doctorat* according to the faculties, although a *baccalauréat* is conferred in law. The *licence* is based on four semesters' work in the university. The *doctorat*, taking from four to seven years, is awarded in two ways: the *doctorat d'Etat*, a state title, carries with it all professional rights and privileges, whereas the *doctorat d'uni-*

versité, awarded only by the university, does not carry any professional prerogatives. The French universities also award a variety of diplomas but these do not confer the rights and privileges common to state degrees. In Germany the doctorate of the various faculties is the only degree granted, but there is a tendency to add new signatures such as Dr. rer. nat. in natural sciences and Dr.-Ing. in engineering. For students not desiring to meet the doctoral requirements, diploma examinations are offered in specialized scientific and technical fields.

British universities grant the bachelor's as the first degree in arts or science. The second degree, M.A. or M.Sc., is obtained everywhere by examination except at Oxford and Cambridge, where it is granted after a period of residence and payment of prescribed fees. The degree of doctor of philosophy (Ph.D.) is offered by all faculties of British universities admitting advanced students. Other doctorates (D.Sc., D.Litt., LL.D., etc.) are available in most branches. In the U.S.S.R. diplomas are awarded on completion of a university course, and two postgraduate degrees, candidate and doctor, are recognized.

In U.S. colleges and universities the rapid expansion of specialization has produced a variety of almost 100 specific academic degrees in about 170 fields of study. Where once there were only four types of bachelor's degrees, there are now over 200. The commonest degrees, however, are still the B.A. and B.S., to which the signature of the special field is added. These special fields have their corresponding designations at the graduate levels, especially the master's degree, and although there is a tendency to retain the Ph.D. as the most advanced degree in arts and science, special signatures are found, as for example Ed.D. (education).

In addition to earned degrees, colleges and universities bestow honorary degrees, such as L.H.D. (doctor of humanities), Litt.D. (doctor of literature) and D.C.L. (doctor of civil law), as a recognition of distinction without regard to academic attainment.

In Canada, degree-granting institutions of higher learning are patterned after those in France and Great Britain, the latter bearing a resemblance to U.S. institutions granting bachelor's, master's and doctor's degrees. The *baccalauréat ès arts* admits the student to the French-language universities, from which he receives a diploma upon completing the required course. Graduate work leads to a *maitrise ès arts, licence* or a *doctorat*.

For medical degrees in various countries *see* MEDICAL EDUCATION. For abbreviations of degree titles *see* ABBREVIATION. *See* also EDUCATION, HISTORY OF; UNIVERSITIES.

See Henry Malden, *On the Origin of Universities and Academical Degrees* (1835); Martena Tenney Sasnett, *Educational Systems of the World* (1952). (J. M. BK.)

DE HAVILLAND, SIR GEOFFREY (1882–1965), British aircraft designer, manufacturer and pioneer in long-distance and commercial jet flying, was born at Haslemere, Surrey, on July 27, 1882, and educated at St. Edward's school, Oxford, and Crystal Palace Engineering school.

He began work in the automobile industry, but in 1908 he designed a 50-h.p. airplane engine and, in conjunction with Frank Hearle, a pusher biplane to fit it. The aircraft crashed, but in 1910 he successfully built and flew a second machine with the same engine. He then joined the Army Balloon factory and originated the British Experimental (B.E.) series of tractor biplanes. During World War I he worked as chief designer and test pilot for the Aircraft Manufacturing company and produced a number of successful fighters and light bombers. In Sept. 1920 he formed the De Havilland Aircraft company. The success of the Moth, a light two-seater, set De Havilland Aircraft on its feet financially and started the flying club movement in Great Britain. In World War II the company's most successful product was the twin-engined Mosquito, a high-speed, all-purpose aircraft of plywood construction. De Havilland was one of the first to make jet-propelled aircraft, producing the Vampire and Venom jet fighters. After the war, he pioneered the Comet airliner and D.H. "Ghost" jet engines.

De Havilland was knighted in 1944 and awarded the Order of Merit in 1962. He died on May 21, 1965, in London. Two of his three sons were killed while testing his planes: John in the crash of a Mosquito in 1943 and Geoffrey Raoul in a D.H. 108 jet in 1946. (D. CR.)

DEHIWALA-MOUNT LAVINIA, an urban area in Ceylon, governed by an urban council and made up of Dehiwala, Galkissa, Mount Lavinia and other settlements lying along the west coast about 6–8 mi. S. of the centre of Colombo. Pop. (1953) 78,213. The whole area is essentially a residential suburb of Colombo, with which it is connected by road and rail services. It grew rapidly in area and population in the mid-20th century, but there are still paddy fields inside its boundary. Mount Lavinia is a seaside resort with fine beaches and a renowned hotel. Dehiwala has an attractive zoological garden. (B. H. F.)

DEHMEL, RICHARD (1863–1920), German poet of note whose work helped to bring about a revival of German poetry at the turn of the 19th century. He was born at Wendisch-Hermesdorf, Brandenburg, Nov. 18, 1863. Like his friend Detlev von Liliencron, he wrote in an impressionistic style, and his poetry is extremely musical; at its finest, his work is sensitive, at its worst, sensational. Its vigorous, even tempestuous character is well suited to the frankness of his utterances. His refusal to cast his poetry into conventional patterns helped to liberate German verse from staleness. Closely associated with the naturalist movement, he was the first important poet to write about the misery of the working classes. His eroticism is also naturalistic, but his belief in the mystical power of love and of sex points beyond naturalism. The sensual relations between man and woman are, for him, the basis of a full development of the human personality and of a higher spiritual life. Following Nietzsche, he extolled the value of individuality and demanded an ecstatic mode of living. The main bulk of his lyrical work is found in *Erlösungen* (1891), *Aber die Liebe* (1893), *Weib und Welt* (1896), *Zwei Menschen* (1903), *Die Verwandlungen der Venus* (1907) and *Schöne wilde Welt* (1913). He was a volunteer in World War I but was soon disillusioned, and gave expression to this feeling in his war diary, *Zwischen Krieg und Menschheit* (1919). He died at Blankenese, near Hamburg, on Feb. 8, 1920.

See Julius Bab, *Richard Dehmel* (1926). (H. S. R.)

DEHRA DUN, a city and district in Uttar Pradesh, India. The city lies at an altitude of 2,200 ft., at the terminus of the Hardwar-Dehra Dun line of the Northern railway, 32 mi. N.N.W. of Hardwar. Pop. (1961) 126,918. It is the headquarters of the Survey of India and the forest department. The Forest Research institute for silvicultural research and the laboratory of the archaeological chemist are there, as are the Indian military college for all three services and the Rashtriya Indian Military academy for army cadet officers. There are two degree-granting colleges connected with Agra university, the Indian Forest college, six museums and many schools.

The cantonment lies northwest of the city which grew up around the temple built in 1699 by the heretical Sikh guru, Ram Rai, a leader of the Udasi sect of ascetics. The temple has a central block (in imitation of the emperor Jahangir's tomb at Lahore) containing the bed on which the guru died.

DEHRA DUN DISTRICT has an area of 1,201 sq.mi. Pop. (1961) 429,014. The Dun proper is a beautiful valley lying between the Siwalik range and the foothills of the Himalayas and crossed by the Ganges on the east and the Jumna on the west. The northern mountainous section rises to 7,000–8,000 ft. and the highest point of the Siwalik range is 6,345 ft. In 1951 the population was 362,005, the principal towns (pop. 1961) being Clement Town (7,793), Rikhikesh (10,925) and the hill station of Mussoorie (*q.v.*, 9,849). Rice, wheat and millets are the main crops. Tea is grown on the lower slopes, and other products are barley, maize, oilseeds, mangoes and timber. The district was ceded to the British after the Gurkha War in 1815 with other territory to the east. (S. S. BH.)

DEHYDRATION is the process of removing water from a solid, liquid or gas. The process involves chemical or physical changes, or both concurrently. Dehydration is of great importance in many industrial and research applications. Food and feed processing, air conditioning and the manufacture of liquefied gases (*see* NEON) are large-scale industrial operations requiring dehydration.

Gases containing water vapour may be dehydrated by compression. For more complete dehydration compression is accompanied by low-temperature refrigeration. For complete removal of water the chilled, compressed gases may be placed in contact with a solid water absorbent. The efficiency of the compression and refrigeration of air for air conditioning is dependent upon the removal of the water content of the circulated air.

Foods and medicinals may be dehydrated by the process of freezing. Sometimes the freezing process is accompanied by storage in a highly evacuated enclosure containing a water-absorbing chemical. Feeds, such as alfalfa, are dehydrated on a large scale by low-level heating in a fast-moving stream of hot air. This is done in order to attain a finished product that has lost none of its food value, but has been greatly reduced in weight.

Liquids, such as organic solvents, are dried by storage in contact with solid water absorbents such as granular barium oxide, dehydrated calcium sulfate, anhydrous calcium chloride, anhydrous magnesium perchlorate, calcined lime, calcined alumina or silica gel. Of these the most efficient dehydration results from the use of anhydrous magnesium perchlorate.

The great variety of equipment employed in dehydration processes includes laboratory desiccators, small- and large-scale electrically heated drying ovens and large rotatory kilns. (G. F. S.)

DEHYDRATION OF FOODS. One of the oldest known methods of food preservation is drying or dehydration. In fact, preservation by dehydration may be termed the natural method, since nature reduces the moisture content of seeds as they mature for their safekeeping. If properly protected or stored the seeds will keep for years. Early man first depended upon nature for his dehydrated foods and later copied the method by using sun and heat from fire to preserve his own stores. The American Indian preserved meat by slicing and drying it in the sun; the New England colonists depended on drying combined with salting and smoking for the preservation of meat and fish. Japan has long been known for its dried rice and fish, China for its dried eggs.

Foods which have been subjected to drying remain in a state of preservation primarily because of their low moisture content. The usual causative agents of spoilage, microorganisms (bacteria, yeasts and molds), are unable to carry on their activities without sufficient moisture. A dehydrated product, therefore, is preserved for as long a time as the water content is held at a low level. Some dehydrated products have a tendency to absorb moisture from the air and must be carefully protected to prevent early spoilage. Enzymes naturally present in the raw food are also detrimental to the quality of the dried product; the action of most enzymes may be inhibited by blanching, in the case of some foods, or by sulfite treatment.

Although drying is one of the simplest and cheapest methods of food preservation, commercial production in large quantities, except for fruits, has generally been undertaken only under the stimulation of wartime conditions. The weight and compactness of dehydrated foods make them ideal items in emergencies, especially when shipping space is at a premium. For example, 100 lb. of fluid milk in dry form weighs only 12 lb. and occupies approximately 3.1 cu.ft. of space; 30 doz. shell eggs packed for shipment occupy 2.5 cu.ft., but when dried they require only little more than half a cubic foot. On the average, 15 lb. of fresh food will yield 1 lb. of dehydrated food.

Great expansion in the commercial dehydration of foods took place during World War I, especially in the United States. Following that war, production decreased rapidly because shipping space was no longer a problem and dried foods were not acceptable to the civilian population. With the advent of World War II a tremendous increase in processing facilities for dehydrated foods occurred in the United States. After hostilities ended, production again decreased but the persistent need for shipping foods overseas helped prevent complete collapse of the industry. Continued interest by the U.S. armed forces in this type of food preservation stimulated extensive scientific studies which brought about improved quality through better understanding of drying and packaging techniques and other complex principles that affect colour, flavour and texture. These many technological advances brought about the development of new products such as dehydrated soup mixtures, potatoes, carrots, onions, desserts, cake mixes, cheese, fruit juices, ice cream mixes and soluble coffee which achieved high consumer acceptance, particularly in the U.S. Simplicity of preparation was a point of special appeal of many of these products.

Generally, dehydration is the term applied to drying of foods by artificial means, especially when forced circulation of the drying air is accomplished by fans. Terms applied to dehydrated products are dried, sun-dried, evaporated or dehydrated. The term sun-dried denotes using any means, while evaporated implies that artificial heat may have been applied, but air movement was by a natural draft. The expression freeze-drying, which suggests the initial process of freezing, includes dehydration in the frozen state without allowing the product to thaw. This method dries heat-sensitive materials with little or no damage.

Dehydrating equipment and drying methods vary with the nature of the product as illustrated by conventional designs used for years: tunnel driers, kiln driers, cabinet or compartment driers, rotary driers, drum driers, vacuum driers, vacuum shelf driers and spray driers. Many so-called improved designs have been developed to produce a dehydrated food of the flavour, colour and texture of fresh food. This has been accomplished through better contact between the product and the drying air, thereby shortening the drying time and improving the dehydrated food.

Sun-drying of fruits and nuts is possible in areas that are generally warm and sunny at harvest time, and where rain is scarce during the drying period. However, the use of kiln-type driers, with natural or forced draft and artificial heat, improves the quality of the product, is generally more efficient and eliminates losses from unseasonable weather. With continued emphasis on better fresh flavour and colour in dehydrated foods, increased quantities of fruits and vegetables are being dried under vacuum.

Dehydration, like other methods of preservation, does not make good foods from poor products. The careful selection of varieties of fruits and vegetables, and their size and maturity at the time of processing are essential considerations in producing satisfactory results. The handling should be rapid to prevent loss of vitamins, colour and flavour.

Fruit and vegetable juices introduced difficult problems because of the low softening or melting point and the hygroscopic nature of their solids. The use of vacuum dryers employing techniques to cause puffing of the solids, as well as entrapping the flavour components, resulted in greatly improved dehydrated juices. When these are packaged in vacuum or inert gas, and the moisture is held low (less than 1%), the juice is excellent.

The dairy industry is one of the largest processors of dehydrated foods. Large quantities of whole milk, cream, skim milk, butter milk, whey and malted milk are dried each year. Although drum driers have been used extensively for some of these products, spray drying came to be generally used. In spray drying, the fluid is atomized into a heated chamber in the form of fine mist where it comes into contact with heated air. The water is almost instantaneously removed from the milk, leaving a fine powder which drops to the bottom of the chamber or is carried in the air stream to collecting equipment. The rapid drying produces a powder of greater solubility than that from drum driers. Vacuum drum drying may be used for very hygroscopic products such as malted milk. The moisture content of dehydrated dairy products should be maintained below 3%.

Dried milks generally have good solubility, but do not disperse readily in water unless mechanical agitation is used. During the mid-1950s, skim milk powders which would disperse rapidly in cold water were introduced. These powders were coarse and grainy, however, compared with the fine powder obtained by conventional spray drying; and modifications of equipment and techniques were required.

Eggs are usually dried with equipment designed for milk drying. Whites, yolks and whole eggs are dried. Dried eggs must also be packaged and stored in a manner which will keep the moisture content low.

Although meat has been dried for centuries, the rehydrated

product is unlike the meat in its fresh condition. Freeze-drying of meat yields a product with excellent stability, which upon rehydration closely resembles fresh meat.

Commercial freeze-drying or drying by sublimation of the water from a frozen state under high vacuum was developed during World War II. In most food products, the cost of production in relation to the value of the product is prohibitive. However, by the early 1960s improvements in drying and packaging techniques had progressed to a point where the use of this method for the dehydration of meat approached commercial feasibility.

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DEIOCES (8th–7th century B.C.) was the first king of the Medes according to Herodotus (book i, 96 ff.). Herodotus relates that when the Medes had won their independence from Assyria they lived at first in villages without any political organization. When they decided to elect a king they chose Deioces, a village judge renowned for the justice of his decisions. Deioces united all the Median tribes, built Ecbatana (Hamadan) as their capital and ruled for 53 years (*c.* 727–675 B.C.).

It is now known, however, that Herodotus' story was ill founded and it appears probable that he confused Deioces with Khshathrita (possibly his son) who established a kingdom in Media and ruled from 673 to 652 B.C. The confusion is enhanced by the fact that he refers to Khshathrita as Phraortes (*q.v.*).

The historical Deioces (Assyrian, Dayukku) was a petty Median chieftain subject to the kingdom of Manna in modern Iranian Azerbaijan. He intrigued with the Urarteans and other enemies of Assyria, was captured by Sargon II in 715 and deported with his family to Hamath in Syria. The statement that the "house of Dayukku" is mentioned in Assyrian inscriptions after this date is based on a misreading. (I. M. D.)

DEIOTARUS (1st century B.C.), a tetrarch of the Tolistobogii, and later king of all Galatia in Asia Minor. He was a faithful ally of the Romans. At the beginning of the third Mithradatic war (74 B.C.), he drove the invading troops of Mithradates VI of Pontus from Phrygia. Pompey, when settling the affairs of Asia (64 B.C.), rewarded him with the title of king and with part of east Pontus. The senate granted him Lesser Armenia and most of Galatia, perhaps in 52 or 51. Deiotarus naturally sided with Pompey in the civil war and after his defeat at Pharsalus escaped with him to Asia. In 47 Caesar arrived in Asia from Egypt and pardoned Deiotarus for having sided with Pompey. In consequence of the complaints of certain Galatian princes, Deiotarus was deprived of part of his dominions, but allowed to retain the title of king. In 45 Deiotarus was accused at Rome by his grandson Castor of having attempted to assassinate Caesar when the latter was his guest in Galatia. Cicero undertook his defense, but the assassination of Caesar prevented any final decision. After Caesar's death, M. Antonius (Mark Antony), for a large sum of money, announced that, in accordance with instructions left by Caesar, Deiotarus was to resume possession of all the territory of which he had been deprived. When civil war again broke out, Deiotarus was persuaded to support Brutus and Cassius, but after their defeat at the battle of Philippi he went over to the triumvirs (*see* ROMAN HISTORY: *The Fall of the Republic*). He remained in possession of his kingdom till his death in 40.

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DEIRA, the southern of the two Anglo-Saxon kingdoms which were united to form Northumbria (*q.v.*), stretched from the Humber to the river Tyne. The earliest English settlements were in the Yorkshire wolds and near York. The first recorded king of Deira, Aelli, is said to have reigned from 560. There is a tradition that when he died in 588 or 590, Deira was seized by Aethelric of Bernicia, whose son Aethelfrith ruled both kingdoms till 616, as did Aelli's son Edwin from 616 to 632. From 632 to 633 Deira was ruled by Edwin's cousin Osric, but was united with Bernicia in Oswald's reign (633–641). Osric's son Oswine held Deira from 641 until Oswiu, brother of Oswald, killed him in 651. After that Deira sometimes had subkings; *i.e.*, Oswald's son Oethelwald (till 654), who sought the protection of Penda of Mercia; Oswiu's son Alhfrith (last heard of in 664); and Alhfrith's brother Aelfwine, killed at a battle on the river Trent in 678.

See Bede, *Historia ecclesiastica*, book i, ch. 34, book ii, ch. 1, 12, book iii, ch. 1, 14, 23f., 28. (D. Wk.)

DEIRDRE (Old Irish DERDRIU), the heroine of the story *Longes Mac n-Uislenn*, which may have been composed in the 9th century, and of the later version *Oidheadh Chloinne Uisneach*, which belongs to the early modern Irish period and has been combined with two other stories to form *Trí Truaighe na Scéalaigheachta* ("The Three Sorrows of Storytelling"). The older version describes the strange circumstances of Deirdre's birth and upbringing; how she fell in love with the young Noísi (Old Irish Noísiu) and persuaded him to carry her away to Scotland from her intended husband Conchobar, king of the Ulstermen; and how Noísi, with his two brothers and Deirdre, was tricked into coming back to Ireland, where the three men were treacherously killed, while Deirdre took her own life to avoid falling into the hands of Conchobar. The later version omits the first half of the story and greatly expands the tragic ending by making Deirdre live for a year with Conchobar before killing herself. The story was immensely popular in Ireland and Scotland and survived down to the 20th century in Scottish oral tradition; its literary influence continued into modern times, when the Anglo-Irish school, notably W. B. Yeats and J. M. Synge, revived the theme. It may also be recalled that Darthula, in James Macpherson's Ossianic cycle, derives from Deirdre.

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DEISM, as the word is customarily employed, describes an unorthodox religious attitude that found expression among a group of English writers beginning with Lord Herbert of Cherbury (1583–1648) and ending with Henry St. John, Viscount Bolingbroke (1678–1751). Though an initial use of the term occurred in 16th-century France, the later appearance of the doctrine on the continent was stimulated by the translation and adaptation of the English models. The high point of deist thought occurred in England from about 1689 through 1742, during a period when, despite widespread counterattacks from the established church, there was relative freedom of religious expression following upon the Glorious Revolution. Deism did not take deep root in 18th-century Germany until after it had ceased to be a vital subject of controversy in England.

Sometimes in the 19th and early 20th centuries the word deism was used theologically in contradistinction to theism (*q.v.*), the belief in an immanent God who actively intervenes in the affairs of men. In this sense deism was represented as the view of those who reduced the role of God to a mere act of creation in accordance with rational laws discoverable by man; after the original act he virtually withdrew and refrained from interfering in the processes of nature and the ways of man. So stark an interpretation of the relations of God and man, however, was accepted by very few deists during the flowering of the doctrine, though their religious antagonists often attempted to force them into this difficult position. Historically, a distinction between theism and deism has never had wide currency in European thought. Diderot, for example, when he translated the works of the earl of Shaftesbury into French, often rendered "deism" as *théisme*. The term is not in current usage as a metaphysical concept, and its significance is really limited to the 17th and 18th centuries.

In 1754, when the deist controversy had passed its peak, John Leland, an opponent, wrote a historical and critical compendium of deist thought, *A view of the principal deistical writers that have appeared in England in the last and present century; with observations upon them, and some account of the answers that have been published against them.* This work, which began with Lord

Herbert and moved through Hobbes, Charles Blount, the earl of Shaftesbury, Anthony Collins, Thomas Woolston, Matthew Tindal, Thomas Morgan, Thomas Chubb and Viscount Bolingbroke, fixed the canon of who should be included among the deist writers. In subsequent works Hobbes usually has been dropped from the list and John Toland included, though he was closer to pantheism than most of the other deists were. Herbert was not known as a deist in his day, but Blount and the rest who figured in Leland's book would have accepted deist as an appropriate designation for their religious position. Simultaneously, it became an adjective of opprobrium in the vocabulary of their opponents. Bishop Edward Stillingfleet's *Letter to a Deist* (1677) is an early example of the orthodox use of the epithet.

In Lord Herbert's treatises five religious ideas were recognized as God-given and innate in the mind of man from the beginning of time: the belief in a supreme being, in the need for his worship, in the pursuit of a pious and virtuous life as the most desirable form of worship, in repentance, and in rewards and punishments in the next world. These fundamental religious beliefs, Herbert held, had been the possession of the first man and they were basic to all the worthy positive institutionalized religions of later times. Differences among sects and cults all over the world were thus mere modifications of universally accepted truths when they were benign and corruptions when they led to inhuman practices such as the immolation of human victims and the slaughter of religious rivals.

In England at the turn of the 17th century this general religious attitude assumed a more militant form, particularly in the works of Toland, Shaftesbury, Tindal, Woolston and Collins. Though the deists differed among themselves, and there is no single work that can be designated as the quintessential expression of deism, they joined in attacking both the existing orthodox church establishment and the wild manifestations of the dissenters. The tone of these writers was often earthy and pungent, but their deist ideal was sober natural religion without the trappings of Catholicism and the high church in England and free from the passionate excesses of Protestant fanatics. In Toland there is great emphasis on the rational element in natural religion; in Shaftesbury more worth is bestowed on the emotive quality of religious experience when it is directed into salutary channels. All are agreed in denouncing every kind of religious intolerance since the core of the various religions is identical. In general there is a negative evaluation of religious institutions and the priestly corps who direct them. Simple primitive monotheism was practised by early men without temples, churches and synagogues, and modern men could readily dispense with religious pomp and ceremony. The more elaborate and exclusive the religious establishment, the more it came under attack. A substantial portion of deist literature is devoted to the description of the noxious practices of all religions in all times, and the similarities between pagan and Roman Catholic rites were emphasized.

The deists who presented purely rationalist proofs for the existence of God, usually variations on the argument from design, were able to derive support from the vision of the lawful physical world Isaac Newton had delineated, and in the 18th century there was a tendency to convert Newton into a matter-of-fact deist—a transmutation that was contrary to the spirit of both his philosophical and his theological writings.

When deists were faced with the problem of how man had lapsed from the pure principles of his first forebears into the multiplicity of religious superstitions and crimes committed in the name of God, they ventured a number of conjectures. They surmised that men had fallen into error because of the inherent weakness of human nature. Or they subscribed to the idea that a conspiracy of priests had intentionally deceived men with a "rout of ceremonials" in order to maintain power over them.

The role of Christianity in the universal history of religion became problematic. For many religious deists the teachings of Christ were not essentially novel but were in reality as old as creation, a republication of primitive monotheism. Religious leaders had arisen among many peoples—Socrates, Buddha, Mohammed—and their mission had been to effect a restoration of the simple religious faith of early men. Some writers, while admitting the similarity of Christ's message to that of other religious teachers, tended to preserve the unique position of Christianity as a divine revelation. It was possible to believe even in prophetic revelation and still remain a deist, for revelation could be considered as a natural historical occurrence consonant with the definition of the goodness of God. The more extreme deists, of course, could not countenance this degree of divine intervention in the affairs of men.

Natural religion was sufficient and certain; the tenets of all positive religions contained extraneous, even impure elements. Deists accepted the moral teachings of the Bible without any commitment to the historical reality of the reports of miracles. Most deist argumentation attacking the literal interpretation of Scripture as divine revelation leaned upon the findings of 17th-century biblical criticism. Woolston, who resorted to an allegorical interpretation of the whole of the New Testament, was an extremist even among the more audacious deists. Tindal was perhaps the most moderate of the group. Toland was violent; his denial of all mystery in religion was supported by analogies among Christian, Judaic and pagan esoteric religious practices, alike condemned as the machinations of priests.

The deists were particularly vehement against any manifestation of religious fanaticism and enthusiasm. In this respect Shaftesbury's *Letter Concerning Enthusiasm* was probably the crucial document in propagating their ideas. Revolted by the Puritan fanatics of the previous century and the wild hysteria of the French exiles prophesying in London in 1707, Shaftesbury denounced all forms of religious extravagance as perversions of true religion. These false prophets were directing religious emotions benign in themselves into the wrong channels. Any description of God that depicted his impending vengeance, vindictiveness, jealousy and destructive cruelty was blasphemous. Since sound religion could find expression only among healthy men, the argument was common in deist literature that the preaching of extreme asceticism, the practice of self-torture, the violence of religious persecutions, were all evidence of psychological illness and had nothing to do with authentic religious sentiment and conduct. The deist God, ever gentle, loving, benevolent, intended men to behave toward one another in the same kindly and tolerant fashion.

Ideas of this general character were voiced on the continent at about the same period by men like Bayle, even though he would have rejected the deist identification. During the heyday of the French *philosophes*, the more daring thinkers—Voltaire among them—gloried in the name deist and declared the filiation of their ideas with those of rationalist English ecclesiastics such as Samuel Clarke, who incidentally would have repudiated the relationship. Diderot drew his inspiration from Shaftesbury, hence his early commitment to a more emotional deism. Later in life he shifted to the atheist materialist circle of Paul Henri Thiry, baron d'Holbach. When Holbach paraphrased or translated the English deists his purpose was frankly atheist; he emphasized those portions of their works that attacked existing religious practices and institutions, neglecting their devotion to natural religion and their adoration of Christ. The Catholic Church in 18th-century France did not recognize fine distinctions among heretics, and deist and atheist works were burned in the same bonfires.

English deism was transmitted to Germany primarily through translations of Shaftesbury, whose influence upon thought was paramount. In a commentary on Shaftesbury published in 1720 Leibniz accepted the deist conception of God as an intelligent creator, but refused the contention that a god who metes out punishments is evil. A sampling of other deist writers was available particularly through the German rendering of Leland's work in 1755 and 1756. Gotthold Ephraim Lessing's *Nathan der Weise* was noteworthy for the introduction of the deist spirit of religion into the drama; in the famous parable of the three rings, the major monotheistic religions were presented as equally true in the eyes of God. In Germany Lessing's rational deism was the object of violent attack on the part of pietist writers and the more mystical thinkers who followed J. G. Hamann. By the 1760s, however, the works of the early 18th-century English deists were supple-

mented by German translations of David Hume's *Natural History of Religion*. Witnesses attest that virtually the whole officer corps of Frederick II was infected with deism and that Collins and Tindal were favourite reading in the army.

By the end of the 18th century deism had become a dominant religious attitude among upper-class Americans, and the first three presidents of the United States held this conviction, as is amply evidenced in their correspondence. "The ten commandments and the sermon on the mount contain my religion," John Adams wrote to Thomas Jefferson in 1816.

See also PANTHEISM.

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DEKABRISTS (DECEMBRISTS), the first Russian revolutionaries, so named after the rising of December (Rus. *Dekabr*) 1825.

The Dekabrist rising was the culmination of a revolutionary movement that dated back to the second half of the 18th century and was influenced by French, American and German ideas. It was the product, not the cause, of mounting demands for national reforms. In 1816, however, a secret society, the Union of Salvation, had been founded to promote economic, social and political reforms, notably the abolition of serfdom and the attainment of some degree of representative government. Its members were predominantly young officers. This union was reorganized in 1818 as the Union of Welfare and then, in 1821, divided into two, the Northern and the Southern societies. The Southern society, dominated by Col. Pavel Pestel, was the more radical: it desired to overthrow the monarchy, to institute a period of military dictatorship and finally to establish a Russian-dominated, centralized, democratic republic. The Northern society, founded by another officer, Nikita Muraviev, sought a liberal constitutional monarchy with regional autonomy and minority rights.

On the death of the emperor, Alexander I (Dec. 1, new style; Nov. 19, old style), Russia was temporarily without an emperor, as Alexander's eldest surviving brother, Constantine (*q.v.*), had secretly renounced his rights to the throne in favour of his brother Nicholas I, and the latter was hesitating to assume authority. The revolutionaries then took advantage of the confusion to agitate among the troops against Nicholas. Expecting the succession of Constantine, the troops had already pledged allegiance to him. When, on Dec. 26 (N.S., 14, O.S.), they were called on to pledge allegiance to Nicholas I, some of them, including the Moscow Guards regiment, aroused by the Dekabrists, refused to do so, demanding "Constantine and a constitution."

The Dekabrist rising was unsuccessful. Some troops failed to go over to the rebel side, and when the rebels could not be persuaded to disband, a few well-directed artillery salvos strewed the Senate square in St. Petersburg with the mangled bodies of about 80 recalcitrant soldiers and civilian spectators. Col. Prince Sergei Trubetskoi, who was to be provisional dictator, fled immediately. A rising in the south proved equally abortive. After an investigation in which Nicholas I himself took a prominent part the revolutionaries were tried and convicted. Five of the leaders, among them Pestel and the poet Kondrati Ryleev, were hanged; some were imprisoned; the others were banished to Siberia. Yet the spirit of their movement lived on. Not only the martyrdom but also many of the ideas of the Dekabrists inspired succeeding generations of revolutionaries.

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DEKKER, EDUARD DOUWES (pseudonym, MULTATULI) (1820–1887), Dutch prose writer and moralist whose ideas on education, politics, society, the position of women, philosophy and religion were in advance of his time, was born on March 2, 1820, at Amsterdam. In 1838 he went to the Netherlands East Indies, where he held a number of government posts until 1856, when he resigned because, as assistant commissioner of Lebak, Java, he was not supported by the colonial government in his attempts to protect the Javanese from their own chiefs. He returned to Europe and described the Javanese situation in his autobiographical novel *Max Havelaar* (1860; Eng. trans., 1927 and 1940). Translated into several languages, the book made an impression comparable to that made earlier by *Uncle Tom's Cabin*, but Dekker was not reinstated officially and, in straitened circumstances, had to earn a living by writing. Separated from his family, he led a bohemian life in Amsterdam, Brussels and elsewhere, finally settling in Germany.

Dekker's chief work, the seven-volume *Ideën* (1865–77), written under the motto "A sower went forth to sow," includes his didactic novel *Woutertje Pieterse* (Eng. trans., 1904) and the drama *Vorstenschool*. It contains innumerable aphorisms, parables and discussions with which he attempted to educate his contemporaries in his own advanced theories and to encourage them to think for themselves. His aphorism *De roeping van de mens is mens to zijn* ("Man's calling is to be a human being") became well known. An atheist, he particularly opposed the influence of the church and religion on the freedom of thought and on economic development. He died at Nieder-Ingelheim, Ger., Feb. 19, 1887.

BIBLIOGRAPHY.—Dekker's widow published his collected works (1888–96) and letters, 10 vol. (1890–96); there was a new edition by G. Stuiveling and Henri A. Ett (1950–). *See* also J. de Gruyter, *Het leven en de werken van E. Douwes Dekker*, 2 vol. (1920); E. du Perron, "De man van Lebak," in *Verzameld Werk*, vol. iv (1956); F. Mauthner, *Der Atheismus und seine Geschichte im Abendlande*, vol. 4 (1924). (GD. W. HS.)

DEKKER, THOMAS (*c.* 1572–*c.* 1632), English dramatist and writer of prose pamphlets, who is memorable for the lively detail of his depictions of London life, was born in London and wrote consciously as a Londoner. Few facts of Dekker's life are certain: he is first mentioned as a playwright on Jan. 8, 1598, in "Henslowe's Diary" (*see* HENSLOWE, PHILIP): in that year Philip Henslowe paid 40*s.* to obtain Dekker's release from imprisonment for debt, and he saved him from arrest in 1599. Writing for his living, he had a hand in at least 42 plays in the next 30 years. Dekker's dramatic invention and ability to construct a truly dramatic action were defective; it is therefore no wonder that in the dispute known as "the poets' war" or "the war of the theatres" (*see* JONSON, BEN), he was satirized in Jonson's *Poetaster* (1601) as Demetrius Fannius, "a very simple fellow . . . a dresser of plays." This anticipated Dekker's own attack on Jonson in *Satiromastix*, written with John Marston (1601). Eleven more of the plays in which Dekker collaborated survive: in them he was associated with such well-known figures as Thomas Middleton, John Webster, Philip Massinger, John Ford and William Rowley. He was also responsible for a fragment of *Sir Thomas More*, the manuscript of which contains three pages widely believed to be in Shakespeare's autograph.

Of the five plays which are entirely Dekker's work, the most popular, and probably the best known, is *The Shoemaker's Holiday* (1600). It is typical of his work in its old-fashioned, forthright tone, in the rush of its prose, its boisterousness, its tenderness and pathos, and in the easy touch with character. Whatever his dramatic defects, Dekker had enormous facility; his eye for detail and his ear for the spate and flow of colloquial speech would have been best utilized in novel-writing or in first-class reportage in a later age. He writes traditional drama, with situations which allow him to show virtue tested and triumphant. He delighted in the thought of honesty, uprightness and patience; yet there is a zest in his rogues and villains as in his lovable comic characters. Capable of satire, and never flinching from realistic portrayal of injustice, misfortune and malice, he writes in a tone which is idealistic and tolerant notwithstanding. His essentially generous nature shows itself in his pictures of London with its solid middle-class citizens, its comic servants who are not treated patronizingly, and its lack of servility toward the royal and the noble. Although he records details of the contemporary scene which were symptoms of deep economic and social changes, Dekker has no

sense of instability. Rather than fearing or hating upheaval and change, he relates what he sees to the age-old conflict between virtue and vice. To some extent the formlessness of his plays may derive from this unawareness of problems and implications. He fights vice, not change; and in this he is an old-fashioned moralist. He is never incompetent in blank verse, despite a tendency toward empty magniloquence; his couplets are deft and workmanlike.

There is zest and energy in the prose pamphlets which he began in 1603, with *The Wonderful Year*, which is also the first of those in which he wrote of London and the Plague. Dekker transcends the art of the journalist, reporting vividly, yet expressing his piety and religious confidence: he shirks nothing, and even dwells imaginatively on the horrors. Satire and denunciation do not destroy his tolerance and sympathy. Such works as *The Bellman of London* (1608) make use of material on roguery and crime borrowed from Robert Greene, John Awdeley and Thomas Harman, but read as if from personal experience. *The Gull's Hornbook* (1609) is possibly the best-known pamphlet and is especially valuable for its account of behaviour in the London theatres.

Between 1613 and 1619 Dekker was in prison for debt. This first-hand experience may be behind the six prison scenes included in the collection of *Characters* published in 1616 under the name of Sir Thomas Overbury. Dekker was also partly responsible for devising the street entertainment to celebrate the entry of James I into London in 1603; he provided the lord mayor's pageant in 1612. His verse is competent in the anonymous *News from Gravesend* (1604), usually attributed to him. Much less exuberant than his other work is the movingly pious *Four Birds of Noah's Ark* (1609), in which the man who deplored the cruelty of bear-baiting showed his sympathy with all in misfortune. It is no longer certain that the lyrics in *Patient Grissil* (1603), a play he wrote together with William Haughton and Henry Chettle, are actually Dekker's, but they certainly express his sweetness of nature.

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(B. L. J.)

DE KOONING, WILLEM (1904–), U.S. painter, widely recognized as one of the leaders of American abstract art and identified with the movement known as Abstract Expressionism, or "Action" painting, was born at Rotterdam, Neth., on April 24, 1904. He emigrated to the United States in 1926 and supported himself for many years as a commercial artist. His first one-man show in New York city was not held until 1948, although he had long been a well-known figure in the avant-garde. De Kooning, somewhat in the manner of Jackson Pollock (*q.v.*), based his style on the expressionistic fury of his paint manipulation and on a broad spirit of improvisation. His paintings, however, have often retained traditional elements of design and figuration. In 1953 he held a one-man show in New York of perhaps his most controversial and powerful series of paintings, built around the theme of "Woman"; in these works recognizable anatomical features of a cult-image, female figure were clearly discernible, although violently distorted. He subsequently returned to abstract modes.
(S. Hu.)

DE KOVEN, (HENRY LOUIS) REGINALD (1861–1920), U.S. composer, conductor and critic who largely established the style of the American light opera, was born at Middletown, Conn., on April 3, 1861. He graduated from Oxford university (1879) and studied composition in Germany, Austria and France. On his return to the U.S. he made his reputation as a composer of light operas and contributed music criticism to *Harper's Weekly* and the New York *World*. Between 1887 and 1913 he wrote 20 light operas, of which the most successful was *Robin Hood* (Chicago, 1890), partly derived from the style of the operas of Gilbert and Sullivan and given in London as *Maid Marian*. His two grand operas, *The Canterbury Pilgrims* (1917) and *Rip Van Winkle* (1920), were less successful. He also wrote more than 400 songs, ballets and piano pieces. He was known as a conductor and in 1902 founded the Washington Philharmonic orchestra, which he conducted until 1905. He died in Chicago on Jan. 16, 1920.

DE LA BECHE, SIR HENRY THOMAS (1796–1855), English geologist, originator and first director of the geological survey of Great Britain, was born in a London suburb in 1796 and was educated for the army. Following the peace of 1815 he joined the Geological Society of London and after a period of travel in Europe began a detailed investigation of the rocks of Cornwall and Devon. Thrown much into contact with the mining community, he conceived the idea that the nation ought to compile a geological map of the United Kingdom, to aid the scientific development of its mineral industries, and persuaded the government to give him an appointment in connection with the ordnance survey. This formed the starting point of the geological survey of Great Britain, which was officially recognized in 1835, when De la Beche was appointed director. Eventually parliament sanctioned the erection of a museum of geology and the organization of a staff of professors.

The establishment, in which were combined the offices of the geological survey, the Museum of Practical Geology, the Royal School of Mines and the Mining Record office, was opened in Jermyn street, London, in 1851.

De la Beche was elected to the Royal society in 1819, was president of the Geological society in 1848–49 and was knighted in 1848. His publications include *Report on the Geology of Cornwall, Devon and West Somerset* (1839); *Researches in Theoretical Geology* (1834); and *Geological Observer* (1851; 2nd ed., 1853). He died on April 13, 1855.

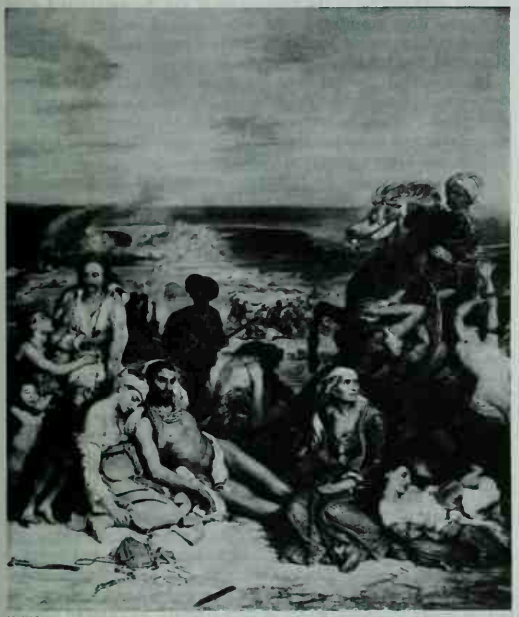
DELACROIX, (FERDINAND VICTOR) EUGÈNE (1798–1863), the most prominent of the French Romantic painters, was born at Charenton-St. Maurice, near Paris, on April 26, 1798. Though he was brought up as the youngest member of the family of a high-ranking official, it was believed by many that his real father was Talleyrand. This legend is given substance by the fact that Delacroix, though a constant opponent of academic orthodoxy, nevertheless received continuous and important patronage from the state. He was educated at the Imperial *lycée*, living with his mother until her death in 1815.

Though devoted from first to last to music, he began in 1816 to study painting under Pierre Guérin at the École des Beaux-Arts; his training therefore was in the formal neoclassical manner established by David and tinctured by his immediate successors with the heroics of the Napoleonic legend. Delacroix's training, moreover, began at the moment when the orderly, codified system of the first empire had collapsed and given place to a new era of faith and dogma ushered in by the re-establishment of the monarchy and the church. So complex was the artistic and personal make-up of Delacroix that it cannot be explained except against this background of rapid change and the turbulent aftermath of a European convulsion.

The artist himself seems to have retained, partly by virtue of his education, a deep respect for order and clarity proper to the French tradition. Yet his debut at the salon of 1822, when he exhibited his "Dante and Virgil in the Infernal Regions," is one of the landmarks in the development of French 19th-century romantic art. Its characteristics of colour, violence and passionate handling show that Delacroix had looked far beyond his master's example for inspiration. His chances for doing this had been exceptional, and it is certain that he would have taken the opportunity of studying the array of classical Italian, Dutch and Flemish works of art brought to the Louvre after Napoleon's great victories. The eclecticism of Delacroix, both in practice and theory, may owe something to these circumstances. Though certain early works—and particularly the "Dante and Virgil"—show the influence of Michelangelo, that of Rubens is predominant, while the rich palette of Veronese and the chiaroscuro of Tintoretto obviously attracted him. Among his contemporaries, the influence of Théodore Géricault, who studied before him at Guérin's and was until his sudden death in 1824 Delacroix's closest friend, is su-

premely important. Meanwhile, the example of the English artist R. P. Bonington, who painted Venetian and medieval subjects in high-pitched, jewellike colours, should not be overlooked.

In his choice of subjects Delacroix shows from the beginning an affinity with the romantic poets of his time; scenes from Dante, Shakespeare, medieval history and, later, the orient are predominant. In 1824, however, Delacroix exhibited the "Massacre at Chios," which, besides being a piece of full-blooded Orientalism, was also a means of expressing his intense feeling on a topical political subject—in this case the Greek rising against the Turks. The same picture is said to reflect the influence of Constable's spontaneity and brilliant tonality, and there is every reason to believe that Delacroix was so inspired. However, it is worth noting



ALINARI

"MASSACRE AT CHIOS" BY DELACROIX. IN THE LOUVRE, PARIS

that through Constable he was discovering qualities which ultimately derive from the great landscapes of Rubens—an artist from whom Delacroix had already derived much and whose influence continued to grow.

He visited England in 1825, meeting Bonington, Etty, Wilkie and Lawrence, his portrait of Baron Schwiter (National gallery, London) of 1826 reflecting the influence of the last (*see* PORTRAIT PAINTING). In England, as in France, Delacroix had made many studies of medieval and late antique manuscripts, mosaics, armour, costume, tombs and sculpture, while his sketchbooks contain many superb animal studies. Such material was employed in spectacular works such as the "Death of Sardanapalus" of 1827 (Louvre, Paris), a violent Byronic subject in which animals, slaves, women, jewels and rich fabrics are typically combined. His interest in the later years of the ancient world appears in the "Pandects of Justinian," ordered in 1826 for the Conseil d'État; it was the first of a continuing series of state commissions which indicate influential but concealed support. Among the few critics who applauded Delacroix's early masterpieces was the young Louis Thiers. Like his friend Géricault, Delacroix explored the new medium of lithography and his 19 Faust subjects date from 1828. In 1830, to commemorate the rising of that year, he painted "Liberty Guiding the People" (Louvre), a mixture of allegory and realism somewhat reminiscent of the war pictures of Goya; in the following year he gained the Légion d'Honneur.

In 1832 he traveled to Algeria, Spain and Morocco, curiously omitting a visit to Italy. His colour thenceforward is still more rich and translucent, as can be seen in the "Algerian Women" of 1834 (Louvre). It was in works such as this, in which jewelry and rich stuffs predominate, that Delacroix began to juxtapose areas of complementary colours in such a way that each would intensify the other. His colour methods had considerable influence on both Impressionist and post-Impressionist painters. Delacroix continued to receive important state commissions, the most notable being the decoration of the libraries at the Palais Bourbon and the Luxembourg (1838–47), the ceiling of the Salon d'Apollon at the Louvre (1848–50), the Salon de la Paix at the Hôtel de Ville (1849–53; burned in 1871) and two large murals in the Chapelle des Anges, St. Sulpice (1857–61). He also painted many canvases on the largest scale, among the most famous being the "Entry of the Crusaders into Constantinople," painted for Versailles (1840, Louvre), and the "Justice of Trajan" (1840, Rouen). Among his later works are many superb animal and hunt scenes ("Lion Hunt," 1855, Bordeaux; "Fighting Horses," 1860, Louvre) and a group of marine subjects in which Delacroix's colour notation can be seen at its most advanced. His *Journals* are probably the most penetrating of artists' notebooks since those of Leonardo da Vinci. Delacroix died in Paris on Aug. 13, 1863.

See also references under "Delacroix, (Ferdinand Victor) Eugène" in the Index volume.

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(D. C. T. T.)

DE LA GARDIE, JACOB PONTUSSON, COUNT OF LÄCKÖ (1583–1652), Swedish general and statesman, was born in Revel on June 20, 1583. Having served under Maurice of Orange (1606–08), he was mainly responsible for introducing Dutch military methods to the Swedes. He commanded the Swedish forces in Russia from 1608 to 1613, sustaining the disastrous defeat of Klushino (Kluszyn) in 1610; bore the brunt of the negotiations concerning the Swedish candidature for the Russian throne; and was the chief negotiator of the peace of Stolbovo with Russia (1617). He took part in the campaigns in Livonia after 1621 and commanded in chief there from 1626 to 1628, but showed so little enterprise that he was recalled. Long an advocate of peace, he was one of the Swedish commissioners at the truce of Stuhmsdorf with Poland (1635). A member of the council from 1613, he was appointed to the office of marshal in 1620 and so became, in 1632, one of the five regents for Queen Christina during her minority. In 1636 the laxity in the marshal's office was severely criticized; but De La Gardie was an excellent businessman, who made handsome profits from leasing crown revenues and lending money to the king. His defeatist attitude to the war and his French sympathies did not commend him to the chancellor Axel Oxenstierna (*q.v.*) after 1632, but on the whole he supported Oxenstierna during the regency, at all events after their reconciliation in 1636. In 1618 he had married Ebba Brahe, after Gustavus Adolphus had been constrained by his mother not to do so. He died in Stockholm on Aug. 12, 1652.

See E. Grill, *Jacob de la Gardie . . . , 1608–1636* (1949). (MI. R.)

DE LA GARDIE, MAGNUS GABRIEL, COUNT (1622–1686), Swedish statesman, head of Charles XI's administration from 1660 to 1680, was born at Revel on Oct. 15, 1622. After studying abroad he rose rapidly in the government. He became a councilor of state in 1647, a general in 1648 and treasurer in 1652. After being high in Queen Christina's favour, he fell into disgrace in 1653 and had to leave the court. During the reign of Charles X Gustavus he campaigned without success in the Baltic provinces. Politically, he came to the fore after Oct. 1660, when he was appointed grand chancellor and became head of the council of regency for Charles XI. Despite strong opposition he carried through the alliance with France of 1672. His wavering financial policies had grave consequences. In 1647 he had married Maria Euphrosyne, a sister of Charles X Gustavus, and when Charles came of age in 1672 the chancellor became his foremost minister.

The outbreak of war with Denmark and Brandenburg in 1675 signified the failure of his foreign policy; and military preparations brought to light the financial disorder. De La Gardie was replaced as chief minister by Johan Gyllenstierna. After the war, in 1680, he was appointed to the sinecure office of *riksdrots*. At the same time, an inquiry into the regency's administration led to his being heavily fined. Formerly one of the country's richest men, he died quite poor. Though skilful in foreign affairs, De La Gardie was a mediocre leader, lacking in perseverance and somewhat irresponsible. As a patron of the arts and as chancellor of Uppsala university he made valuable contributions in the cultural sphere, being remembered for his gift to the university library at Uppsala of the *Codex Argenteus*, an early 6th-century version of the Gothic Gospels of Ulfilas. He died at Venngarn on April 26, 1686.

See R. Fåhraeus, *Magnus Gabriel de la Gardie* (1936). (N. G. R.)

DELAGE, YVES (1854–1920), French zoologist and biologist who had a profound effect on the development of zoology in France, was born at Avignon, on May 13, 1854. Having graduated in medicine, he took up the study of zoology under F. H. de Lacaze-Duthiers in 1881. He became professor of zoology at Caen in 1883 and director of the marine laboratory at Luc-sur-Mer in 1884. In 1886 he was made professor of comparative anatomy at the Faculté des Sciences, Paris, and in 1901 was elected to the Académie des Sciences, in that year also becoming director of the marine laboratory at Roscoff, Finistère, on the death of Lacaze-Duthiers. His earlier work included *L'Evolution de la sacculine* (1884), *L'Embryologie et la Classification des éponges* (1889), *L'Anatomie des cynthiadées* (1889) and *Les Baleinoptères*. In collaboration with his colleague E. Hérouard he compiled the *Traité de zoologie concrète* (1896–1903), of which five volumes were published. Later, Delage turned to general biological problems and wrote *La Structure du protoplasma, et les théories sur l'hérédité et les grands problèmes de la biologie générale* (1895). He also founded *L'Année biologique*. Even after becoming blind in 1904 he continued his biological studies. He made fundamental researches on artificial parthenogenesis summarized in *La Parthénogénèse naturelle et expérimentale* (1913) written with his pupil Marie Goldsmith, and also produced *Le Rêve, étude psychologique, philosophique et littéraire* (1919). He died at Sceaux on Oct. 8, 1920. (Ed. He.)

DELAGOA BAY is situated on the southeast coast of Africa at about 26° S., near the border of Portuguese East Africa (Mozambique) and the Republic of South Africa. The name may have originated from its use as a port of call on the return voyage from Goa, but more probably it derives from Baía da Lagoa meaning the "bay of the lagoon." It is known officially as the Baía de Lourenço Marques.

The bay is 19 mi. long and 16 mi. wide, its southern extremity consisting of the Inhaca peninsula and Inhaca Island, the latter being developed as a tourist resort. To the north of the island, shoals separate the outer bay from the Indian ocean. The inner bay, 7 mi. long and 1 mi. wide, is the site of the town and harbour of Lourenço Marques (*q.v.*), the capital of Mozambique and one of the most important ports on the east coast of Africa, accessible to large ships at all times of the year. The harbour has a depth of from 3 to 13 fathoms at low spring tide and is protected from the southeast gales. The Matola, Tembe and Umbeluzi rivers meet in the estuary called by the Portuguese the Espírito Santo, but generally known as the English river, which flows into the inner bay, while the larger Maputo and Komati rivers discharge into the outer bay.

Delagoa bay was discovered in 1502 by António do Campo, who commanded one of Vasco da Gama's ships, and was first explored in 1544 by Lourenço Marques, a Portuguese trader. In the same year a fortress was built near Catembe by the Portuguese and the bay was then visited periodically by vessels trading in slaves and ivory. The Dutch East India company held the bay from 1721 to 1730, but the attempt was disastrous and the settlement abandoned. Continued occupation of the bay by any European power was rendered extremely difficult by its unhealthy nature (fever was prevalent as a result of the low altitude and swampy nature of the surrounding countryside), attacks by pirates and local tribes, and the lack of an accessible hinterland. In 1771 an Austrian trading company tried to establish itself on the bay, but was expelled by the Portuguese, who in 1787 built a fortress on the left bank of the Espírito Santo from which the town of Lourenço Marques developed.

In 1823 and 1824 rival treaties were drawn up by the British and Portuguese with native chiefs living round the bay. During the 1830s Portuguese forts in Mozambique were destroyed by the Shangaans, but they were then slowly reoccupied by the Portuguese. In 1838 the *voortrekker* leader Louis Trichardt and some of his followers died there. Another attempt was made by the British to control the bay in 1861, the British flag being hoisted on Inhaca Island. It was the discovery of diamonds in 1867, and later of gold, culminating in the opening up of the Witwatersrand after 1886, that drew attention to the importance of the bay, for it was the nearest avenue of approach to the mineral fields on the high plateau of South Africa.

Possession of the bay was therefore disputed by the Boers, British and Portuguese. However, in 1869 the Transvaal republic recognized Portuguese sovereignty, and in 1872 Great Britain and Portugal agreed to submit the problem of ownership to the arbitration of the French president, who in 1875 gave the decision in favour of Portugal. In that year an attempt by Pres. T. F. Burgers to build a railway from Delagoa bay to the Transvaal failed, and the railway only reached the Witwatersrand in 1894. The Portuguese seized this railway in 1889, but in 1900 Portugal was forced to pay compensation to shareholders in the railway company.

For an account of the Delagoa bay arbitration proceedings *see* Sir E. Hertslet, *The Map of Africa by Treaty* (1909). (N. C. P.)

DELAINE (French for "of wool") originally meant a high quality women's wear dress goods and is still applied to a staple all-wool fabric made in plain weave and of compact structure. Fabrics and garments made from it are rather expensive. A better-known modern usage of the word is for a fine combing wool made into high-grade woolen and worsted fabrics. Delaine sheep, a Merino type, are raised in the United States, Australia, New Zealand, Saxony, Silesia and to a lesser extent in France. (G. E. L.)

DE LA MARE, WALTER (JOHN) (1873–1956), British poet and novelist with an unusual power to evoke the magic poetic moments in life, was born at Charlton, Kent, April 25, 1873. He was educated at St. Paul's cathedral choir school, and in 1890 went to work in the London office of the Anglo-American Oil company. From 1902, however, when his *Songs of Childhood* appeared under the pseudonym "Walter Ramal," he devoted himself increasingly to writing; his first novel, *Henry Brocken*, appeared in 1904, *Poems* in 1906. After 1908, on the advice of Henry (later Sir Henry) Newbolt, who had published his poems in the *Monthly Review*, he received an annual grant from the privy purse, and gave up office work, except for a short time as a civil servant during World War I. Outwardly the rest of his life was uneventful; his adventures were all of the spirit. His books continued to appear: poems and short stories for adults and children; novels, of which *Memoirs of a Midget* (1921) reached a height of poetic fantasy; a fairy play, *Crossings* (1921); essays, literary studies and anthologies (*Come Hither* [1923] is one of the best and most original selections in the language). He was made a companion of honour in 1948, received the Order of Merit in 1953, and died at Twickenham, Middlesex, June 22, 1956.

De la Mare's work falls into none of the categories of modern criticism. It is intelligent and subtle, but not "intellectual." All its varied phases are informed by the feeling that every experience is an object of wonder, existing in isolation. It was this immediacy of perception, which has been likened to that of Henry Vaughan, Thomas Traherne and William Blake, combined with his skill in catching the feel of the nursery rhyme, which gave his work for children its freshness and charm. A conscious technician, he broke no new ground as a stylist, but he used familiar poetic forms with a simple-seeming sureness of touch.

The deliberate beauty of De la Mare's work should not, however, make the reader forget its darker side. His stories, especially, are often macabre, and his dream world does not neglect

the nightmare. One poem, "The Feckless Dinner-Party," is an example of horror breaking into a theme treated with biting satire, and the preface to the anthology *Love* (1943) shows that his otherworldliness meets modern psychology at many points.

Collected Poems appeared in 1920, 1935 and 1944; *Collected Rhymes and Verses* in 1944 and *Collected Stories for Children* in 1947. Later poetry included *The Burning Glass* (1945); *The Traveller* (1946); *Inward Companion* (1950); and *O Lovely England* (1953). (S. H. Sr.)

DELAMBRE, JEAN BAPTISTE JOSEPH (1749–1822), French astronomer, prepared tables of the motion of Uranus. He was born at Amiens on Sept. 19, 1749. In 1771 he became tutor to the son of M. d'Assy, receiver-general of finances. He attended the lectures of J. J. Lalande, who induced d'Assy in 1788 to install an observatory for his benefit at his own residence. There Delambre observed and computed almost uninterruptedly, and in 1792 published *Tables du Soleil, de Jupiter, de Saturne, d'Uranus et des satellites de Jupiter* at Paris. He was admitted to the Institut de France on its organization in 1795, and became, in 1803, perpetual secretary to its mathematical section. He served from 1795 on the bureau of longitudes. From 1792 to 1799 he was occupied with the measurement of the arc of the meridian extending from Dunkirk to Barcelona, and published a detailed account of the operations in *Base du système métrique* (3 vol., 1806, 1807, 1810). He succeeded Lalande in 1807 as professor of astronomy at the Collège de France, and was treasurer to the imperial university from 1808 until its suppression in 1815. Delambre died in Paris on Aug. 19, 1822. He wrote histories of ancient, medieval and modern astronomy. His *Tables écliptiques des satellites de Jupiter* were republished by the bureau of longitudes in 1817.

DELAMERE (De la Mer), **GEORGE BOOTH,** 1st Baron (1622–1684), English royalist who gave his name to an abortive revolt against the Commonwealth government in 1659, was born in Aug. 1622. He was returned for Cheshire to the Long parliament in 1645 and to the protectorate parliaments of 1654 and 1656. In 1655 he was appointed military commissioner for Cheshire and treasurer at war. He was one of the excluded members who tried and failed to regain their seats after the fall of Richard Cromwell in 1659. This sharpened his desire for a free parliament and brought him closer to those Presbyterian royalists who were soon to unite with the Cavaliers in effecting the Restoration. A rising was arranged for Aug. 5 in several districts, and Booth took charge of operations in Cheshire, Lancashire and north Wales. A declaration was issued, calling for a free parliament and a change of government, but it made no reference to restoring the monarchy. Booth seized Chester on Aug. 19, but the plot failed elsewhere and Gen. John Lambert defeated Booth's men at Nantwich bridge. Booth himself was captured at Newport Pagnell on Aug. 23 and was imprisoned in the Tower of London. He was soon liberated, sat in the parliament of 1659–60 and was one of the 12 members deputed to carry the message of the commons to Charles II at The Hague. In July 1660 he received a grant of £10,000 and in 1661 he was created Baron Delamere. He died in Cheshire on Aug. 8, 1684.

Delamere's second son and successor, Henry (1652–94), was created earl of Warrington in 1690. He was implicated in the Rye House plot (1683) and received many honours from William III. (H. G. Ro.)

DELAND, MARGARET (Margaretta Wade Deland, née Campbell) (1857–1945), U.S. writer noted in her time for her fiction based on small-town life, was born in Allegheny, Pa., Feb. 23, 1857. She studied at private schools and at Cooper union in New York, and for a time taught drawing. In 1886 she published *The Old Garden*, a collection of poems. Her first novel, *John Ward, Preacher* (1888), which dealt with religious and social questions after the manner of Mrs. Humphry Ward, attracted considerable attention. She achieved her greatest popularity with a series of nostalgic village chronicles, *Old Chester Tales* (1899), *Dr. Lavendar's People* (1903), *Around Old Chester* (1915) and *New Friends in Old Chester* (1924); but after the appearance of the more realistic small-town portrayals of Sherwood Anderson and Sinclair Lewis her fame declined. Her "problem" novels, such as *The Awakening of Helena Richie* (1906), *The Iron Woman* (1911), *The Rising Tide* (1916) and *The Vehement Flame* (1922), are perhaps her most interesting works. An autobiography, *If This Be I (As I Suppose It Be)*, appeared in 1935. She died on Jan. 13, 1945.

DELANE, JOHN THADEUS (1817–1879), editor of the *Times* from 1841 to 1877 who gave the paper a political influence greater than that of any other, and a circulation ten times that of its nearest rival. Born in London on Oct. 11, 1817, and educated at King's college, London, and Magdalen college, Oxford, at the age of 23 he was appointed editor of the *Times* of which his father was treasurer, although he was not given full editorial control until 1847. Unlike his predecessor, Thomas Barnes (*q.v.*), Delane was not a writing editor but, in a sense, the first of the modern managing editors. He wrote few leading articles but supervised almost every word printed, claiming that "not a column has appeared that has not some of my handwriting on the margin." He had an extraordinary capacity for acquiring the confidence of ministers and obtaining private information: so much so that Lord John Russell complained to Queen Victoria that: "The degree of information possessed by the *Times* with regard to the most secret affairs of State is mortifying, humiliating and incomprehensible." Backed by John Walter III, the proprietor, and Mowbray Morris, the manager, he greatly extended the exclusive news services of the *Times* from its correspondents abroad, and in the Crimean War the dispatches of his war correspondent left all official sources far behind. His journalistic philosophy, and the source of his influence, was expressed in two famous leading articles written by Henry Reeve under his direction in Feb. 1852 in reply to charges of irresponsibility by Lord Derby. In these, he denied that the press should be bound by the same limitations and responsibilities as governments, and stated as its first duty "to obtain the earliest and most correct intelligence of the events of the time and instantly, by disclosing them, to make them the common property of the nation." He died at Ascot Heath, Berkshire, on Nov. 22, 1879.

See the biographies by Arthur Irwin Dasent, 2 vol. (1908), and by Sir Edward Cook (1915); also *The History of The Times*, vol. 2: *The Tradition Established, 1841–1884* (1939). (E. F.-Ws.)

DELANO, JANE ARMINDA (1862–1919), co-ordinator of professional nursing services in the U.S. and abroad, was born near Montour Falls, N.Y., March 12, 1862. After graduating from Bellevue hospital school of nursing in 1886 she occupied a series of responsible executive positions. She raised the standards of her profession, broadened its sphere of daily usefulness and organized it for effective emergency service. As superintendent of nurses in a hospital in Jacksonville, Fla., in 1888 she limited the spread of yellow fever by establishing use of mosquito netting. She then dealt with a typhoid fever epidemic in a Bisbee, Ariz., copper-mining camp. As instructor and assistant superintendent of nurses in the training school for nurses at the hospital of the University of Pennsylvania (1890–95), her many improvements, firm discipline and human sympathy won official commendation and infused students with enthusiasm and energy. She served with distinction as superintendent of the training school of Bellevue hospital (1902–06), president of the board of directors of the *American Journal of Nursing* (1908–11), president of American Nurses' association (1909–12) and superintendent of the U.S. army nurse corps (1909–12). As chairman of the national committee on Red Cross nursing service (1910–19) she devoted her attention to public health, disaster services, visiting nurses, volunteer nurses' aides and home-nursing manuals.

Miss Delano died at Savenay, France, April 15, 1919, and was interred in Arlington National cemetery. She characteristically allotted her estate chiefly to the Red Cross, but also established funds for relief of sick nurses at the Pennsylvania and Bellevue hospitals.

Bibliography.—M. V. Stephenson, *First Fifty Years of the Training School for Nurses* (1940); Meta R. Pennock (ed.), *Makers of Nursing History* (1940); Mary A. Clarke, *Memories of Jane A. Delano* (1934). (J. P. N.)

DELANY, MARY (née GRANVILLE) (1700–1788), Englishwoman who left an interesting picture of polite and literary society in her *Autobiography and Correspondence* (6 vol., 1861–62), was born at Coulston, Wiltshire, on May 14, 1700, a niece of the 1st Lord Lansdowne. In 1718 she was forced into marriage with Alexander Pendarves, a rich and elderly Cornish landowner, who died in 1725. During a visit to Ireland she met Dean Swift and his friend Patrick Delany, whose second wife she became in 1743. After his death in 1768 she spent every summer with her friend the dowager duchess of Portland, and when the latter died George III and Queen Charlotte, whose affection for their "dearest Mrs. Delany" seems to have been deep and sincere, gave her a small house at Windsor and a pension of £300 a year. At this time Mrs. Delany was a charming old lady with a reputation for making the ingenious "paper mosaiks" which have been preserved in the British museum, London. She had known many literary figures of her day, had corresponded with Swift and Edward Young, and was responsible for introducing Fanny Burney to the king and queen and obtaining for her a post in the royal household. Edmund Burke calls her "a real fine lady," "the model of an accomplished woman of former times." She died in London on April 15, 1788.

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DE LA REY, JACOBUS HERCULES (1847–1914), Boer general, one of the most talented and popular of the Boer leaders in the South African War, was born near Winburg in the Orange Free State, but grew up in the Transvaal. He had little formal education but gained military experience in wars against Bantu tribes. In 1893, representing Lichtenburg, he entered the *volksraad* (parliament) of the South African republic, where he opposed Pres. Paul Kruger's *Uitlander* policy. On the outbreak of the South African War in 1899, De la Rey became a general, and fought in the western campaign. On July 1, 1900, he assumed full charge of operations in the western Transvaal. He was conspicuously successful in the guerrilla stage of the war, when he demonstrated that among the Boer generals only Louis Botha was his military superior. On March 7, 1902, at Tweebosch, he captured Lord Methuen. The British general was wounded in the action and De la Rey released him, being unable to provide proper medical assistance. Such humanity marked his conduct throughout the war. After the conclusion of peace in 1902, he visited Europe with other Boer generals to raise funds for reconstruction.

In the postwar years De la Rey supported Botha, and in May 1904 was elected to the head committee of Botha's party, Het Volk ("The People"). In the period of responsible government (1907–10) he represented Ventersdorp in the Transvaal legislative assembly. In 1908 De la Rey was chosen by Botha as a delegate to the national convention, in the hope that his presence would give the Boers confidence in its recommendations for union. From 1910 to 1914 he sat in the Union's first senate. On the outbreak of World War I, he laid plans for a rising in the western Transvaal, believing that a God-given opportunity to restore republican independence was at hand. Following discussions with Botha and J. C. Smuts (Aug. 13), he wavered, but after parliament had confirmed the decision to attack German South-West Africa, he determined to rebel. On Sept. 15, 1914, while traveling to Potchefstroom to start the rising, he was shot dead in Johannesburg by a police patrol. The rising did not take place; but the ill-feeling and suspicion aroused by the circumstances of his death helped foment the rebellion that broke out in October. (N. G. GA.)

DE LA RIVE, AUGUSTE ARTHUR: *see* LA RIVE, AUGUSTE ARTHUR DE.

DELAROCHE, HIPPOLYTE, commonly known as PAUL, (1797–1856), a popular French painter of painstakingly realistic historical subjects, was born in Paris on July 17, 1797. His father was an art expert; his uncle was curator of the Cabinet des Estampes; and his brother was the painter Jules Hippolyte Delaroche. He studied under A. Gros and exhibited in the Salon of 1822 where his work was praised by J. Géricault. In 1832 he became a professor at the École des Beaux-Arts and was made a member of the Institute. He visited Italy in 1834, 1838 and 1843, and there married the daughter of Horace Vernet who was in Italy as director of the French Academy. Delaroche's subjects, illustrating certain views of history dear to partisans, yet romantic in their general interest, were painted with a firm, solid, smooth surface, which gave an appearance of the highest finish. He held a course midway between the classicists and the romanticists. His long series of historical pictures had a great popular success and were made familiar in thousands of homes by engravings of them. After 1837 Delaroche turned more toward portraits and religious subjects. Often in developing his compositions he first made wax models of them.

In 1837 Delaroche received the commission for the great mural, 27 m. long, in the hemicycle of the lecture theatre of the École des Beaux-Arts. This represents a history of art with the great artists of the modern ages assembled in groups on either hand of a central elevation of white marble steps, on the topmost of which are three thrones filled by the architects and sculptors of the Parthenon. The genii or muses, who symbolize or reign over the arts, lean against the balustrade of the steps. It was finished in 1841 and considerably injured by a fire in 1855. Delaroche immediately set himself to remedy the injury but he died on Nov. 4, 1856, before he had well begun.

DE LA ROCHE, MAZO (1879–1961), Canadian author whose series of novels about the Whiteoak family of Jalna made her one of the most popular "family saga" novelists of the period 1925–50. Born at Newmarket, Ont., on Jan. 15, 1879, the only child of a family of French, Irish and English descent, she studied art, but her talent for fiction predominated. In 1927 her fourth book, *Jalna*, won a $10,000 prize from the *Atlantic Monthly*. *Jalna* ended with the 100th birthday of Grandmother Adeline Whiteoak, a magnificently lusty character later celebrated in a long-run play, *Whiteoaks*, and a film (1935) starring Ethel Barrymore. From Gran's "century party" in 1924, the saga fanned out to include the family's tempestuous history from before the American Civil War to the 1950s.

Although the locale of *Jalna* is Ontario, the story was more popular in the United States, Britain and Europe than in Canada. Many Canadian readers, hoping for a faithful account of life in Canada, were disappointed, for the Whiteoaks really dwell in the timeless realm of romance. Gran Whiteoak's imperious need for human affection ("Somebody kiss me—quick!") is the keynote of the family's experience. Though the author feels life intensely, she cannot, finally, explain it; and because her situations often toy implausibly with the problems of the sexes, her saga is much less penetrating and serious than Galsworthy's *Forsyte Saga*, though frequently much livelier. *Jalna* (1927) and *Whiteoaks of Jalna* (1929) are noteworthy. Her other works include juveniles, travel, drama and fiction. Miss de la Roche died at Toronto, Ont., July 12, 1961.

See Desmond Pacey, *Creative Writing in Canada* (1952); Julian Park (ed.), *The Culture of Contemporary Canada* (1957).
(H. A. MCP.)

DE LA RUE, WARREN (1815–1889), British astronomer and pioneer in celestial photography, was born in Guernsey, Channel Islands, on Jan. 18, 1815. He was educated at the Collège Sainte-Barbe in Paris and entered the printing business. He invented, with Edwin Hill, the first envelope-making machine. As an amateur astronomer, he pioneered in the application of the collodion, or wet-plate, process to celestial photography and invented the photoheliograph for taking daily photographs of the sun's surface. His photographs taken at the solar eclipse of July 16, 1860, proved conclusively that the prominences belonged to the sun and not to the moon. With the collaboration of Hugo Müller he carried on many chemical and electrical experiments in his private laboratory, including some researches on Rangoon tar, which led to a profitable patent, and on electrical discharge through gases, which provided a valuable body of data for later work on the aurora borealis. De La Rue was elected president of the Royal Astronomical society and the Chemical society and received the gold medal of the former in 1862. He also received a

royal medal from the Royal society in 1864 and the Lalande prize of the French Academy of Sciences in 1865. He died in London on April 19, 1889. (O. J. E.)

DELATOR, in ancient Roman law meant "prosecutor" or "informer." Rome had no adequate police force and no public prosecutor; informers were therefore indispensable (Tacitus, *Annals*, iv, 30) both in criminal law and in regard to fiscal claims. They naturally required incentives; hence slaves were rewarded with freedom, foreigners with citizenship, citizens with honours, while under the empire pecuniary rewards were most common. These made delation a lucrative profession, and the term *delator* acquired an ill repute (as did the Greek *sycophantes*, "informer"). The law aimed at checking abuses; thus *calumnia* (vexatious accusation in bad faith) was penalized in early days by *infamia* (loss of many civic rights), branding and perhaps a fine, and later even by flogging, banishment or whatever punishment might have been due to the original defendant, if he had been convicted. The emperor Constantine I seems even to have ordered the punishment of any *delator* who did not prove his charge. But delation was prevalent, especially under emperors who feared conspiracy or who needed to replenish the treasury by confiscating condemned men's goods. Under the successors of such emperors delators were often punished on the assumption that their victims had been innocent (*e.g.* in A.D. 69, 79, 96–100), but the great political figures who had been prominent as accusers usually escaped even then.

See T. Mommsen, *Droit pénal romain*, vol. ii, 179–203 (1907); A. Berger, *Encyclopaedic Dictionary of Roman Law*, p. 429, with bibliography (1953). (P. A. Br.)

DELATOUR: *see* La Tour, Georges de.

DELAUNAY, (JULES) ÉLIE (1828–1891), French painter, was born at Nantes on June 12, 1828. He studied under H. Flandrin and L. Lamothe at the École des Beaux-Arts, which he entered in 1848. In 1853 he made his debut at the Paris Salon. He worked in the classicist manner of J. A. D. Ingres until, after winning the Prix de Rome, he went to Italy in 1856, and abandoned the ideal of Raphaelesque perfection for the sincerity and severity of the quattrocentists. He was a pure and firm draftsman. After his return from Rome he was entrusted with many important commissions for decorative paintings, including the frescoes in the church of St. Nicholas at Nantes; the three panels of "Apollo," "Orpheus" and "Amphion" at the Paris opera house (together with P. Baudry); 12 paintings for the great hall of the council of state in the Palais Royal; and "Scenes From the Life of Ste. Geneviève," designed for the Panthéon but unfinished at his death. In the last decade of his life he achieved great popularity as a portrait painter. He died in Paris on Sept. 5, 1891.

DELAUNAY, ROBERT (1885–1941), French Cubist painter, was born in Paris in 1885. At an early age Delaunay came under the spell of the Postimpressionist use of colour, especially by Seurat and Cézanne. By 1910 he made his own contribution to Cubism in a series entitled the "Eiffel Tower," which combined fragmented Cubist form with light and vibrant colour. His new and individual use of colour prisms was less cerebral than original Cubism and had a more immediate appeal to the senses. This style, called Orphism, had immediate effect on the work of the German Blue Riders, especially Franz Marc, Paul Klee and Lyonel Feininger. Delaunay, in turn, perhaps under Wassily Kandinsky's influence, found his way toward completely nonobjective painting when he did his famous colour disks in 1912. He also inspired Morgan Russell and S. Macdonald-Wright toward a related style—Synchromism—which was the first American movement in abstract painting. Between the wars Delaunay worked on large and most impressive abstract mural decorations in Paris. He died at Montpellier on Oct. 25, 1941. *See* also Painting: *Modern Painting (Late 19th and 20th Centuries)*: *Orphism, Synchromism and Vorticism.* (P. H. S.)

DELAVIGNE, JEAN FRANÇOIS CASIMIR (1793–1843), French poet and dramatist whose patriotic compositions made him "national poet" in the years following Waterloo. Born at Le Havre on April 4, 1793, he was a brilliant scholar at the Lycée Napoléon in Paris. The patriotism shown in his early work, which won the emperor's approval, responded to the catastrophe of 1815 with *Les Messéniennes* (1816–22), stirring poems which brought him great popularity. Two plays, *Les Vêpres siciliennes* (1819) and *L'École des vieillards* (1823) were also successful and in 1825 Delavigne was elected to the Académie. A further crisis in French history—the revolution of 1830—stimulated him to write "La Parisienne," which, set to music by D. Auber, rivaled the "Marseillaise" in popularity. Under the July monarchy he produced a series of historical dramas—*Louis XI* (1832), *Les Enfants d'Edouard* (1833), *Don Juan d'Autriche* (1835), *Une Famille au temps de Luther* (1836) and *La Fille du Cid* (1839)—but they possess no great literary value. He died at Lyons, Dec. 11, 1843.

DELAWARE, one of the original 13 states of the United States, is known as the "First state" because it was the first to ratify the U.S. constitution, Dec. 7, 1787. It is also known as the "Diamond state" because of its worth in relation to its size. It is situated in the northeastern part of the peninsula formed by Chesapeake bay and the estuary of the Delaware river. The state has a length (north-south) of 95 mi. and a width (east-west) of 40 mi.; its total area is 2,057 sq.mi., of which 79 sq.mi. are inland water surface. Excepting Rhode Island, it is the smallest state in the union.

Delaware is bounded on the north and northwest by Pennsylvania, on the east by the Delaware river and Delaware bay, which separate it from New Jersey, and by the Atlantic ocean; and on the south and west by Maryland. The capital city is Dover (*q.v.*). The state flower is the peach blossom; the state bird is the Blue hen chicken; and the state tree is the American holly.

PHYSICAL GEOGRAPHY

Physical Features.—Delaware lies on the Atlantic coastal plain and is for the most part level and low, its average elevation being about 60 ft. above sea level. Topographically, the state is two unequal areas divided by a line following the general course of White Clay and Christina creeks. Northward of this line the country is rolling, with bold hills, moderately deep valleys and rapid streams. Southward, the country is level or gently undulating. The principal harbours are those of Wilmington, New Castle and Lewes. In Kent county there are more than 60,000 ac. of tidal marshland, some of which has been reclaimed by means of dikes; Cypress swamp, in the extreme south, has an area of 30,000 ac. In the north the prevailing soils are clays, sometimes mixed with loam. Next, to the southward, come the Cretaceous formations and clays suitable for terra-cotta manufacture. The soils of this region are mainly loams. The remainder of the state has a sandy soil resting on Tertiary white and blue clays.

Minerals of economic value are found only in the north part of the state. Kaolin, mined chiefly in the vicinity of Hockessin, New Castle county; granite, used for road making and rough construction work, found near Wilmington; and brick and tile clays are the products of greatest importance.

Climate.—The climate of Delaware is temperate and humid, with hot summers and mild winters. The mean annual temperature ranges from 55° F. in New Castle county to 56° F. in Kent and Sussex. The highest temperature on record is 110° and the lowest −17°, both at Millsboro. Temperatures of 90° or higher occur on 25 to 30 days per year at inland points but only 15 to 20 days in coastal areas—hence the popularity of the coast as a summer resort and vacation area, where on hot summer days the thermometer may register 10° to 15° lower than at points inland. Humidity averages from 60%–65% in February–March to 75%–80% in August–October. Annual rainfall varies from 44 in. in the north to 47 in the south. Precipitation is variable in the summer, and irrigation is increasingly employed downstate to safeguard crops from drought. The average length of the growing (frost-free) season is 175 to 195 days.

Vegetation and Animal Life.—When the white man came to Delaware he found the land heavily forested, with hardwoods predominating except in the south, where there was a plentiful stand of white cedar and bald cypress (*Taxodium distichum*) in the inland swamps and pine on higher ground. Though forests have been cut over and swamps drained or "mined" for timber, 42% of Sussex county is still (or has been returned to) forest, and half that

much in the other counties. Lumbering, though not a large industry in modern times, has continued since colonial days. Holly is sufficiently plentiful to furnish employment at Christmas time for wreath-making. Bears, wolves and beaver, once plentiful, have been driven out; deer have returned to the state only in recent years. Foxes, raccoons and opossums are found throughout the state. Muskrats are trapped in the coastal marshes in considerable numbers. Delaware is in the path of the annual bird migrations and there is a rich bird fauna. There are probably as many species of fish as in the past.

Historic Sites and Parks.—Preservation of historic buildings and sites became an increasing state-wide interest during and after the 1930s. In 1931 the tercentenary of the first white settlement was celebrated at Lewes, the Dutch Swanendael; in 1938 the tercentenary of the first permanent settlement, Swedes and Finns at Wilmington; in 1951 the tercentenary of the founding of New Castle by Dutch settlers and their establishment of the first elements of self-government on Delaware soil. The colonial mansions of William Corbit at Odessa and John Dickinson (*q.v.*) near Dover have been restored and are open to the public. Many old houses in New Castle and Dover are opened annually on designated days. Henry Francis du Pont's collection of early American furniture and furnishings, housed in 100 period rooms at Winterthur, is a public museum. A new museum of early American industry, on the site of the original Du Pont powder mills on the Brandywine, was dedicated in 1957. The Delaware State museum at Dover was formally opened in 1950. Holy Trinity (Old Swedes) church in Wilmington, erected in 1698, is still in use.

State parks include Ft. Delaware, on Pea Patch Island in the Delaware river, opened as a state park in 1954. During the American Civil War it was used as a place of confinement for Confederate prisoners. Ft. Christina, site of the first permanent settlement, in Wilmington, also has been made a state park. State parks with facilities for outdoor recreation include Brandywine Springs and Trapp Pond state parks and Indian River Inlet park in the dunes, which include miles of state-owned lands extending between the bays and the Atlantic ocean. State forests include Blackbird, Ellendale and Redden state forests and the Owens and Red Lion tracts. The state maintains a number of wildlife areas and the Bombay Hook federal waterfowl refuge is near Smyrna.

HISTORY

Exploration.—Before the coming of the white men, the present state of Delaware was inhabited by tribes of aborigines of the Leni Lenape stock, later called Delaware Indians (*q.v.*). Henry Hudson discovered Delaware bay and river for the Dutch, in 1609. The following year, Capt. Samuel Argall of Virginia named the bay for Lord De la Warr, the governor of that colony. After the Dutch lost this, their "South river," the name Delaware survived.

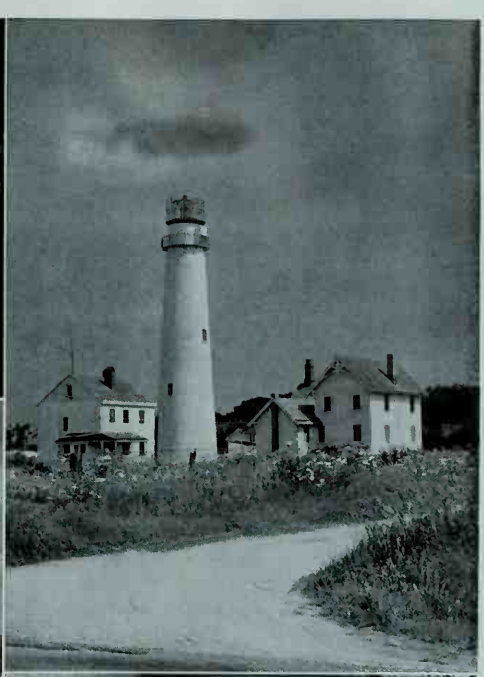
The territory was more thoroughly explored in 1615–16 by Cornelis Hendricksen, whose reports did much to cause the incorporation of the Dutch West India company (*q.v.*) in 1621. Recent research indicates that as early as 1624 the company sent a few Walloon families to the Delaware, who settled on an island in the river opposite the present Burlington, N.J., but later withdrew to Manhattan. In 1631 the first settlement on Delaware soil was made at Swanendael (the present Lewes) under a patroonship granted to Samuel Godyn of Amsterdam. Its purpose was to catch whales and plant grain and tobacco. But the settlers were massacred by the Indians and the project was abandoned.

Dutch and Swedish Settlements.—When the Dutch West India company failed to meet the expectations of its founder, William Usselinx, he proposed plans for trade and colonizing to Gustavus Adolphus of Sweden. Swedish and Dutch interest resulted finally in a jointly financed company and an expedition to the Dutch South river, the Delaware, in charge of Peter Minuit, former Dutch governor of New Netherland. In 1638, Minuit, who was an investor in the New Sweden company as well as expedition leader, established a settlement at what is now Wilmington, naming it Ft. Christina in honour of the child queen Christina, and naming the entire territory, bought by Minuit from the Minquas Indians and extending indefinitely westward from the Delaware river between Bombay hook and the mouth of the Schuylkill river, New Sweden. After the Swedish purchase of Dutch holdings in the New Sweden company, the next settlement was made by a group of Dutch, Swedes and Finns in 1641. In 1642 mature plans for colonization were adopted. A new company, popularly known as the South company, was chartered, and a governor, Johan Printz (*c.* 1600–63), was sent out by the crown. He arrived early in 1643 and subsequently established settlements, including one on the island of Tinicum, at the site of Essington, Pa., and another at the mouth of Salem creek, N.J. Printz remained governor of New Sweden for a period of ten years; his mansion, fort and church were on Tinicum Island. Friction soon arose with the Dutch, who looked upon the Swedes as interlopers and unwelcome competitors for the fur trade with the Indians. In 1651, Peter Stuyvesant, governor of New Netherland, and more aggressive than his predecessors, built Ft. Casimir, near what is now New Castle. In 1654 Printz's successor, Johan Claesson Rising, who had arrived from Sweden with a large number of colonists, expelled the Dutch from Ft. Casimir. In retaliation, Stuyvesant, in 1655, with seven vessels and several hundred men, recaptured the fort and also captured Ft. Christina (Wilmington). New Sweden thus passed into Dutch control and became a dependency of New Netherland. In 1656, however, the Dutch West India company sold the region including Ft. Casimir to the city of Amsterdam, which in the following year established a settlement called New Amstel at Ft. Casimir (New Castle). This settlement, badly administered, made little progress.

English Administration.—In 1663 the whole of the Delaware country came under the jurisdiction of the city of Amsterdam, but in the following year with New Netherland was seized by the English. For a brief interval, in 1673–74, the Dutch were again in control, but in the latter year, by the treaty of Westminster, the "three counties on the Delaware" again became part of the English possessions in America held by the duke of York, later James II. His formal grant from Charles II was not received until March 1683. In order that no other settlements should encroach upon his centre of government, New Castle, the northern boundary was determined by drawing an arc of a circle 12 mi. in radius with New Castle as the centre. This accounts for the curved boundary line between Delaware and Pennsylvania. However, in Aug. 1682, the duke of York conveyed the entire territory to William Penn by deeds of feoffment and leases for 10,000 years, a transfer later challenged by Maryland. But differences in national origin and religion, economic rivalry between New Castle and Pennsylvania towns, and petty political quarrels over representation and office holding, similar to those in the other American colonies, were so intense that Penn in 1691 appointed a special deputy governor for the lower counties.

Although reunited with the "province" of Pennsylvania in 1693, the so-called territories or lower counties secured a separate legislature in 1704 and a separate executive council in 1710; the governor of Pennsylvania, however, was the chief executive until 1776. A protracted dispute with Maryland was not settled until 1767, when the boundaries, surveyed by Charles Mason and Jeremiah Dixon, were adopted as a part of the territorial adjustment that included the Mason and Dixon line (*q.v.*). In the American Revolution Delaware furnished only two regiments to the Continental army, but they were among the best in the service. One of the companies of the first regiment carried a number of gamecocks said to have been the brood of a blue hen; hence the soldiers, and later the people of the state, have been popularly known as the "blue hen's chickens," though the state itself, as already mentioned, is popularly called the "Diamond state."

Statehood.—In 1776 a state government was organized, and the name Delaware state was first adopted. In the constitution of 1792 the title was changed to state of Delaware. One of the peculiarities of the government under the first constitution was that, in addition to the regular executive, legislative and judicial departments, there was a privy council without whose approval the governor's power was little more than nominal. In 1786 Delaware was one of the five states whose delegates attended the Annapolis convention (*q.v.*), and it was the first (Dec. 7, 1787) to ratify the federal constitution. The state was strongly Federalist for 30



BY COURTESY OF (TOP LEFT) TIDEWATER OIL CO., (OTHERS) DELAWARE STATE DEVELOPMENT DEPARTMENT; PHOTOGRAPHS, (TOP RIGHT) LUDITSH & BUNGARZ, (CENTRE LEFT) HERBERT E. MOORE, (BOTTOM RIGHT) ROBERT J. BENNETT

SCENES IN DELAWARE

Top left: Modern oil refinery near Delaware City
Top right: Fenwick Island lighthouse, southern Delaware
Centre left: Ayrshire cattle in central Delaware. Dairying is a leading industry of the state
Bottom left: Memorial park, or the Battery, at Lewes on Delaware bay, contains cannon used in returning the fire of the British, who bombarded the town during the War of 1812
Bottom right: Grading and packing Delaware chicks for shipment to growers

DELAWARE

BY COURTESY OF DELAWARE STATE DEVELOPMENT DEPARTMENT; PHOTOGRAPHS, (TOP LEFT) BROOKS STUDIO, (TOP RIGHT, CENTRE, BOTTOM LEFT) LUBITSH & BUNGARZ

SCENES IN DELAWARE

Top left: Legislative hall, the state capitol, Dover, part of a group of state buildings in the Georgian Colonial style of architecture

Top right: Zwaanendael house, a museum in Lewes, a smaller-scale adaptation of the town hall at Hoorn, Neth., ancestral home of the original Dutch settlers of Lewes

Centre: Delaware Memorial bridge, showing New Jersey in the background, connects Delaware with the New Jersey turnpike

Bottom left: The Strand, New Castle, a community of well-preserved early American homes that are opened to the public one day a year

Bottom right: Statue of Caesar Rodney, one of signers of the Declaration of Independence, in Wilmington

years after the adoption of the federal constitution, and in several presidential elections stood almost alone in choosing Federalist electors. Sentiment in Federalist Delaware opposed going to war with Britain in 1812. James A. Bayard of Delaware led an unsuccessful fight in the senate to postpone action on Pres. James Madison's war message until the country was better prepared to fight a war.

The Civil War Period.—Delaware was a slave state. The closest it ever came to abolishing slavery of its own accord was in 1847, when a bill for gradual emancipation was lost in the legislature by one vote. In 1861 sentiment on the slavery issue divided the state along the same geographical lines as the country at large. Northern Delaware, dominated by the growing industrial city of Wilmington, and with much of its immigrant population coming from neighbouring free states and from abroad, was the centre of antislavery activity. Southern Delaware, rural and tied by family relationships to adjoining Maryland, favoured or at least condoned the "peculiar institution." Delaware was unique among the slave states in prohibiting the sale of its slaves outside the state (acts of 1787 and 1789). Negroes constituted about one-fifth of the population, but the proportion of slaves declined from 70% in 1790 to only 8% in 1860, two-thirds of whom were in Sussex, the southernmost and economically the most backward of the three counties. Though slavery was less rigorous in Delaware than in the deep south, the whites' attitude toward the Negro was typical of the slave states as a whole. He was considered an inferior being and could not vote, hold office or testify in court against whites (Revised Statutes, 1852). Intermarriage of Negroes and whites was prohibited by an act of 1829 which in the 1960s was still in force.

Delaware refused to join in the secession movement which followed the Republican victory in the national election of 1860 but sympathized with the southern states which chose that course. The general assembly endorsed the Crittenden compromise proposals of 1861 (*see* CRITTENDEN, JOHN JORDAN). They failed, and with the outbreak of hostilities saving the union became the paramount issue. Delaware rallied to the cause and, it is claimed, furnished more soldiers to the union armies in proportion to its population than any other state. The Delaware volunteers fought to preserve the union, not to free the slaves. On the other side, an uncounted number of men—probably several hundred—secretly left the state to join the Confederate forces. Smuggling of contraband goods (medical supplies, for example) to the enemy was a problem in the lower part of the state. Seaford remained a centre of this illicit traffic throughout the war. Early in the war President Lincoln sought to initiate his plan of compensated emancipation in Delaware, since it was the smallest of the slave states. The state was to enact a law for the gradual abolition of slavery (to be completed in ten years) on condition that congress would reimburse the dispossessed owners. In an informal poll of the legislature the plan failed by the narrow margin of one vote (Feb. 1862) and was abandoned.

In Delaware as elsewhere the Negroes' best friends were the Quakers. Outstanding among them was Thomas Garrett, a merchant of Wilmington, who, along with John Hunn, Harriet Tubman, and other underground railroad agents helped runaway slaves through Delaware on their way to free soil. Garrett was nearing the 3,000 mark when the dislocations of war rendered his further efforts unnecessary. No battles were fought on Delaware soil during the American Civil War, but throughout the four years of the struggle a kind of "cold war" subsisted between the supporters of the Lincoln administration and its Democratic critics, who had opposed coercion of the south from the outset and sought to restore peace at almost any price. New Castle, the northernmost of the three counties, supported the Republican administration in elections during the war years. It had slightly over one-half (46,000) of the state's 90,000 inhabitants but only one-third of the membership in each house of the legislature, and so was outvoted on Civil War policy by the combined strength of Democratic Kent and Sussex. In the presidential election of 1864 Delaware gave its electoral votes to George B. McClellan—one of the three states which he carried.

The Post-Civil War Period.—After the war the legislature remained under Democratic control for another quarter of a century It rejected the 13th, 14th and 15th amendments to the constitution (these were not ratified by Delaware until 1901) and in 1873 proclaimed its "unceasing opposition" to any measure designed "to promote the equality of the negro with the white man in any of the relations of life." With the ratification of the 15th amendment Negroes voted for the first time in the election of 1870, but enough white votes were switched to the Democratic side to keep the party in control. Since only taxpayers could vote, the Democrats, by allowing local tax collectors to drop delinquent taxpayers from the rolls at their discretion, were able to keep considerable numbers of Republicans, white as well as Negroes, from the polls on election day. This practice was effective until the constitution of 1897 replaced the tax-paying requirement by a literacy test. Since then Negroes have voted freely and solidly Republican, until the era of Franklin D. Roosevelt. After mid-20th century the Democrats continued to get a share of the Negro vote.

In 1889 the Republicans for the first time since the Civil War secured a majority in the legislature; Anthony J. Higgins (Republican) was elected to the United States senate (senators at that time being chosen by state legislatures). Internal dissensions in the Republican party, arising out of a struggle between the so-called Regular Republicans and a personal "machine" built up by J. Edward Addicks, a Wilmington capitalist, prevented the election of a senator in 1895. The next election brought the Democrats into power, and the vacancy was filled by Richard R. Kenney. The struggle between the Republican factions continued, and with the expiration of Sen. George Gray's term in 1899 an election was again prevented. The state was wholly without representation in the United States senate from the expiration of Senator Kenney's term in 1901 until 1903, when a compromise was effected whereby two Republicans, one of each faction, were chosen. Again in 1905 the legislature adjourned without being able to fill a vacancy in the senate. The deadlock, however, was broken at a special session of the legislature called in 1906 when in June of that year Henry A. du Pont was elected senator.

Ebe W. Tunnell (1897–1901) was the last Democrat to be elected governor for 40 years. Under his Republican successors Delaware prospered through World War I, helped by the great profits accruing to the du Ponts and other Delaware explosives manufacturers who furnished munitions to the United States and its allies. The war made multimillionaires of millionaires in Delaware, and they spent their gains lavishly on projects beneficial to their state. Coleman du Pont built a state-long modern highway (1911–24) and presented it to the state. Alfred I. du Pont set up a private fund to pay old-age pensions and induced the legislature to establish an Old Age Welfare commission on a state-wide basis (1931), replacing the old county poor houses. Pierre S. du Pont spent millions on education (*see* below). The legislature withheld approval of the 19th (women's suffrage) amendment to the constitution but was prompt in ratifying the 18th (prohibition) amendment (March 1918) and equally prompt in helping to secure its repeal (1933). Pari-mutuel betting on horse races was authorized in 1935 and the first track, Delaware park, opened in 1937.

Richard C. McMullen (1937–41) was the first Democrat to be elected governor in the 20th century, aided by the New Deal, which made a dent in the wall of the solidly Republican Negro vote for which both parties now compete. Post-World War II immigration into the state probably helped the Democrats, who shared in the Lyndon B. Johnson landslide of 1964. An exception was Republican John J. Williams, who won an unprecedented fourth term in the U.S. senate.

For over a century, underrepresentation in the legislature was a standing complaint in Wilmington and New Castle county. At first the three counties were about equal in population and had equal membership in the unicameral colonial assembly and the bicameral legislature of the national period. With the increasing industrialization of the Wilmington area, New Castle county overtook the others in terms of population by 1820 and has lengthened its lead ever since. The amended constitution of 1853 provided for proportional representation in the lower house but this con-

cardiacs, alcoholics, the bedridden aged, and children and adults who are victims of infantile paralysis. Other state agencies care for the blind, deaf, dumb, tubercular and feeble-minded. Three state training schools provide academic and vocational education for delinquent children and youth. These are Ferris school for white and Negro boys, Kruse school for Negro girls and Woods Haven for white girls. Sterilization of the feeble-minded, epileptic and insane is provided for by law.

THE ECONOMY

Agriculture.—Delaware's population was chiefly rural and agricultural until 1920, when the urban population exceeded the rural for the first time. This change in population ratio was in a great measure due to rapid industrial development during World War I. The development of agriculture was also rapid. In 1929 the value of all farm crops and livestock sold, traded, or used by farm households amounted to $21,000,000. By the end of World War II, the total annual cash farm income was $90,000,000 and by 1960 it exceeded $110,000,000, over half of which came from a single item, broilers. The broiler industry, centred in Sussex county, got its start in Delaware in 1923 when Mrs. Wilmer Steele of Ocean View marketed 500 young chickens at the handsome price of 62 cents a pound (as compared with 16 to 18 cents in the 1960s). In a few years she and her imitators raised 10,000 to 25,000 young chickens a year. State production rose from 2,000,000 in 1928 to 24,000,000 in 1939 and 60,000,000 in 1944, making Sussex one of the highest agricultural income counties in the nation. Although broiler production became state-wide, Sussex remained the leader into the 1960s. Other livestock products are fluid milk (New Castle and Kent counties), eggs, cattle, turkeys and hogs. Crops include corn, truck crops, soybeans and potatoes. Peaches, for which Delaware was famous in the mid-19th century, almost disappeared, and other tree fruits are of minor importance.

Industry.—The development of manufacturing in Delaware—centred largely within the northern part of New Castle county, including Wilmington and the river shore as far south as New Castle—had its origin in the abundant water power from the streams and easy access to the state's great waterway, the Delaware river. Wilmington, an active shipbuilding and shipping port and centre of mill industries from colonial days, expanded after the American Civil War into a notable centre for such special industries as carriage and car-building, fibre and paper making and machine-tool production with the growth of its regular gun-powder, textile, leather and iron manufacturing. Early industries along the millstreams of the adjoining county added to the Wilmington area's potential facilities for increased industrial importance during and following World War I. Throughout the state canning and other food processing developed into a major industry. Production of nylon, chemicals, motor vehicles and parts, aircraft, and steel and iron manufacturing and shipbuilding reached their peaks during and after World War II. During this period Wilmington became an outstanding chemical centre of the world with large experimental stations for basic and applied research by the du Pont company (founded in 1802) and its smaller offshoots, Hercules and Atlas, all three of which have expanded from explosives into the general chemical field. Industrial expansion southward after 1950 included an automobile assembly and tank plant at Newark, which turned out its first army tank in 1952, and a large oil refinery at Delaware City, which went into production in 1957.

Transportation.—Delaware's transportation facilities include the water-borne traffic of the Delaware river and the sea-level canal connecting the Delaware with Chesapeake bay; the marine terminal at the port of Wilmington with wharf facilities for the largest ocean vessels; airports with passenger and freight services (and a U.S. air force base—*see* DOVER); about 4,000 mi. of highways, over 2,000 of which are paved, the rest well-tended secondary roads; and about 300 mi. of railroads. Because of increasing competition from airplane, bus, and private motorcar transportation, railroad passenger service down the peninsula has been greatly reduced. The Delaware system of wide dual highways and good secondary roads connects with all adjoining state systems. A $45,000,000 suspension bridge across the Delaware river south of Wilmington, opened in 1951, meets the southern terminus of the New Jersey turnpike. The state pays about 85% of highway costs in Delaware. There are no toll roads.

The Chesapeake and Delaware canal cuts 14 mi. across the upper Delmarva peninsula. It is 27 ft. deep, tidal and toll free, owned and operated by the U.S. government as part of the eastern inland waterway system, and accommodates all but the largest ocean-going vessels. It is crossed by modern fixed-span bridges at St. Georges, Del., and Chesapeake City, Md. Such a waterway was talked of as early as 1661. In 1804 a company started work on a lock canal, somewhat farther north than the present one, but soon ran out of money. Another company, with an enlarged and relocated project, pushed it through to completion in 1829. It was a lock canal also, and continued to be operated as such until 1919, when the U.S. government, then the largest stockholder, bought the canal and converted it to its present form. The old canal had a life of its own. Showboats tied up along its banks to play the canal towns, and floating stores sold their wares from place to place. Passenger service between Baltimore and Philadelphia through the canal continued till the 1920s.

Lewes, with its 300 ac. of artificial harbour, provides pilot service for Delaware river shipping to and from Philadelphia.

See also references under "Delaware" in the Index.

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For statistics *see* the various publications of the U.S. Bureau of the Census, the U.S. Weather Bureau, the Delaware State Chamber of Commerce and the University of Delaware Agricultural Experiment Station.

Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures are summarized annually in the *Britannica Book of the Year,* American edition. (H. C. RE.)

DELAWARE INDIANS, village bands of Algonkian-speaking Indians that occupied the Atlantic seaboard from Cape Henlopen, Del., to western Long Island and especially the river valley of that name. To themselves they were *Leni Lenape,* or simply *Lenape,* "the people." American scholars following D. G. Brinton have divided their confederacy into three subtribes, each of which formed a clan or totem and a political subdivision:

Unalachtigo (Turkey), Unami (Turtle) and Munsee (Wolf). It appears that they comprised 30 or 40 autonomous communities and that the clans were distributed among them. The lands of each band included individual hunting territories measuring up to 200 sq.mi., the title to which was subject to band sanction. Their priority of occupation on the Atlantic coast is not clear: the Nanticoke of Maryland and the Mahican of the Hudson river termed them "grandfathers"; their linguistic affinity is to central Algonkian; and their migration legend, *Walam Olum*, brings them east. But archaeological evidence places them near the coast by A.D. 1000 and suggests earlier cultural antecedents in the area. The Delaware were the Indians most friendly to William Penn, and the Munsee were rewarded by the infamous "Walking Purchase," a treaty that forced them to settle on lands assigned by the Iroquois. Encroached on by whites and made "as women" by the rising Iroquois after 1690, they drifted westward in stages, stopping on the Susquehanna, the Allegheny, then the Muskingum in Ohio and the White river in Indiana; and, after 1800, to Missouri, Kansas, Texas and Oklahoma. After 60 years of displacement, their remnants and accretions rekindled a tribal fire beyond the Ohio, threw off the garb of women by defeating the English general Edward Braddock in the French and Indian War and asserted their manhood with vengeance for a half-century. They then had an eastern wing under Teedyuscung and a western pro-French wing under Shingas. For a time they supported the Americans during the Revolution but defected to the British for want of presents and because of the murder of White-Eyes and the invasion of their Ohio hunting grounds. These they ceded at the treaty of Greenville in 1795. Two Moravian missionaries, D. Zeisberger and J. Heckewelder, are the best sources on their history, movements and acculturation into the 19th century. In mid-20th century the Delaware numbered about 2,000, half of whom lived in Oklahoma, the rest in Wisconsin and Ontario.

See also ALGONKIAN TRIBES.

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(W. N. F.)

DELAWARE RIVER, a stream of the Atlantic slope of the United States, meeting tidewater at Trenton, N.J., 130 mi. above its mouth. Its total length, from the head of the longest branch to the capes, is 410 mi. It constitutes in part the boundary between Pennsylvania and New York, the boundary between New Jersey and Pennsylvania and, for a few miles, the boundary between Delaware and New Jersey. The main or west branch rises in Schoharie county, N.Y., about 1,886 ft. above the sea, and flows tortuously through the plateau in a deep trough until it emerges from the Catskills. Other branches rise in Greene and Delaware counties, N.Y. In the upper portion of its course the varied scenery of its hilly and wooded banks is beautiful. After leaving the mountains and plateau, the river flows down broad Appalachian valleys, skirts the Kittatinny range, which it crosses at Delaware Water Gap between nearly vertical walls of sandstone, and passes through a quiet and charming country of farm and forest, diversified with plateaus and escarpments, until it crosses the Appalachian plain and enters the hills again at Easton, Pa. From this point it is flanked at intervals by fine hills, and in places by cliffs, of which the finest are the Nockamixon rocks, three miles long and more than 200 ft. high. At Trenton there is a fall of eight feet.

Below Trenton the river becomes a broad, sluggish inlet of the sea, with many marshes along its sides, widening steadily into its great estuary, Delaware bay. Its main tributaries in New York are the Mongaup and Neversink rivers and Callicoon creek; from Pennsylvania, the Lackawaxen, Lehigh and Schuylkill rivers; and from New Jersey, Rancocas creek and the Musconetcong and Maurice rivers. Major cities on the Delaware include Port Jervis, N.Y.; Easton, Philadelphia and Chester, Pa.; Trenton and Camden, N.J.; and Wilmington, Del. Commerce was once important on the upper river, but only before the beginning of railway competition (1857). Of the various early canals only two continued to be of any importance—the canal from Trenton to New Brunswick, uniting the waters of the Delaware and Raritan rivers, and the Delaware and Chesapeake canal, joining the waters of the Delaware with those of Chesapeake bay. The magnitude of the commerce of Philadelphia made the improvements of the river below that port of great importance. The Interstate Commission on the Delaware River Basin (INCODEL) was formed in 1936 by the four states in the watershed of the river, New York, New Jersey, Pennsylvania and Delaware, to control and prevent pollution, plan the conservation of water supply for the use of cities and plan development along the course of the entire river. At a cost of many millions of dollars to the U.S. government, a 32-ft. channel 600 ft. wide was opened from the deep water in Delaware bay to Philadelphia and a 12-ft. channel from there to Trenton.

On Christmas night of 1776, in a bad storm, George Washington and about 2,400 of his soldiers crossed the Delaware from Pennsylvania to New Jersey nine miles above Trenton and successfully surprised Hessian troops who had their winter quarters in Trenton (*see* TRENTON AND PRINCETON, BATTLES OF). In commemoration of this victory the site of Washington's landing was converted into a state park. (F. O. A.)

DE LA WARR (DELAWARE), **BARONS AND EARLS,** an English title, the holders of which are descended from SIR ROGER LA WARRE (d. 1320) who was summoned to parliament as a baron from 1299. His grandson ROGER (1326–70), 3rd baron, was a notable soldier who fought at Crécy and Poitiers. This male line became extinct with the death, on May 7, 1427, of THOMAS, 5th baron, who was succeeded by his nephew REGINALD WEST (1395–1450), 3rd Baron West and 6th (or 1st) Baron De La Warr. He was the second son of Thomas' half-sister Joan by her marriage with Thomas (1365–1405), 1st Baron West. Reginald was summoned to parliament in 1427 as Baron La Warr. His grandson THOMAS (d. 1525), 8th (or 3rd) baron, was a courtier and soldier during the reigns of Henry VII and Henry VIII, and the 8th baron's son THOMAS (d. 1554), 9th baron, was a person of some note during the reigns of Henry VIII and Edward VI. He died without issue on Sept. 25, 1554, when the baronies of West and De La Warr fell into abeyance.

The 9th baron had settled his estates on his nephew WILLIAM WEST (d. 1595), who was disabled by act of parliament (1550) from taking the titles for having tried to poison his uncle. However William was created by patent Baron De La Warr in 1570 and his son THOMAS (*c.* 1556–1602), 11th baron, was granted the precedence of the ancient barony De La Warr in 1597.

The 11th baron's son, THOMAS (1577–1618), 12th baron, was born on July 9, 1577. He fought in the Netherlands and in Ireland under the earl of Essex. He was imprisoned for complicity in Essex's revolt (1601), but was soon released. He became a member of the council of the Virginia company and was appointed (1610) governor and captain general of Virginia for life. Sailing in March 1610 with three ships, 150 settlers and supplies, he arrived at Jamestown on June 10, in time to intercept the colonists who had embarked for England and were abandoning the enterprise. Lord De La Warr's rule was strict but just; he constructed two forts near the mouth of the James river, rebuilt Jamestown, and in general brought order out of chaos. He returned in 1611 to London where he published, at the request of the company's council, his *Relation* (1611, reprinted 1858) of the condition of affairs in Virginia. He remained in England until 1618, when the news of the tyrannical rule of the deputy, Samuel Argall, led him to start again for Virginia. He embarked in May, but died en route on June 7, 1618, and was buried at sea. Delaware bay and the state of Delaware were named in his honour.

In 1761 the 12th baron's great-great-grandson, JOHN (1693–1766), 16th baron, was created Viscount Cantelupe and 1st Earl De La Warr. He was a prominent figure in the house of lords, at first as a supporter of Sir Robert Walpole. He also served in the British army and fought at Dettingen, and he was governor of Guernsey 1752–60. His descendant GEORGE JOHN WEST (1791–1869), 5th earl, married Elizabeth Sackville in 1813, and

in 1843 he and his sons took the name of Sackville-West. The earl was twice lord chamberlain to Queen Victoria, and is celebrated as "Fair Euryalus" in the *Childish Recollections* of his schoolfellow, Lord Byron. His son, CHARLES RICHARD (1815–73), 6th earl, served in the first Sikh war and in the Crimea. His descendant HERBRAND EDWARD (1900–), 11th earl, was postmaster general from 1951 to 1955.

DELBRÜCK, BERTHOLD (1842–1922), German linguist, an Indo-Europeanist specializing in problems of syntax, was born at Putbus on the island of Rügen, on July 26, 1842. He was educated at Halle and Berlin, and was professor of Sanskrit and comparative linguistics at Jena from 1870 until his retirement in 1912.

Delbrück was the first Indo-Europeanist to study comparative syntax; in his doctoral dissertation he investigated the usage of the Greek infinitive; soon after, he turned to the syntax of the dative in the Rigveda; and in 1871 he published his classic work on the subjunctive and optative in Sanskrit and Greek (*Syntaktische Forschungen*, vol. i. ed. by Delbrück and E. Windisch), the first thoroughly methodical and complete treatment of a problem in comparative syntax. The method which Delbrück used, of comparing, contrasting and classifying large numbers of similar utterances, although extended and refined, has never been fundamentally superseded. Delbrück was the author of the three volumes on Indo-European syntax in the *Grundriss der vergleichenden Grammatik der indo-germanischen Sprachen;* this great synthesis is his masterwork.

On a question much debated in his time, he took the stand that adherence to or denial of the principles of any school of psychology or philosophy or sociology need have no influence upon the linguistic work done by a scientifically trained linguist. The same position has since been held by others; Delbrück was the first great linguist to give it explicit statement. He died at Jena on Jan. 3, 1922.

A complete bibliography of Delbrück's work is published in E. Hermann, *Berthold Delbrück* (1923). (MY. F.)

DELBRÜCK, HANS GOTTLIEB LEOPOLD (1848–1929), German military historian and politician, was born at Bergen on the island of Rügen, on Nov. 11, 1848. He studied at Greifswald, Heidelberg and Bonn. Work on a biography of August Gneisenau first roused his interest in military history, and he wrote on both ancient and modern strategy. His strategical theories were by no means generally accepted, however, and it was not until 1895 that he was given a professional chair, succeeding Heinrich von Treitschke at Berlin a year later. Delbrück maintained that he entered politics as a historian. He sat in the Prussian lower house from 1882 to 1885 and in the *Reichstag* from 1884 to 1890. Calling himself an enlightened conservative, he was in fact a liberal with nationalist tendencies in foreign policy. In 1883 he became co-editor with Treitschke of the *Preussische Jahrbuch* (a monthly journal for politics, history and literature) and was sole editor from 1889 to 1919. During World War I he urged a policy of moderation. He died in Berlin on July 14, 1929.

Among his numerous works are *Geschichte der Kriegskunst im Rahmen der politischen Geschichte*, 7 vol. (1900–27) and *Weltgeschichte*, 5 vol. (1923–28).

DELBRÜCK, RUDOLF VON (1817–1903), Prussian statesman, chief executor of Bismarck's free-trade policy, was born at Berlin on April 16, 1817. On completing his legal studies he entered the government service in 1837; in 1848 he was transferred to the ministry of commerce. Both Germany and Austria had realized the influence of commercial upon political union. Delbrück in 1851 induced Hanover, Oldenburg and Schaumburg-Lippe to join the *Zollverein*, and the southern states, which had agreed to admit Austria to the union, found themselves forced in 1853 to renew the old union, from which Austria was excluded. Delbrück now began, with the support of Bismarck, to apply the principles of free trade to Prussian fiscal policy. In 1862 he concluded an important commercial treaty with France. In 1867 he became the first president of the chancery of the North German confederation and represented Bismarck on the federal tariff council (*Zollbundesrat*). In 1868 he became a Prussian minister without portfolio. In Oct. 1870, when the union of Germany under Prussian leadership became a practical question, Delbrück was chosen to go on a mission to the South German states, and he contributed greatly to the agreements concluded at Versailles in November. In 1871 he became president of the newly constituted *Reichskanzleramt*. Delbrück, however, began to feel uneasy under Bismarck's leanings toward protection and state control. When Bismarck introduced a plan for state acquisition of the railways, Delbrück resigned office, pleading ill-health (June 1, 1876). In 1879 he opposed in the *Reichstag* the new protectionist tariff and then retired definitely from public life. He died at Berlin on Feb. 1, 1903.

See his *Lebenserinnerungen 1817–1867*, 2 vol., 2nd ed. (1905), with an additional section on the events of 1870.

DELCASSÉ, THÉOPHILE (1852–1923), French statesman, a principal architect of the *entente cordiale* between France and Great Britain and of Franco-Russian understanding in the years before World War I, was born at Pamiers on March 1, 1852, and educated locally. He contributed to the *République française* and entered politics as a supporter of Léon Gambetta and of the colonial policy of Jules Ferry. The unpopularity of colonialism in 1885 ensured his defeat in the elections of that year, but in 1889 he was elected deputy for Foix, in his native *département* of Ariège.

Having in 1887 married the widow of a wealthy man, he was freed from financial cares. Appointed undersecretary for the colonies in Alexandre Ribot's cabinet (Jan. 1893), he retained this post throughout Charles Dupuy's first ministry (April–Nov. 1893) and became minister of colonies on Dupuy's return to office (May 1894–Jan. 1895).

Delcassé belonged to the anticlericalist wing of the Radicals and, in 1898, attacked Jules Méline's ministry for its tolerance of clericalism. But throughout the Dreyfus affair he kept aloof, devoting his energies to colonial and foreign affairs. Méline fell as a result of the elections of 1898, and Delcassé's career reached its zenith when he accepted the office of minister of foreign affairs in Henri Brisson's ministry which succeeded Méline's. He held that office under the succeeding premierships of Dupuy, René Waldeck-Rousseau and Émile Combes and for the first part of that of Maurice Rouvier. This continuous tenure of seven years (June 1898–June 1905) was unprecedented in the third republic. They were years of crucial importance for French foreign policy, to the reshaping of which Delcassé brought remarkable consistency of purpose and pertinacity of will. France had already, in 1893, entered into an alliance with Russia. But since the making of the triple alliance of 1882 between Germany, Austria-Hungary and Italy, the balance of diplomatic power in Europe had tipped dangerously against France. Amid divided counsels as to whether France should pursue a policy of *détente* ("seeking better relations") with Germany or one of alliance with Great Britain, Delcassé resolutely worked for resistance to Germany and for alliance with Great Britain. It was an undertaking beset with difficulties and dangers, but he triumphantly overcame them all.

The first danger, which confronted him as soon as he took office, was of war with Great Britain over the dispute at Fashoda (*see* EGYPT: *Modern History*). It created acute tension between the two countries, but J. B. Marchand was recalled from the Nile in Nov. 1898 and the danger was removed mainly by Delcassé's tact and moderation. Germany's clumsy encouragement of the Boers in their conflict with the British helped Delcassé in his aims, for the experience of isolation during the South African War made Great Britain more receptive to overtures for an alliance. In 1904, however, the outbreak of war between Japan and Russia created fresh difficulties: Great Britain was an ally of Japan, France an ally of Russia. Again Delcassé's moderating influence smoothed out these difficulties. Through Paul Cambon, French ambassador in London, he worked patiently for agreement with Great Britain about the two main areas of colonial tension, Egypt and Morocco. In April 1904 France and Great Britain signed a convention which became a landmark in European diplomacy: it not only removed all outstanding colonial frictions between the two countries, but also formed the foundation for a broad *rapprochement* covering

European affairs in general and grew into the *entente cordiale*. After Russian warships had fired on British trawlers off the Dogger bank (Oct. 1904), Delcassé was able to mediate between Great Britain and Russia and so to pave the way for the eventual triple entente of 1907 as counterpoise to the triple alliance.

Meanwhile, however, his position was becoming untenable because of resistance to his policy within the government. Maurice Rouvier, the financier who became premier in Jan. 1905, sought to ease Franco-German relations by economic co-operation and by resisting the completion of alliance with Great Britain. In this he was supported by other members of his ministry. Parliamentary opinion, too, was alarmed by the menacing diplomacy of Germany and by German armed strength and afraid that Delcassé's policy of defiance would lead to war. In the session of the chamber on April 18 he was criticized from all sides. When it became apparent that Rouvier was acting behind his back to seek reconciliation with Germany, Delcassé resigned after a stormy meeting of the council of ministers on June 6, 1905. Since Germany had been pressing for the summoning of an international conference about Morocco and had been attacking him personally, it seemed that France's foreign minister had been ousted under German pressure. As a result Franco-German relations deteriorated, and in Great Britain the entente with France won new sympathy and support. When Delcassé left the foreign ministry the international position of France had been completely transformed by his labours. Agreement had been reached with Italy about Tunisia and Tripolitania in 1902 and with Spain as well as with Great Britain about Morocco in 1904. The triple entente, which was to be completed by the Anglo-Russian treaty of Aug. 1907, was virtually his achievement.

Delcassé remained out of office for six years and made no political pronouncement for two years after his resignation. He was active in parliament, however; and when, in Jan. 1908, he took the opportunity of a debate on Morocco to make a speech vindicating his policy he was warmly acclaimed. He returned to prominence in 1909, when he was appointed chairman of a parliamentary committee to inquire into French naval weakness: the report that he produced resulted in the resignation of Georges Clemenceau's ministry. Appointed minister of marine under Ernest Monis, in March 1911, he retained that office for nearly two years, under Joseph Caillaux and Raymond Poincaré. In 1912 he was responsible for the exchange of letters between Pierre Paul Cambon and the British foreign secretary, Sir Edward Grey, which approved French naval concentration in the Mediterranean and British naval concentration in the North sea and in the English channel. The two governments, as Grey could insist in 1914, were still not bound together by any formal alliance; but such a disposition of naval forces for mutual defense cemented the entente and ensured formal alliance when World War I broke out in 1914.

In Feb. 1913 Delcassé was sent by Aristide Briand to the post of ambassador at St. Petersburg. He enjoyed, to a unique degree, the confidence of the tsar Nicholas II and of his foreign minister, S. D. Sazonov, and used his influence to strengthen the Franco-Russian alliance, which had weakened in the interval since his tenure of the foreign ministry. He urged moderation on Russia in its disputes with Turkey and with Austria-Hungary and on France in its extension of commitments in Syria, which he feared might revive Franco-British dissensions.

After 1914 Delcassé lost the sureness of touch and grip which had been so conspicuous in his previous career. He was minister of war in Alexandre Ribot's short-lived cabinet of 1914. Returning to the ministry of foreign affairs under René Viviani in Aug. 1914, in World War I, he approved the treaty of London with Italy in April 1915 (this finally disrupted the triple alliance), but resigned in Oct. 1915 in protest against the Salonika expedition. In Balkan affairs, it must be acknowledged, he lacked clearness of vision and proved to be as persistent in errors as he had previously been consistent in success. Delcassé retired into private life in 1916 and expressed repeated disapproval of the policy followed by the French and British governments in 1918 and 1919. He urged preservation of the Franco-British alliance and keeping the Rhineland as a bulwark against Germany. He died in seclusion, at Nice, on Feb. 21, 1923. In spite of his later failures, he remains one of the greatest foreign ministers of modern France.

See C. W. Porter, *The Career of Théophile Delcassé* (1936); Albéric Neton, *Delcassé* (1952). (D. Tn.)

DELEDDA, GRAZIA (1875–1936), Italian novelist, an outstanding writer of the *verismo* school in Italian literature, who was awarded the Nobel prize for literature in 1926, was born at Nuoro, Sardinia, on Sept. 27, 1875. She married very young and moved to Rome, where she lived quietly, frequently visiting her native island, which remained the source of her literary inspiration. She died in Rome on Aug. 15, 1936.

Almost without formal schooling, she wrote her first stories when she was 17. They were based on sentimental treatment of themes from folklore, but with *Il vecchio della montagna* (1900) she began to write about the tragic effects of temptation and sin within the conscience and consciousness of primitive human beings. Her masterpieces are *Elias Portolu* (1903), the story of a mystical former convict in love with his brother's bride, whom he refuses to marry when she becomes a widow, deciding to consecrate himself to the priesthood; *Cenere* (1904; Eng. trans., *Ashes*, 1910) in which an illegitimate son causes his mother's suicide; *L'edera* (1908), which tells of a servant who kills to save her master from financial ruin and later finds in marriage with him only expiation for her sin; *La madre* (1920; Eng. trans., *The Woman and the Priest* [*The Mother*], 1923), the tragedy of a mother who realizes her dream of making a priest of her son only to see him yielding to the temptations of the flesh. Nearly 50 other novels developed similar themes, an exception being *Cosima* (1937), an autobiographical account of her early life.

Grazia Deledda's conception of Sardinian psychology resembled Giovanni Verga's idea of the Sicilian peasant, and she is considered, after him, the greatest representative of *verismo*, the Italian offshoot of French naturalism, which is distinctive in its evocation of regional life.

Bibliography.—M. Mundula, *Grazia Deledda* (1929); E. de Michelis, *Grazia Deledda e il decadentismo*, with full bibliography (1938); B. Croce, *La letteratura della nuova Italia*, vol. vi (1940). (F. Di.)

DELEHAYE, HIPPOLYTE (1859–1941), Belgian scholar and Bollandist, the foremost exponent of biographical church history from the archaeological as well as the documentary viewpoint, was born in Antwerp on Aug. 19, 1859. He became a Jesuit in 1879, was ordained priest in 1890 and then identified himself with the work of the Bollandists (*q.v.*), becoming head of their group in 1912. He died in Brussels on April 1, 1941.

Delehaye took a decisive part in the census of extant lives of saints, both printed and manuscript, specializing in the early Christian centuries, with a predilection for the Greek and other Byzantine sources; he edited the *Bibliotheca hagiographica Graeca* (1895; 2nd ed., 1909). His fame rests on half a dozen books directed to historians in general on the critical method as applied to the lives of saints. The best known are: *Les Légendes hagiographiques* (1905; best ed. 1927; Eng. trans. 1962); *Les Origines du culte des martyrs* (1912); *Les Passions des martyrs et les genres littéraires* (1921); *Sanctus* (1927). He edited the Constantinople *Synaxarium* (1902), explained word by word the *Martyrologium Hieronymianum* (1931), and took the leading part in the Bollandists' commentary on the *Martyrologium Romanum* (1940). He was a constant contributor to *Acta Sanctorum* and to *Analecta Bollandiana*, as well as to other learned journals.

See P. Peeters' notice, with bibliography, in *L'Oeuvre des Bollandistes*, new ed. (1961), and *Figures Bollandiennes contemporaines* (1948). (Pl. Gn.)

DELESCLUZE, LOUIS CHARLES (1809–1871), French republican journalist and a leading member of the Paris Commune of 1871, was born at Dreux (Eure-et-Loir) on Oct. 2, 1809. Though still a law student, he fought in the revolution of 1830 and, adopting extreme republican views, took part in the insurrection of June 1832. Because of his continued opposition to Louis Philippe, he was forced to leave France in 1836. On his return in 1840 he settled at Valenciennes, becoming editor of *L'Impartial du Nord*. After the revolution of 1848, he was appointed commissioner of the republic in the Nord and Pas-de-Calais *départements*. Resigning his post on the meeting of the

national assembly, he went to Paris, where, in his journal *La Révolution démocratique et sociale,* he denounced the government's increasing conservatism. Through a society called Solidarité Républicaine, he intended to champion the republic against its enemies. When the radical uprising of June 1849 failed, he had to flee to England, but he returned in 1853. Betrayed by an informer, he was banished to a convict settlement in Guiana, from which he returned in 1859 broken in health (*see* his *De Paris à Cayenne: journal d'un transporté,* 1869). He resumed journalism and was again imprisoned but escaped to Belgium in 1870, returning on the fall of the second empire. Though personally hostile to Auguste Blanqui, he was deeply influenced by his ideas: neither a socialist nor an internationalist, he was commonly described as a "Jacobin." Elected a member of the national assembly and also of the Paris Commune in 1871, he chose to sit in the latter. His seniority, ability and administrative experience gave him authority in the Commune, and he was its most capable and disinterested leader. On May 9 he was appointed civil delegate for war by 42 votes to 2, but the troops from Versailles broke into Paris on May 22, and the Communard forces scattered to their local sections. For three days Delescluze tried to reorganize the defense and fought with reckless courage, but on May 25, he sensed that defeat was inevitable: alone and unarmed, he climbed a barricade off the boulevard Voltaire under heavy fire and was killed.

DELESSERT, (JULES PAUL) BENJAMIN (1773–1847), French banker who began the first savings bank in France, was born at Lyons, Feb. 14, 1773. He became manager of his family's discount bank in 1795. In 1801 he founded the first cotton factory in France, and in 1802 France's first sugar factory, for which he was made a baron of the empire. For many years he was a member of the chamber of deputies and a regent of the Bank of France. He founded many learned and philanthropic societies. By avocation he was an eminent botanist and the author of several books. He died in Paris, March 1, 1847. (J. R. Lt.)

DELFICO, MELCHIORRE (1744–1835), Italian economist, was born at Teramo in the Abruzzi on Aug. 1, 1744, and was educated at Naples. He devoted himself specially to the study of jurisprudence and political economy, and his numerous publications exercised great practical influence in the correction and extinction of many abuses. Under Joseph Bonaparte, Delfico was made a councilor of state, an office which he held until the restoration of Ferdinand IV, when he was appointed president of the commission of archives, from which he retired in 1825. He died at Teramo on June 21, 1835. (Fk. L. K.)

DELFT, a town of South Holland province, Neth., is situated in flat polder country 9 km. (5½ mi.) S.S.E. of The Hague by road and 18 km. N.W. of Rotterdam. Pop. (1957 est.) 69,865 (mun.). The old inner town is threaded by picturesque canals. The Gothic Oude Kerk, founded in the 13th century, dates in its present form from about 1500 and contains memorials to the admirals Martin Tromp and Piet Heyn and to the microscopist Anton van Leeuwenhoek, a native of Delft. The Gothic 14th-century Nieuwe Kerk (formerly St. Ursula's) has a tall tower with a carillon; the members of the house of Orange-Nassau are buried there (the tomb of William the Silent was executed by Hendrik de Keyser and his son in 1614–21) and there too is the tomb of Hugo Grotius, a native statesman whose statue is in the market place. The Renaissance town hall was built about 1618 round a medieval tower. West of this, in the Oude Delft, which runs right down the old town on the west side, is the Prinsenhof where William the Silent was assassinated in 1584; it was a nunnery before it became his residence and is now the town museum where an antique fair is held. The assembly hall of the Technical university, which was founded in 1842 as the Royal academy, in 1864 became the Polytechnic and in 1905 assumed its present status, is a 15th-century chapel. In the Oude Delft are many ancient houses, among them the headquarters of the Hoogheemraadschap (Union of Inland Polders) with a late Gothic façade. The Lambert van Meerten museum, near the Prinsenhof, has a remarkable international collection of tiles, while the Armamentarium is a 17th-century armoury of the states of Holland. The town archives are in a 16th-century house, Oude Delft 169. The Museum Paul Tetar van Elven, at the Koornmarkt, has rooms in different styles.

Delft is on the railway from Rotterdam to The Hague and Amsterdam. The making of pottery, cables, yeast, spirits and penicillin are the chief industries. Delft received its charter from Count William II in 1246 and in 1536 was largely destroyed by fire. In 1654 it was heavily damaged when a powder magazine blew up. Jan Vermeer (1632–75) is the greatest of the many painters born in Delft. The production of beautiful faïence pottery, known as Delft, flourished in the 17th century but declined subsequently. Only one firm continues production, using modern techniques. (D. P. O.)

DELHI, the site of several capital cities of India including New Delhi, formerly (1912–47) the capital of British India and now of the Republic of India, is situated on the west bank of the river Jumna (Yamuna). The cities and surrounding areas of Dilli (the earlier cities before the Moguls), Delhi (the present city popularly known as "Old Delhi") and New Delhi, and the cantonment comprise the Union territory which covers an area of 573 sq.mi. and had a population (1961) of 2,644,058. The population of Old Delhi was 2,051,622 and that of New Delhi 260,272. Delhi occupies an almost central position in the Indian subcontinent, equidistant from the great commercial cities of Calcutta, Bombay and Karachi. It is a pivotal point in the network of national railways, highways and airways. Geographically it is unique because of its central position in the whole of the eastern hemisphere.

The site of Delhi is a natural fortress in the shape of a triangle, the western side of which is formed by the famous Delhi ridge that is the northernmost extremity of the Aravalli range. The eastern side is formed by the river Jumna which meets the Delhi ridge at Wazirabad in the north and forms the apex. The base is an eastern offshoot of the ridge, branching off from the main body near Mahrauli about 11 mi. S. of Wazirabad.

It is within the triangular area that at least 15 different cities of Delhi are believed to have emerged at different times, but all except the last two, Old and New Delhi, have perished. Each conqueror, having destroyed the city of his predecessor, built a new one on the triangular plain, and so Delhi successively changed its location, its character and even its name, yet it preserved its continuous existence.

HISTORY

The earliest-known city of Delhi, Indraprastha, flourished in the 15th century B.C. In the epic of *Mahabharata,* where it is described, it was built by Yudhistra, a Pandava king, and it was situated on a huge mound on the western bank of the Jumna, now occupied by the Purana Kila (old fort). There are no visible remains of Indraprastha but according to legend it was a great city.

It is believed that in the first century B.C. Raja Dillu built a city about 7 mi. S.W. of Indraprastha, on the site where the Kutb Minar now stands, and named it Dilli, the first appearance of this name. The next big city to emerge in the Delhi plain was Surajkund, built on a rocky spur about 6 mi. S.E. of Dilli by a Tomar Rajput, Raja Anangapala, in A.D. 1020. A few years later it was moved to the old site of Dilli. Anangapala and his successors, who reigned for about a century, converted the town into a fine walled city called Lal Kot. It had a large tank, Anangtal, many temples and the famous Iron Pillar which still stands as the memorial of that city. The Tomars were displaced by the Chauhans, and when Prithvi Raja (the last Hindu ruler of Dilli) ascended the throne in 1170, he expanded the city four times. He built fine temples, on the lines of well-developed Rajput architecture, and also a high tower. He enclosed the city with a high wall and it came to be known as Kila Rai Pathora.

The Muslim Invasion.—In 1191 came the invasion of Mohammed of Ghor (Mohammed Ghori) who, defeated on this occasion, returned two years later, overthrew the Hindus and killed Prithvi Raja. Mohammed Ghori returned to Ghor leaving Qutb-ud-Din Aibak (his general and slave) in charge. Qutb-ud-Din proclaimed himself independent in 1206 and became the first sultan of Dilli (Delhi). Although he retained the old capital he destroyed 27 Hindu temples to make a grand mosque, Kuvvat-ul-Islam

(meaning "might of Islam"). The big tower was altered and converted into the Kutb Minar. The life of Dilli centred on these buildings for the next century and the limits of the old capital sufficed for the Muslim kings.

'Ala ud-Din Khalji (1296–1316) built a new city at Siri about 3 mi. N.E. of Dilli. It was a big fortress town with a palace of 1,000 pillars and a huge tank, Hauz Khas.

Another capital was built at Tughlakabad by Ghiyas-ud-Din Tughlak in 1321 about 5 mi. S.E. of Lal Kot. The city hardly survived the death of its builder, who was succeeded by his son Mohammed ibn Tughlak (1325–51). Under him the Dilli sultanate attained its maximum growth. He built a new capital called Jahanpannah at a site between Dilli and Siri, the fourth of the seven Islamic cities of the Delhi plain. His successor, Firuz Shah Tughlak, transferred the capital in 1354 to a new town, Firuzabad, about 8 mi. N. of Dilli (Lal Kot). The new city was built on the western bank of the Jumna, 2 mi. N. of Indraprastha (the first city). It covered a large area, spreading fanwise from the palace. With the death of Firuz Shah ended the glory of the Tughlak dynasty. In Dec. 1398 Timur (*q.v.*) invaded India and captured Dilli. Enraged at a surprise attack by the Tughlaks under Mallu Khan, he ordered the massacre of 100,000 Hindu captives and the looting of the city. Regular government was not established until 1414 under a Sayyid dynasty which was ousted in 1451 by the Lodis who transferred the capital to Agra (*q.v.*). (*See* also DELHI, SULTANATE OF.)

The Mogul Period.—In 1526 Babur (*q.v.*), a descendant of Timur, invaded India, defeated and killed the king, Ibrahim Lodi, at Panipat and proclaimed himself emperor of Hindustan. Babur continued to have Agra as his capital but his son and successor, Humayun, began building a new capital at the old site of Indraprastha, which he called Dinepannah. Before the new city could be completed Humayun was defeated and expelled by the Afghan Sher Shah Sur who rebuilt the city, enclosing and fortifying it with a strong wall. Parts of this wall can be seen in Purana Kila. In 1555 Humayun recovered his kingdom but he died within six months and was succeeded by his son, the famous Akbar (*q.v.*).

During Akbar's reign and that of his son Jahangir the capital was either at Agra or at Lahore (*q.v.*). Akbar's grandson, Shah Jahan, was crowned at Agra in 1628 and between 1638 and 1658 he built a new city, about 2 mi. N. of Firuzabad, which he named Shahjahanabad. This city survives as the present city of Delhi. The royal palaces and the fort were completed first and the emperor moved to Shahjahanabad in 1648. Delhi in Shah Jahan's time, and for some years after, was the centre of the Mogul empire at the height of its glory and power. Its fame and grandeur spread far and wide and created the legend of "the Great Mogul."

Shah Jahan was deposed in 1658 by his son Aurangzeb (*q.v.*) during whose reign the empire began to decline. After the death of Aurangzeb in 1707 chaos and anarchy supervened for many years and in 1739 Nadir Shah of Persia invaded India and sacked Delhi. He departed with a vast booty including the famous Peacock throne and the Koh-i-nor diamond. Delhi was plundered again by Ahmad Shah Abdali of Afghanistan in 1757 but by then Muslim power had become very weak and the Marathas began to exert their influence. In 1771 Shah Alam, great-grandson of Aurangzeb, was raised to the throne, as the nominal head, by the Marathas who were in turn thrown out by Gen. Gerard Lake's forces in 1803. Delhi was again attacked by the Marathas in 1804 but they were defeated and the city with its surrounding area passed under British administration.

The 19th Century.—After that the city flourished steadily except for the year of the mutiny in 1857 (*see* INDIAN MUTINY). Promised that his life would be spared, Bahadur Shah II, the last of the Moguls, surrendered to Maj. William Stephen Raikes Hodson and was banished to Rangoon, Burma. Delhi remained under military authority for several months and in 1858 the British civil authorities took over the administration of the country, with their headquarters at Calcutta. Nevertheless, Delhi played an important role. It was chosen as the venue for the imperial proclamation when Queen Victoria was proclaimed empress of India on Jan. 1, 1877, and for the great durbars held in Jan. 1903 for the proclamation of King Edward VII and in Dec. 1911 for the coronation of King George V.

The latter half of the 19th century saw some of the most important developments in Delhi including the advent of railways and metaled roads connecting Delhi with other towns. Delhi became a prosperous commercial city. (*See* also INDIA-PAKISTAN, SUBCONTINENT OF: *History.*)

The Growth of New Delhi.—The transfer of the capital from Calcutta to Delhi was first announced by King George V at the Delhi coronation durbar on Dec. 12, 1911. A town planning committee was formed who chose a site 3 mi. S. of the existing city of Delhi, around Raisina hill, for the imperial capital. This was a well-drained, healthy area between the ridge and the river and provided ample room for expansion. The Raisina hill, which commanded the view of the entire area, stood 50 ft. above the plain, but the top 20 ft. were blasted off to make a level plateau for the great buildings and to fill in depressions. With this low acropolis as the focus of the city, Sir Edwin L. Lutyens laid out his plan which was as ambitious in scale as that for Washington, D.C. His central mall and his diagonal avenues may owe something to P. C. L'Enfant's plan for Washington and to Sir Christopher Wren's plan for London after the Great Fire, but the total result was quite different. The plan of New Delhi followed the garden-city pattern based on a series of large hexagons with wide avenues having double rows of trees on either side, thus creating vistas, connecting various points of interest.

The main buildings of the acropolis are the two secretariat blocks, designed by Sir Herbert Baker, and the former viceroy's palace, now Rashtrapati Bhawan (the residence of the president of the Indian republic), with its beautiful Mogul gardens, designed by Lutyens. Northeast of the acropolis, on the plain below, is a circular building with a continuous open colonnade one-half mile in diameter which contains the two houses of parliament, the council of states (*rajya sabha*) and the house of the people (*lok sabha*). These four buildings stand out most prominently and are splendid contributions combining the Roman classical architecture with Indian architectural details. Immediately to the east of the secretariat blocks is the Great place (now called Vijay Chauk), the centre of the road system, based on a diagonal pattern. The main axis leads to the ancient site of Indraprastha about two miles to the east. The northeast axis radiates from there at an angle of 60° and is focused on the Jamma Masjid, or Great mosque, in the city. The southeast axis, at an angle of 30°, leads to other ancient monuments to the south. The central vista on the main axis is a great parkway lined with canals and adorned with fountains. From the eastern portion of the central vista, there is a magnificent view of the War Memorial arch (popularly known as the India gate). A graceful marble statue of King George V, with its high canopy, stands a few yards to the east of the arch.

The original site covered about 10 sq.mi. and was planned for the residence of 70,000 persons. Now the area extends to 32.8 sq.mi. Most of the original plan and its important buildings were completed between 1920–30 and the formal inauguration took place on Feb. 8, 1931. In the 1930s the Lakshmi Narain temple (popularly known as the Birla Mandir)—a splendid temple with a well laid out garden—was built on the eastern slope of the ridge. Important additions to the city in the 1940s were the modern All India Radio building and the National stadium.

The partition of the Indian subcontinent in 1947 brought in about 500,000 refugees to Delhi and many suburban colonies were developed as rehabilitation centres. Important among them are Rajinder Nagar, Patel Nagar, Jangpura, Nizamuddin and Lajpat Nagar. Because of the considerable expansion of central government activities after independence, many buildings were constructed for office accommodation and more than a score of residential colonies were built for the government employees. In addition, many buildings of national importance, such as the National museum, supreme court, National Physical laboratory, Reserve Bank of India, Ashoka hotel, All India Institute of Medical Sciences, were constructed during the 1950s. A new Zoological

W. SUSCHITZKY

THE MOTI MASJID OR PEARL MOSQUE BEYOND THE WALLS OF THE LAL KILA OR RED FORT, BOTH BUILT UNDER SHAH JAHAN, 17TH CENTURY, OLD DELHI, INDIA

garden on the western bank of the Jumna near the site of Indraprastha was laid out in the late 1950s. Asaf Ali road and Parliament street are the two newly developed commercial localities with large modern buildings which house the increasing commercial enterprises. The main shopping centre of New Delhi is Connaught place, which forms a complete circle.

On the western bank of the Jumna near Delhi gate is the hallowed spot, Raj Ghat, where Mahatma Gandhi was cremated on Jan. 31, 1948. An impressive *samadh* was built at this site which has become a national shrine and regular place of pilgrimage. Thousands of persons, including foreign dignitaries, pay homage there to the memory of Gandhi.

The Delhi public library in Queens road was established in association with UNESCO as a model for public library development in southeast Asia. The latest development is the growth of the Diplomatic enclave or the Chanakyapuri, a colony specially planned and developed by the government of India for the offices and residential accommodation of the diplomatic missions. Specimens of modern architecture can be seen here, designed by architects of various foreign countries.

OLD BUILDINGS AND MONUMENTS

Old Delhi.—The city of Delhi occupies the northern part of the Delhi triangular plain. The greater portion of the city is still confined within Shah Jahan's walls, which were originally 6,664 yd. long, 4 yd. wide and 9 yd. high. They had 27 towers and 14 gates of which Kashmiri gate, Delhi gate, Turkman gate and Ajmiri gate still stand and the sites of the others can easily be identified. Most of the original walls have been pulled down but some portions near Kashmiri gate and Delhi gate remain intact.

The Lal Kila, or the Red fort, is one of the important buildings of the city with its 75-ft.-high massive red sandstone walls. Within the fort are palaces, gardens, military barracks and other buildings. The two most famous of these are the Diwan-i-Am and Diwan-i-Khas. The Diwan-i-Am (hall of the public audience) is a magnificent building with 60 red sandstone pillars supporting a flat roof. Its royal balcony contains some of the finest *pietra dura* works. The Diwan-i-Khas (hall of the private audience) is smaller and has a pavilion of white marble in the interior of which the art of the Moguls reached perfection in its jewellike decoration. There stood the famous Peacock throne, inlaid with sapphires, rubies, emeralds and other precious stones and pearls of different colours.

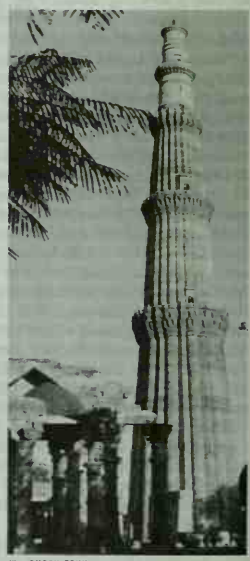
Another Mogul creation (1650) was Chandni Chauk (Silver street), once supposed to be the richest street in the world. It was 1,520 yd. long and 40 yd. wide and is still a long and imposing avenue and the principal shopping centre of Old Delhi. During the course of its history it was sacked four times. A short distance south of Chandni Chauk is the Jamma Masjid built on a rocky eminence in 1644–58 by Shah Jahan. The mosque, approached by a magnificent flight of stone steps, is paved with marble, and three domes of white marble rise from its roofs with two tall minarets at the front corners.

The other mosques in Delhi are the Kali Masjid, or the Black mosque, built about 1380 by Firuz Shah, and the Moti Masjid, or the Pearl mosque, Aurangzeb's private place of prayer.

The northern part of the city beyond Kashmiri gate was developed during the British period and is known as the civil lines. The impressive old secretariat buildings (now occupied by the Delhi administration) and the old viceregal lodge (now Delhi university) were built in 1912 to accommodate the government of India offices when New Delhi was being built.

New Delhi.—About 8 mi. S. of New Delhi, at the earliest site of Dilli, stands the Iron Pillar, unrusted despite centuries of exposure to wind and rain, with clear inscriptions. It is one of the most curious monuments in India and testifies to the metallurgical skill of the Hindus of the 4th century. Weighing about six tons, the pillar is a solid shaft of wrought iron with an ornamental top. It is 23 ft. 8 in. in length, with its diameter increasing from 12.5 in. at the top to 16.4 in. at the ground. The inscription of six lines describes the conquests of King Chandra Gupta II Vikramaditya (A.D. 375–413) and another inscription mentions the name of Raja Anangapala (1052–1109).

A few yards east of the Iron Pillar stands the famous Kutb Minar, regarded as one of the most perfect towers in the world. It is 238 ft. high with a base diameter of 47 ft. 3 in. and consists of 5 stories of red sandstone and white marble enclosing a spiral staircase of 376 steps leading to the top, which is 9 ft. in diameter. A bold projecting balcony, richly ornamented, runs round each story, and the dark bands of Arabic writing round the three lower stories contrast with the red sandstone. After much controversy over the origin of the Minar, it is now clear that it was originally a Hindu tower and a part of the temple that contained the Iron Pillar. The temple was later converted into the Kuvvat-ul-Islam mosque and the tower into the Kutb Minar. The alterations in the tower were started by Qutb-ud-Din in 1200 and completed by Iltutmish (Altamash) in 1220. It was struck by lightning in 1368 and almost entirely rebuilt by Firuz Shah who added one story. Damaged by earthquakes in 1782 and 1803, it was restored in 1829.



W. SUSCHITZKY

KUTB MINAR, BEGUN LATE 12TH CENTURY, NEW DELHI, INDIA

Among the hundreds of tombs lying to the south and the southeast of the city, the tomb of

Humayun, the second emperor of the Mogul dynasty, is the most imposing. It was built in 1565 by his widow, Haji Begum, who had shared his exile in Persia. This fine tomb in Persian style, standing in the middle of the spacious walled garden, was the first example of Mogul architecture and was a model for the Taj Mahal at Agra. In the centre stands a platform about 20 ft. high by 200 ft. square, supported by arches, and above it rises the mausoleum with a great dome of white marble. Beautiful in symmetry and proportion, this noble monument is built of rose-coloured sandstone inlaid with marble.

The Jantar Mantar (astronomical observatory) is a Rajput relic erected in 1710 by the astronomer king, Maharajah Jai Singh II of Jaipur. Built on the plan of Ulug-Beg's observatory of Samarkand and situated opposite New Delhi Municipal hall in Parliament street, it contains six stout masonry instruments devised to determine and study the location and movements of the sun, the moon and other celestial bodies.

THE UNION TERRITORY

The Union territory of Delhi consists of 300 villages and 3 towns. The district of Delhi was first constituted in 1819 in the Northwestern province of India. In 1858 it was transferred to the Punjab, but Delhi remained the divisional headquarters till 1912 when it became the capital of British India and a province with a chief commissioner under the direct control of the central government. In 1952 it was made a state and on the reorganization of the states in 1956 it was constituted a Union territory.

Administration and Population.—The territory is administered directly by parliament through the home minister, who has an advisory council. The chief executive officer is the chief commissioner. The municipal functions are covered by three local bodies: the Delhi Municipal corporation, New Delhi Municipal committee and the Delhi Cantonment board.

According to the census of 1961 the population of the Union territory has increased by 52% since 1951 when the figure was 1,744,072. This included 1,467,854 Hindus, 137,096 Sikhs and 99,501 Muslims. In the years 1950–61 literacy increased from 38.4% to 52.7%.

The people of Delhi have preserved the past in their festivals. The Hindu festivals of Dasehra and Diwali and the Muslim Id are celebrated as they were centuries ago. The latest national festivity, the Republic day celebrations on Jan. 26, is a big state event with its armed forces parade and colourful pageantry.

The University.—Delhi university, founded in 1922 as a residential university, has developed into a teaching and affiliating body with faculties of arts, science, law, medicine, education, social sciences, technology and music. There are numerous institutions affiliated to it, including the Lady Hardinge Medical College for Women, the College of Nursing, the Central Institute of Education, the Central College of Agriculture, the Delhi Polytechnic, the School of Economics, the School of Social Work, the School of International Studies and the Lady Irwin College for Women.

Industries.—The modern city of Delhi (with New Delhi) forms a large commercial and industrial centre. It is also famous for its handicrafts, particularly ivory-carving, jewelry, gold and silver-thread embroidery, metal work in brass and copper, and pottery. Two new areas have been developed for large-scale industries, the Okhla Industrial estate in the south and Najafgarh Industrial area in the west of the city. The main industries are cotton-milling, hand and power-loom weaving, flour-milling and the manufacture of hosiery, wire netting, rubber and leather goods, paints and varnishes and vegetable oil. Cottage industries have developed considerably since the partition (1947) and there are a large number of work centres mostly run and managed by refugee women.

Agriculture mainly consists of growing millets, wheat, barley, sugar cane, fruits and vegetables.

Communications.—Delhi is one of the biggest railway junctions in India and the principal interstate roads also converge on the city. The Delhi Transport service is responsible for local bus and tram services. Delhi is linked with the rest of the world by air services operated through its two airports, Safdarjang and Palam..

See also references under "Delhi, India" in the Index volume.

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DELHI, SULTANATE OF, the principal Muslim kingdom in north India from Sultan Iltutmish (1211–36) until its submergence in the Mogul empire under Akbar (1556–1605). It was made possible by the campaigns of Mohammed of Ghor and his lieutenant Qutb ud-din Aibak between 1175 and 1206 and particularly by the victories of Tara'in in 1192 and of Chandawar in 1194. The Ghorid Turk and Khalji soldiers of fortune in India did not sever their political connection with Ghor and Ghazni until Iltutmish had made his permanent capital at Delhi, had repulsed attempts by other former slaves of Mohammed of Ghor to take over the Ghorid conquests in India and, in the 1220s, had withdrawn his forces from contact with the Mongol armies which had by then conquered the area of Afghanistan. Iltutmish also grasped firmly the main urban strategic centres of the north Indian plain, from which he could keep in check the refractory Rajput chiefs. A decade (1236–46) of factional struggle was succeeded by nearly 40 years of stability under Ghiyas ud-din Balban, first as *na'ib* of the kingdom and then as sultan (1266–87), when Delhi remained on the defensive against the Mongols and undertook only holding actions against the Rajputs. Under the Khalji sultans (1290–1320), however, the Delhi sultanate became an imperial power. 'Ala ud-Din Khalji (1296–1316) conquered Gujarat (1297), the principal fortified places in Rajasthan (1301–12), and reduced to vassalage the principal Hindu kingdoms of southern India (1307–12). His forces also defeated (1297–1306) very serious Mongol onslaughts by the Chagatays of Transoxiana.

Mohammed ibn Tughlak (1325–51) attempted to settle a Muslim military, administrative and cultural elite in the Deccan with a second capital at Daulatabad (*q.v.*), but the Deccan Muslim aristocracy threw off the overlordship of Delhi and set up (1347) the Bahmani (*q.v.*) sultanate.

Firuz Shah Tughlak (1351–88) made no effort to reconquer the Deccan. The power of the Delhi sultanate in north India was shattered by the invasion in 1398–99 of the Turk Timur (*q.v.*), when Delhi itself was sacked. Under the Sayyids (1414–51) it was reduced to a country power continually contending on an equal footing with other petty Muslim and Hindu principalities. Under the Lodi Afghans (1451–1526), with the aid of large-scale immigration from Afghanistan, the Delhi sultanate partially recovered its hegemony. The Mogul Babur (*q.v.*) destroyed the Lodi sultanate at Panipat in 1526, but after 15 years of Mogul rule the Afghan Sher Shah Sur re-established the Afghan sultanate in Delhi until, in 1555, Humayun re-entered India to restake that Mogul claim to empire which his son Akbar was to make good.

The Delhi sultanate made no break with the political traditions of the later Hindu period; namely, that rulers sought paramountcy rather than sovereignty. It never reduced Hindu chiefs to unarmed impotence or established an exclusive claim to allegiance. The sultan was served by a heterogeneous elite of Turks, Afghans, Khaljis and Hindu converts; he readily accepted Hindu officials and Hindu vassals. Threatened for long periods with Mongol invasion from the northwest and hampered by indifferent communications, the Delhi sultans perforce left a large discretion to their local governors and officials.

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DELIA, an ancient quadrennial festival of the Ionians, held on Delos (hence the name) in honour of Apollo. The local title was Apollonia, which seems always to have been used for the corresponding yearly festival. After great brilliancy in early times, it declined with the political importance of Ionia, but was revived in 426 by the Athenians as part of their imperial policy.

See M. P. Nilsson, *Griechische Feste*, pp. 144 ff. (1906).

DELIAN LEAGUE, a confederacy of Greek states under the leadership of Athens, with headquarters at Delos, founded in 478–477 B.C. after the repulse of the Persians from Greece. It was dissolved in 404 when Athens at the end of the Peloponnesian War capitulated to Sparta, but it was revived in a modified form in 377 and lasted until the defeat of the Athenians and their allies by Philip II of Macedonia at Chaeronea (338).

Background.—When in 499 the Ionian Greek cities of Asia Minor revolted against Persian rule, Aristagoras, tyrant of Miletus, appealed for help to the mainland Greeks. King Cleomenes I (*see* CLEOMENES) of Sparta refused help, but at Athens, traditionally the mother-city of the Ionians, the assembly agreed to send 20 ships and the Eretrians of Euboea sent 5. After sacking Sardis, the Persian governor's capital, the Ionians were defeated at Ephesus and the Athenians withdrew. The revolt was crushed within five years. The first Persian attempt to punish Athens failed at Marathon (490), and in 480 Xerxes led the full imperial levy, including Greeks from Asia Minor, to conquer Greece. This great expedition was unexpectedly but overwhelmingly defeated at Salamis and Plataea in mainland Greece and Mycale in Asia Minor (480–479). The Spartans had commanded by land and sea, but the Athenian navy, now considerably the largest in Greece, had turned the scales. In 478 a fresh force, led by Pausanias the Spartan regent, victor of Plataea, sailed first to Cyprus to drive out Persian garrisons from the Greek cities, and then to Byzantium, which commanded one of the easiest crossings from Asia to Europe and the entrance to the Black sea. At Byzantium Pausanias became increasingly overbearing and was recalled to Sparta; the allies led by Chios, Samos and Lesbos appealed to Aristides (*q.v.*), the Athenian commander, to lead them and the Delian League was formed. The Spartans, always reluctant to commit themselves heavily overseas, accepted the situation. (For a detailed narrative of this period *see* GRECO-PERSIAN WARS.)

Organization.—The original organization of the league is sketched briefly but clearly by Thucydides (bk. 1, ch. 96). All Greeks were invited to join a confederacy to protect themselves from Persia and to retaliate for the damage done by the Persians. The Athenians were to supply the commanders-in-chief, who would also preside over meetings to discuss policy. They were to decide which states were to provide ships, and which money, and the money was to be received and controlled by Athenian treasurers, ten *hellenotamiae* ("treasurers of the Greeks"). Representatives of all member-states were to meet (probably annually) to discuss policy and every state was to have an equal vote. These meetings were to be held at Delos and there, in the temple of Apollo, the treasury was to be kept, for Delos had long been an Ionian religious centre familiar to the Athenians, the islanders and the Greeks of Asia Minor. Simple oaths of loyalty were taken by the allies to Athens and the alliance and by Athens to the allies. The autonomy of members was assumed rather than made explicit, for fear of Athenian dominance was quite alien to the mood. The original membership probably included most of the Aegean islands except Aegina, Melos and Thera, most of the cities of Chalcidice, the shores of the Hellespont and Bosporus, some of Aeolia (in northwest Asia Minor), most of Ionia and a few eastern Dorian and non-Greek Carian cities. The assessment of tribute was entrusted to Aristides who, because of his fairness, remained popular. Thucydides says that the first total was 460 talents. His figure is widely considered too high, in view of later recorded assessments, but it is not impossible.

History.—The first task of the league was to drive Pausanias from Byzantium, which he had privately reoccupied when officially discredited. Next (476) the league forces under Cimon (*q.v.*) expelled the Persian garrison from Eion at the mouth of the Strymon river (Struma) in Thrace and won over the cities of the Thracian coast. Doriscus, unsuccessfully attacked, was the only Persian garrison left in Europe; Eion was occupied by Athenian settlers, as was the island of Scyros, cleared of its non-Greek piratical inhabitants in 475. Little is heard in our meagre sources of further action against Persia in the first 10 years, but no doubt further attacks were made on isolated Persian pockets and league membership was extended more widely into Caria and the Dorian cities of Asia Minor. But there were also warnings of Athens' later imperialism. In 472 Carystus, at the southern tip of Euboea, was forced into the league; a little later when Naxos wished to secede it was reduced and "subjugated"—Thucydides quotes this as the first occasion for such treatment of an ally. But these disturbing signs were eclipsed by the spectacular victory of the Eurymedon river (*c.* 467–466). Cimon sailed at the head of a large confederate fleet along the south coast of Asia Minor, driving out Persian garrisons and bringing the coastal cities into the league. The Persians mobilized an army and navy at the mouth of the Eurymedon river (Kopru) in Pamphylia and were expecting reinforcements from Cyprus, which they had partly regained. Cimon struck fast and hard; the Persian fleet was destroyed, the camp sacked, and the reinforcements from Cyprus were also defeated. In the following years small task forces sailed east of the Chelidonian (Besaldalar) isles (west of the Eurymedon, recognized by the Peace of Callias as a boundary mark for the Persian fleet) without opposition.

The great victory of the Eurymedon could not be more fully exploited, because a quarrel developed with the north Aegean island of Thasos (465). The Athenians' desire to extend their economic power in the Strymon area clashed with Thasian mining interests. The Thasians revolted, withstood a long siege, but after two years were reduced: they had to surrender their fleet and pay tribute instead, dismantle their walls, pay an indemnity, and give up their mainland possessions. But the attempt to settle a large colony of Athenians and allies at Ennea Hodoi ("Nine Ways," later Amphipolis) on the Strymon failed disastrously; the colonists were annihilated by the Thracians.

League policy entered on a new phase shortly afterward as a result of the eclipse at Athens of Cimon and the political triumph of the radical democrats led by Ephialtes (*q.v.*). In 461 relations between Athens and Sparta broke down and the Athenians were committed to war with the Peloponnesian league (460–445). At the same time, however, they launched a large-scale eastern offensive. They had already sent a large league force to win over Cyprus (460) when they accepted the appeal of Inaros, a Libyan prince who had raised Egypt in revolt. The league fleet was diverted to Egypt and from 460–454 attempted to secure control of Cyprus, Egypt and the eastern Mediterranean. After initial successes the league force was virtually destroyed in Egypt (though it is possible that a large part of the original fleet had been withdrawn to home waters). Meanwhile the Athenians at home, with allied contingents, had been campaigning successfully against the Peloponnesians. They had reduced their old trade rival Aegina to tribute-paying subjection and had extended their control over Boeotia and central Greece. The Egyptian disaster was a severe check to Athenian expansion. Cyprus as well as Egypt was lost and the Persians could reasonably be expected to mount an offensive. The Athenians used this argument to justify their transfer of the league treasury from Delos to Athens (454); the consequences were to be important. This act probably added to the unrest already caused by defeat; there is evidence of anti-Athenian movements about this time in Miletus, Erythrae, and Colophon. Hostilities in Greece were broken off, Cimon was specially recalled from ostracism and a five years' truce was made with Sparta (451). In 450 (or perhaps 451) Cimon again led a league force into the eastern Mediterranean; but Cimon died and the fleet withdrew after limited successes in Cyprus. This withdrawal marked the end of fighting against Persia; it is almost certain that hostilities were soon formally ended by the Peace of Callias *c.* 449. By this the Persian king Artaxerxes I guaranteed autonomy to the Greek states in Asia and undertook not to send his fleet into the Aegean, nor his troops into the territory of the Greek cities.

The Peace of Callias marks a decisive turning point; a league which had during the 450s become increasingly dominated by Athenian interests now became an acknowledged empire. The allies' independence was already undermined. Only Chios, Samos and Lesbos retained their fleets; the remainder had already converted ship contributions to tribute. It is probable that with the ending of war with Persia the league council ceased to meet. The Athenians after an abortive attempt to call a conference on a

general rebuilding program decided to use the league reserves to rebuild the Athenian temples destroyed by the Persians. Athenian silver coinage, weights and measures were made compulsory throughout the empire. Tribute collection was tightened. These measures were unpopular but Athens did not compromise. Athenians were settled in cleruchies (*see* CLERUCHY) at strategic points; revolts were suppressed. In 446 when the truce with Sparta expired Boeotia regained its independence, Euboea revolted, and the revolt might have spread, but Pericles (*q.v.*) reacted vigorously. Euboea was reduced and stiff terms were imposed; the Spartans acted only half-heartedly and were content to make a thirty years' peace with Athens recognizing the Athenian right to control the allies; even Aegina had to continue paying tribute, though the Aeginetans were formally guaranteed freedom in their internal affairs. Samos revolted in 440 but after stubborn resistance was reduced and Athens entered the Peloponnesian War (*q.v.*) with the empire intact, apart from the beginnings of trouble in Chalcidice.

The war (431–404) imposed serious strains on the allies. The Athenians demanded increased tribute to finance the war, and increased military support to replace their own losses. But the allies remained more loyal than the Spartans expected. The revolt of Mytilene was crushed (428–427). There was widespread revolt in Chalcidice when the Spartan Brasidas (*q.v.*) intervened and Amphipolis was lost (424) but other areas remained secure until the defeat of the Athenians in Sicily (413). Thera and Melos were forcibly incorporated into the empire. After the Sicilian disaster revolt spread more widely but Athens was still supported by the democratic parties in most of the cities and Samos remained stubbornly loyal even after the decisive defeat at Aegospotami (405).

Political Control.—Athens' long hold over the allies is chiefly to be explained by the support of democracy. Oligarchs on the other hand were normally hostile and led the revolts of Samos, Mytilene and other states. When the Athenians suppressed revolts they normally imposed democracies and garrisons. Athenian political residents were stationed in many cities of the empire, and good use was made of local supporters, who were honoured as *proxenoi* and relied on for political intelligence.

Jurisdiction.—The evidence is difficult to interpret but it is clear that the Athenians interfered increasingly in jurisdiction and eventually made the allies bring cases involving the penalties of death, exile, loss of rights or total confiscation of property to Athenian courts. They also encouraged informers to bring cases at Athens against suspected oligarchs. In ordinary non-political cases, however, they seem not to have taken advantage of their power, but to have made procedural agreements (*symbolai*) individually with the cities according to current interstate custom.

Tribute.—The tribute was reassessed in the years of the Great Panathenaic Festival at Athens (450, 446, etc.), with certain exceptions (443, 428, 425), and adjusted according to the economic condition of the allies and the financial and political needs of Athens. So in the crisis of 446 a large number of reductions were made to conciliate the empire which were largely revoked after the Samian revolt had been crushed. More money was needed in wartime and higher assessments were imposed in 428 and in 425 when the total rose sharply to nearly 1,500 talents. In 414/413 the tribute was replaced by a 5% import and export tax but after the victory of Cyzicus (410) tribute was reimposed.

The Second League.—After the Peloponnesian War the Spartans inherited the Athenian opportunities for empire and squandered them. For political control they relied on narrowly based oligarchies in the cities and purges without trial. Their commanders were ineffectual and unpopular. Meanwhile Athenian influence revived. The fortifications of Athens were restored and powerful allies were found in Corinth, Argos and Boeotia. The Persian fleet, helped by Conon, defeated the Spartan fleet at the battle of Cnidus (394). War broke out with Sparta, but was concluded (387–386) by the Peace of Antalcidas, the terms of which were dictated by the Persian king Artaxerxes II (*see* ANTALCIDAS). In the following years the Spartans attempted to recover their supremacy and the Aegean world turned increasingly to Athens. The opportunity came when the Spartans, while campaigning in Boeotia, raided Attica in 378. The Athenians with a small nucleus of allies, Chios, Mytilene, Methymna, Rhodes, and Byzantium devised terms for a new naval league which were published in 377. They were soon joined by Thebes.

The terms of alliance were deliberately designed to show that the Athenians had learnt the lessons of the Delian league. There were to be no Athenian political residents in the cities and no garrisons. The Athenians undertook not to acquire property, publicly or privately, in any ally's territory. The allies' representatives were to meet under their own president and the agreement of both Athens and the allies, voting separately, was required before action could be taken. The autonomy of members was guaranteed and instead of tribute (*phoros*) imposed by Athens there were to be contributions (*syntaxeis*) made by the cities. The objective was by joint action to preserve the peace and prevent Spartan agression. The terms were popular and allies were quickly won. The main cities of Euboea joined at once, followed by many of the Aegean islands. A Spartan attempt in 376 to break Athens' growing naval power was defeated at the battle of Naxos. Naval demonstrations by Chabrias in the Aegean and by Timotheus in western waters led to the enrolment of many new members. By 371 at least 50 states had joined and the alliance had reached the peak of its effectiveness.

The defeat of the Spartans by the Boeotians under Epaminondas at Leuctra (371) marks the beginning of decline. There was no longer a common fear of Sparta to keep the allies together; the Thebans developed imperial ambitions and broke away; the Athenians, reacting to apathy or discontent among members, began again to interfere in jurisdiction and to use pressure to enforce the payment of contributions. New allies joined in the Peloponnese and the total swelled to 75 but many of the new allies soon lapsed. In 357 Mausolus, the satrap of Caria, stirred up an island league against the Athenians, who had to face war against Chios, Rhodes and Cos, joined later by Byzantium, Perinthus and Selymbria. The war was indecisive but expensive; in 355 peace was made and the Athenians recognized the independence of the rebels. The league continued to exist but with little effectiveness. When peace was negotiated with Philip II of Macedonia in 346 the allies' council passed a resolution, but it was ignored. Philip's crushing victory at Chaeronea (338) meant the end of the league.

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DELIBES, (CLÉMENT PHILIDOR) LÉO (1836–1891), French composer of operas and ballets who, as a follower of Adolphe Adam, reflected the spirit of the second empire and who contributed to the 20th-century vogue for the ballet. Born at Saint-Germain-du-Val (Sarthe), on Feb. 21, 1836, he studied at the Paris Conservatoire under Felix Le Couppey, François Benoist, François Bazin and Adolphe Adam, and in 1853 became accompanist at the Théâtre-Lyrique. He came before the public with a one-act operetta, *Deux Sous de charbon* or *Le Suicide de Bigorneau* (1856), described as an *"asphyxie lyrique."* This was followed by a series of amusing operettas, parodies and farces in which Delibes was associated with Offenbach and other composers. They include *L'Omelette à la Follembuche* (1859), *Les Musiciens de l'orchestre* (1861), a parody of Auber's *Muette de Portici* in which Offenbach was one of his collaborators, *Les Eaux d'Ems* (1861), written for production in Germany, and *Le Boeuf Apis* (1865), a parody of Rossini's *Mosè*. In *Malbrouk s'en va-t-en guerre* (1867) Bizet was one of his collaborators. A new sphere was opened to Delibes by his appointment in 1863 as accompanist at the Paris Opéra. Here he collaborated with Ludwig Minkus in the ballet *La Source* (1866), and was commissioned to write his successful large-scale ballets, *Coppélia* (1870), based on a story of E. T. A. Hoffmann, and *Sylvia* (1876). In the meantime he developed his gifts for opera. *Le Roi l'a dit* was produced at the Opéra Comique in 1873 and was followed by *Jean de Nivelle* (1880) and *Lakmé* (1883), his masterpiece. His last opera,

Kassya, was completed by Massenet and produced in 1893. He was appointed professor of composition at the Conservatoire in 1881 and a member of the French Institute in 1884. He died in Paris on Jan. 16, 1891.

Delibes' work falls into three categories: operettas, ballets and operas. The wit of his operettas is found also in the music of his ballets, the original orchestration of which inspired Tchaikovsky. Among his operas *Jean de Nivelle*, written following a visit to Bayreuth, was overambitious, but in *Lakmé*, known by its coloratura "Bell Song" ("Où va la jeune indoue"), he illustrated oriental scenes with music of a novel exotic character. Delibes also wrote some picturesque songs, among which "Les Filles de Cadix" suggests the style of Bizet.

See H. de Curzon, *Léo Delibes* (1926). (E. Lr.)

DELILAH (in the Douai version of the Bible, Dalila), in the Old Testament, the heroine of Samson's last love story (Judg. xvi). She was a Philistine who, bribed to entrap Samson, coaxed him (after several failures) into telling her the secret of his strength (his long hair), whereupon she took advantage of his confidence and betrayed him to his enemies. *See* Samson.

DELILLE, JACQUES (1738–1813), French *abbé* and writer, greatly venerated by his contemporaries, was born at Clermont-Ferrand on May 27, 1738. He was educated at the Collège de Lisieux in Paris, became a teacher and meanwhile acquired gradual recognition as a poet. The publication in 1769 of his translation of the *Georgics* of Virgil made him famous, and in 1774 he was elected to the Academy. Shortly afterward he became professor of Latin poetry at the Collège de France and was given a valuable benefice—the abbey of Saint-Séverin—by the comte d'Artois, later Charles X. The outbreak of the Revolution caused the loss of these posts and he retired to St. Dié to complete his translation of the *Aeneid*. Later he emigrated, first to Switzerland, then to Germany and finally to London, where he translated *Paradise Lost*.

In 1802, having returned to France, he resumed his professorship and his chair at the Academy, but lived in retirement. He died at Paris on May 1, 1813.

Delille's original poems, of which the most notable are in *Jardins* (1782), *L'Homme des champs* (1800) and *Les trois règnes de la nature* (1808), show a great love of nature and, with his translations, enjoyed an enormous popularity during their author's lifetime. His reputation, however, did not long survive his death; and posterity has accepted Sainte-Beuve's verdict that not only was Delille not a great poet, but that he was scarcely a poet at all.

See V. Z. Örs, *Jacques Delille* (1936).

DELIQUESCENCE is the property of some substances of attracting and absorbing moisture from the atmosphere. The reverse is termed efflorescence (*q.v.*).

Some compounds are capable of forming hydrates by weak chemical union with water. When moderate heat is applied, they expel water vapour into the surrounding air and are dehydrated. Under subsequent exposure to moist air at ordinary temperatures the water is reabsorbed by deliquescence.

The effectiveness of calcined calcium chloride in settling road dust is a result of its deliquescence. When spread in the form of a powder or flakes, it absorbs more than its own weight of water and forms a liquid. (G. F. S.)

DELIRIUM is a mental disturbance marked by a specific kind of confused thinking (called disorientation) in which the patient incorrectly comprehends his surroundings. A patient in the hospital may think he is at home. Because of a disturbed sense of equilibrium he may think he is aboard ship. He is drowsy, restless and fearful of imaginary disasters. He may see imaginary animals that terrify him, and may think the building is on fire. Maniacal excitement may follow.

Delirium usually results from some intoxication or other physical disorder, such as fever or heart failure or a blow on the head, that affects the brain. It often results from the abuse of sedatives, especially bromide, and can be provoked by the too abrupt discontinuance of barbiturates in addicts. Alcoholic delirium—called delirium tremens because of the characteristic tremor—is due not merely to excessive consumption of alcohol but to a complicating exhaustion, inanition and dehydration; prior to the outbreak of delirium the patient has usually been deteriorating physically owing to vomiting and restlessness.

Bewildering changes of scene facilitate the onset of delirium. When a patient is on the verge of delirium, transfer from home to hospital is therefore a threat, which can be lessened if members of his family stay with him. To be surrounded by familiar rather than strange faces and things is a protection.

Delirium usually, but not always, clears up fairly soon after the physical causes have been checked. Recovery depends not only on riddance of poisons but also on the extent of the damage they have done to the brain and on the capacity of reparative mechanisms to undo it. *See* also Psychiatry. (Mx. L.)

DELIRIUM TREMENS, a type of delirium (*q.v.*) characterized by trembling, great anxiety, mental distress, sweating and pain over the heart or stomach. It usually occurs as result of excessive use of alcohol. *See* Alcoholism: *Nature of Addiction.*

DELISLE, GUILLAUME (1675–1726), French cartographer who led the reform of map making in his own country, was born at Paris on Feb. 28, 1675. He was the son of the geographer and historian Claude Delisle (1644–1720), and brother of the astronomer Joseph Nicolas Delisle (1688–1768). As a pupil of G. D. Cassini, Delisle was able to incorporate in his maps the positions of many places accurately fixed by astronomical observations at the Paris observatory, with the resulting reformation of cartography in France. His earliest works, published in 1700, were a pair of globes, maps of the continents and a world map in hemispheres. Revised editions of these were published later in Delisle's career, and his output amounted to about 100 maps. While Delisle had little new material for the interiors of the continents, he was able to draw their outlines with much greater accuracy and to reduce the gross errors in longitude found in earlier maps. Delisle was the first to run longitudes from a prime meridian 20° W. of Paris. He was the author of treatises on mensuration and ancient geography. In 1702 he became a member of the Académie des Sciences, and in 1718 was appointed first *premier géographe du roi*. Delisle died at Paris, Jan. 25, 1726. (R. A. Sn.)

DELISLE, JOSEPH NICOLAS (1688–1768), French astronomer who proposed in 1715 the diffraction theory of the sun's corona, was born in Paris on April 4, 1688. He visited England and was received into the Royal society in 1724, and left Paris for St. Petersburg on a summons from the empress Catherine in 1725. Having founded an observatory there, he returned to Paris in 1747, was appointed geographical astronomer to the naval department and installed an observatory in the Hôtel Cluny. He died of apoplexy at Paris on Sept. 12, 1768.

Delisle is also remembered as the author of a method for observing the transits of Venus and Mercury by instants of contacts, which was first proposed by him in a letter to J. Cassini in 1743. His *Mémoires pour servir à l'histoire et au progrès de l'astronomie* (1738) gave the first method for determining the heliocentric coordinates of sunspots.

DELISLE, LÉOPOLD VICTOR (1826–1910), French bibliophile and historian whose close study of medieval history, paleography and printing, and untiring industry made him an outstanding administrator of the Bibliothèque Nationale. He was born at Valognes (Manche), Oct. 24, 1826, and studied at the École des Chartes. His early works dealt with the history of his native province; and his study (1851) of the conditions of agriculture and the agricultural labourer in Normandy in the middle ages, which condensed material from local archives, showed the nature of his gifts and became a classic. He entered the manuscript department of the Bibliothèque Impériale (later Nationale) in 1852 and became administrator in 1874. There he brought order into the arrangement of manuscripts, and was responsible for starting the general catalogue (1897) and for many important acquisitions, notably valuable manuscripts from the Ashburnham collection. He also inaugurated the holding of exhibitions. In 1857 Delisle was elected to the Académie des Inscriptions et Belles Lettres and became a member of the staff of the *Recueil des historiens de la France*, editing entirely vol. 24, a primary source for 13th-

century social history. He also worked on the *Histoire littéraire de la France*. After his retirement (1905) he prepared a descriptive catalogue of the Musée Condé at Chantilly, where he died, July 21, 1910. His numerous published works include edited collections of documents on the reigns of Innocent III (1857), Charles V (1874) and Henry II of England (1909), and on the financial transactions of the Templars (1889).

See P. Lacome, *Bibliographie des travaux de L. Delisle* (1902; suppl. 1911); R. L. Poole, "Leopold Delisle," in *Proc. Brit. Acad.* (1911–12).

DELITZSCH, FRANZ (1813–1890), German biblical scholar, one of the foremost Old Testament exegetes of the 19th century and the leading Christian student of Judaica of his day, was born at Leipzig on Feb. 23, 1813. He was educated at the University of Leipzig and began his teaching career there in 1844. After teaching at Rostock and Erlangen, he returned to Leipzig in 1867. Delitzsch was a staunch Lutheran and combined deep piety with great learning. As some of his commentaries and other works were translated, he had a great influence on Old Testament studies in England and America before the critical school arose. Of Jewish descent, he was greatly interested in furthering the conversion of Jews. To this end he translated the New Testament into Hebrew and founded an Institute for Jewish Studies at Leipzig. At first averse to the "higher criticism," he made large concessions to it in his last years. He died at Leipzig on March 4, 1890.

Delitzsch's commentaries on Genesis (Eng. trans. 1888), Psalms (Eng. trans. 1886) and Isaiah (Eng. trans. 1890) deserve special mention. Of abiding interest are his attempts to bring to life the Jewish background of New Testament times, in such writings as *Jesus und Hillel* (1867); *Handwerkerleben zur Zeit Jesu* (1868; Eng. trans. 1902); *Ein Tag in Capernaum* (1871); and *Iris* (1888; Eng. trans. 1889).

FRIEDRICH DELITZSCH (1850–1922), son of Franz Delitzsch, a great Assyriologist and teacher of most of the men who developed that science up to the time of his death, was born at Erlangen on Sept. 3, 1850, and educated at Leipzig. He taught at Leipzig, Breslau and Berlin. His grammars, chrestomathies and dictionaries of Assyrian and Sumerian were of fundamental importance. Twice in his life Delitzsch created great sensations. His lectures *Babel und Bibel* (1902–03; Eng. trans. 1903), in which he claimed heavy dependence of the Old Testament on Babylonian prototypes, caused world-wide repercussions, but also had a profound effect in furthering excavations. His *Die Grosse Täuschung* (2 vol., 1920–21) expressed a disillusionment with the Old Testament heritage in Christianity and brought him the accusation of furthering anti-Semitism. Delitzsch contributed importantly to Hebrew lexicography and biblical geography. His *Assyrische Lesestücke* (5th ed. 1912), *Assyrisches Handwörterbuch* (1896) and *Assyrische Grammatik* (1889; Eng. trans. 1889) may be mentioned. He died on Dec. 19, 1922.

For Friedrich Delitzsch's theological views *see* E. G. Kraeling, *The Old Testament Since the Reformation* (1955). (E. G. KR.)

DELITZSCH, a town of Germany which after the partition of the nation following World War II became a regional capital in the *Bezirk* (district) of Leipzig of the German Democratic Republic. It is situated on the Lobe, a tributary of the Zwickauer Mulde, 30 km. (19 mi.) N. of Leipzig and 50 km. (31 mi.) S. of Dessau. Pop. (1959 est.) 22,793. One of the largest sugar beet-raising regions of the country surrounds Delitzsch; consequently there are a number of sugar and candy factories. In addition there are a refined-steel mill, a shoe factory, railway repair shops, tobacco and chemical plants. The town grew out of a Sorbian Wendish settlement and has a 14th-century castle. Later a possession of the bishops of Merseburg and the Saxe-Merseberg family, it was incorporated with electoral Saxony in 1738 and passed to Prussia in 1815.

DELIUM, BATTLE OF. The battle of Delium in 424 B.C. ended the Athenians' attempt to conquer Boeotia during the Peloponnesian War (*q.v.*). The plan to attack Boeotia at three points miscarried, and a Boeotian army of 7,000 hoplites, 1,000 cavalry and 10,000 light-armed troops caught as many Athenian hoplites and cavalry at Delium (the modern village of Dhilesi). The Boeotian commander, Pagondas, placed a mass of Theban hoplites, 25 ranks deep, on his right wing, which, crossing a ridge and charging downhill, overwhelmed the Athenian left wing, which was in the usual formation, 8 ranks deep. Meanwhile the Athenian right wing was victorious, but Pagondas moved all his cavalry thither and took the Athenians in the flank. Victory was complete, the Athenians losing 1,000 hoplites. (N. G. L. H.)

DELIUS, FREDERICK (1862–1934), British composer, one of the most distinctive figures in the revival of English music at the end of the 19th century, was born at Bradford, Yorkshire, Jan. 29, 1862, the son of Julius Delius, a German manufacturer who had become a naturalized British subject in 1860. The younger Delius was educated at Bradford grammar school and the International college, Isleworth, London. After a period as a traveler for his father's firm, he went in 1884 to Florida as an orange planter, but devoted his spare time to musical study with a friend, Thomas Ward, an organist. In 1886 he left Florida for Leipzig and there underwent a more or less regular training from Salomon Jadassohn and became a friend of Edvard Grieg. Two years later he went to live in Paris and after his marriage in 1901 to the painter Delka Rosen he made his home at Grez-sur-Loing (Seine-et-Marne). Some songs, an orchestral suite (*Florida*) and an opera (*Irmelin*) were all written before he had a work published, the first published work being *Legend* for violin and orchestra (1893). These were followed by more ambitious works which aroused considerable interest, especially in Germany, during the first decade of the 20th century. Three of his six operas (*Koanga*, 1895–97; *A Village Romeo and Juliet*, 1900–01; and *Fennimore and Gerda*, 1908–10) and several of his larger choral and orchestral works (*Appalachia*, 1902; *Sea Drift*, 1903; *Paris: the Song of a Great City*, 1899) were first heard in Germany. Later his reputation spread to England, mainly through the persuasive advocacy of Sir Thomas Beecham, who was his finest interpreter.

Even after he was stricken blind and paralyzed in his early 60s, Delius continued to compose, working with an amanuensis, Eric Fenby. His other major works included *A Mass of Life* (1904–05) and a *Requiem* (1914–16), both to texts by Nietzsche; *Brigg Fair* (1907) for orchestra; four concertos for various instruments; three sonatas for violin and piano; and many smaller orchestral pieces and songs. He was created a Companion of Honour in 1929. He died at Grez-sur-Loing on June 10, 1934.

In distinction and originality of idiom Delius' music can hold its own with that of his contemporary Elgar, and for a time he was considered by many to be a composer of equal stature. But his expressive range was more limited and his invention less vigorous than Elgar's. His miniatures, such as the haunting orchestral tone poem *On Hearing the First Cuckoo in Spring* (1912), are the works that have held their place best.

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DELLA CRUSCANS, THE, a group of insignificant English versifiers led by R. Merry, who was actually a member of the Florentine academy *della Crusca*—hence the name, and Hannah Cowley (1743–1809; wrote as Anna Matilda). Their first production was a *Florentine Miscellany* (1785) to which Mrs. Piozzi (*q.v.*) contributed. Returning to England in 1787, Merry began to publish verses in *The World*, and the collected poems of the group appeared in *The British Album* (1789, four editions). In 1794 William Gifford (*q.v.*) fell upon them in *The Baviad*, giving quotations which amply justify the severity of his satire. He renewed the attacks in *The Maeviad* (1795) and there are references to the Della Cruscans in T. J. Mathias' *Pursuits of Literature* (1794–97). The Della Cruscan manner came merely to stand for a particular kind of fantastic and insipid verse.

DELLA ROBBIA: *see* ROBBIA, DELLA.

DELLO JOIO, NORMAN (1913–), U.S. composer, one of the most successful exponents of neoclassicism in the United States, was born in New York city on Jan. 24, 1913. A member of a musical Italo-American family, he studied organ with his father and with Pietro Yon, and composition with Bernard Wage-

naar and Paul Hindemith. He developed a technique of practical modernism; his works are often played in the U.S. They include two operas on the life of Joan of Arc, *The Triumph of Saint Joan* (1950) and *The Trial at Rouen* (1956); an opera on an American historical subject, *Blood Moon* (1961); *Ricercari* for piano and orchestra (1946); *Three Symphonic Dances* (1947); sextet for three recorders and string trio (1943); several ballets, sacred and secular choruses, various chamber works, three piano sonatas, and songs. In 1957 he received the Pulitzer prize in music for *Meditation on Ecclesiastes* for string orchestra. (N. Sv.)

DELMARVA PENINSULA, a part of the Atlantic coastal plain of the United States, bordered on the west by Chesapeake bay, on the east by Delaware bay and the Atlantic ocean. It derives its name from the three states (Delaware, Maryland, Virginia) among which its area is divided. The peninsula is a lowland 176 mi. long and up to 70 mi. wide. Its smooth ocean coast line is dotted with beach resorts; on its deeply indented Chesapeake bay shore lie several small fishing ports. Rural industries include poultry farming, livestock raising and vegetable farming. The commercial centre of the peninsula is Salisbury, Md. (F. O. A.)

DELMEDIGO, a Cretan Jewish family prominent during the Renaissance. Its most important members are:

Elijah Delmedigo (*c.* 1460–1497), philosopher, who was born and died in Candia (modern Iraklion), Crete, taught in several Italian centres of learning (Pico della Mirandola was one of his pupils). He translated some of Averroes' commentaries into Latin and wrote a Latin commentary on Aristotle's *Physics*. His principal work, *Behinat ha-Dat* ("Investigation of Religion"), departs from the scholastic identification of religion and philosophy. He strongly criticized the Cabala.

Joseph Solomon Delmedigo (1591–1655), a great-grandson of Elijah Delmedigo and a pupil of Galileo, wrote many books on science and philosophy. In his *Masref le-Hokhmah* he defends the Cabala against Elijah Delmedigo's strictures, but his attitude toward both mysticism and philosophy wavers considerably. Born in Candia, he traveled extensively in Europe, practising medicine in several cities. He died in Prague.

DELMENHORST, a town of Germany which after partition of the nation following World War II was included in the *Land* (state) of Lower Saxony, Federal Republic of Germany. It is situated on the Delme about 5 km. (3 mi.) from its confluence with the Ochtum, a tributary of the Weser, and 15 km. (9 mi.) W. of Bremen by road. Pop. (1959 est.) 55,238. Delmenhorst is an industrial town but has wide streets and the feeling of a garden city. The parish church has burial vaults of the dukes of Oldenburg. Fitger house was the birthplace of the painter-poet Arthur Fitger in 1840. Wool, jute, linoleum, cork products, metalwork, food, luxury goods, clothing and chemical articles are produced. Delmenhorst was first mentioned about 1260. A branch of the family of the dukes of Oldenburg lived there in a massive moated castle, in the shadow of which the town developed. It reached civic status in 1371. In World War II Delmenhorst was captured by the Allies in April 1945.

DELONEY, THOMAS (1563?–1600), English writer of ballads, pamphlets and prose stories which form the earliest English popular fiction. By trade a silk weaver, probably of Norwich, Deloney wrote topical ballads and, through his pamphlets, took part in religious controversy. For alleged sedition he was proscribed in London and, as an itinerant weaver and ballad seller, collected material in the provinces for his prose stories. His "many pleasant songs and pretty poems to new notes" appeared as *The Garland of Good Will* (1593). *Strange Histories of Kings, Princes, Dukes, Earls, Lords, Ladies, Knights, and Gentlemen*, in verse, and a long poem, *Canaan's Calamity*, are undated. His *Jack of Newbury* (1597), *The Gentle Craft*, parts i and ii (1597–*c.* 1598) and *Thomas of Reading* (1599?) furnished plots for such dramatists as Thomas Dekker. Deloney died in March 1600.

Though widely read, Deloney was condemned by the university-educated writers as a mere ballad maker and purveyor of plebeian romance, and his literary merits went unrecognized until the 20th century. There is poetry as well as patriotism in his ballads, and while in his fiction he glorifies common life and the English artisan, he portrays people with humour and some irony, achieving both simple comedy and simple tragedy. Long Meg of Westminster, in *The Gentle Craft*, is especially lifelike and entertaining: Deloney excels at reproducing women's artless conversation. His power as a narrator is shown in the horror of the cold-blooded murder of Thomas of Reading (typically he relieves the tension with a report of wry gossip on the event). Although the structure in each book is episodic, coherence, with climax, can be found; and on this rests his claim to the invention of the English popular novel.

See the *Works of Thomas Deloney*, ed. by F. O. Mann (1912); A. Chevalley, *Thomas Deloney. Le roman des métiers au temps de Shakespeare* (1926); R. G. Howarth, *Two Elizabethan Writers of Fiction: Thomas Nashe and Thomas Deloney* (1956). (R. G. Hh.)

DE LONG, GEORGE WASHINGTON (1844–1881), U.S. explorer whose disastrous arctic expedition confirmed the theory of transarctic drift, was born in New York city on Aug. 22, 1844. He graduated from the U.S. Naval academy in 1865 and entered the U.S. navy, attaining the rank of lieutenant in 1869, and lieutenant commander in 1879. In 1873 he sailed in the "Juniata" from Upernavik, Greenland, to search for and relieve the American arctic expedition in the "Polaris." In 1879 he again set out for the arctic in the "Jeannette," but the ship was caught in the polar ice pack on Sept. 5, 1879, and drifted until it was finally crushed on June 13, 1881. About 14 members of the expedition survived, one of whom was De Long. He succeeded in reaching the mouth of the Lena river in one of the boats, only to die of starvation at the end of October or the beginning of November of 1881. His journal, in which he made regular entries until the day of his death, was edited by his wife and published in 1883 under the title of *Voyage of the "Jeannette."* Three years after the ship was sunk, several articles belonging to the crew of the "Jeannette" were found on an ice floe on the southwest coast of Greenland. This discovery gave new support to the theory of a continuous ocean current passing along the then unknown polar regions.

DELORME (de l'Orme), **PHILIBERT** (*c.* 1510–1570), French architect, one of the great masters of the Renaissance, was born at Lyons, the son of the master mason Jehan Delorme. From about 1533 to 1536 he lived in Rome, where he made excavations, was a member of the Académie Vitruvienne and was employed by Pope Paul III. In 1536 he built a mansion at Lyons for the finance minister of Brittany, who appointed him controller of fortifications for the province in 1540, and during 1541–47 he built the château of St. Maur near Paris for Cardinal Jean du Bellay, whom he had known at Rome. In 1545 he became architect to the dauphin, who succeeded as Henry II in 1547 and appointed him overseer of buildings in 1548 and abbé of Ivry in 1549. His chief works for the king were the tomb of Francis I at St. Denis (1547); the royal arsenal (1547–50); the royal stables (1554); the chapel at Vincennes (1548–56); additions to the palace of Fontainebleau (1548–58); the chapel in the park of Villers-Cotterets (1555); and the new château at St. Germain-en-Laye (1556). For Diane de Poitiers he built the magnificent château at Anet (1547–56) and part of Chenonceaux (1556–59). He fell from royal favour after the death of the king (1559) but was called by Catherine de Medici in 1564 to build for her the Tuileries. He was also responsible for work at Notre Dame, of which he was a canon. He died in Paris, Jan. 8, 1570.

A man of independent mind and vigorous originality, and an ardent humanist and student of antiquity, Delorme successfully grafted the spirit of Renaissance new learning onto the classic French tradition. The theory behind his practice is expounded in two books written during his retirement from court, *Nouvelles inventions* (1561) and *Architecture* (1567, revised in 1568).

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DELOS (mod. Gr. Dhilos, sometimes distinguished as Little

Delos [Mikra Dhilos] as opposed to Great Delos [Megali Dhilos], the uninhabited adjacent island now called Rinia), a Greek island in the Aegean, is the smallest but most famous of the Cyclades and, according to ancient belief, the island round which the group arranged itself in a nearly circular form. It is a rugged mass of granite, about 3 mi. long and ½ to 1 mi. broad, about ½ mi. E. of Rinia and 2 mi. W. of Mikonos. Toward the centre it rises to a height of 350 ft. in the steep and rocky peak of Mt. Cynthus, which, though overtopped by several eminences in the neighbouring islands, is very conspicuous from the surrounding sea. A museum was built to contain the antiquities found in the excavations on the island; otherwise Delos is largely uninhabited.

Archaeology.—Excavations were made by the French school at Athens slowly but systematically from 1873. The sacred precinct of Apollo was recovered, as well as the commercial quarter of Hellenistic and Roman times, the theatre, the temples of the foreign gods, the temples on the top of Mt. Cynthus and interesting private houses. Sculpture of all periods was found, and extensive series of inscriptions throwing light upon temple administration.

The ancient mole faces the channel between Delos and Rinia. The precinct is approached by an avenue flanked by porticoes, that upon the seaside bearing the name of Philip V of Macedonia, who dedicated it about 200 B.C. This was the usual approach for sacred embassies and processions; but Nicias of Athens, on the occasion of his embassy, built a bridge from a reef known as the island of Hecate to Delos, that the Athenian procession might not miss its full effect. Facing the avenue were the propylaea, the chief entrance, with a projecting portico of four columns. The sacred road continued across an open space, with the precinct of Artemis on its west side and, on its east side, a terrace on which stood three temples. The southernmost of these was the temple of Apollo, but only its back was visible from the west. The other two faced west and were either dedicated to heroes or minor deities or were treasuries. Beyond them the road sweeps round to the front of the temple of Apollo. The outer side of this curve is hounded by a row of treasuries, similar to those at Delphi and Olympia, to house the offerings of various islands or cities. The temple of Apollo could also be approached directly from the entrance, through a passage with a porch at either end. Just to the north of this is the basis of the colossal Apollo dedicated by the Naxians, with its well-known Archaic inscription and two large fragments of the statue itself.

The temple of Apollo, the centre of the whole precinct, was of Doric style, begun in the mid-5th century B.C. but not finished until the 3rd. Its sculptural decoration was scanty. The metopes were plain. The acroteria were taken to the national museum at Athens. At the one end was Boreas carrying off Oreithyia, at the other Eos and Cephalus, the centre in each case being occupied by the winged figure. To the east of the temple was an oblong prytaneum or other official building with a colonnade on each side. Beyond it is the most interesting and characteristic of all the monuments of Delos, a long narrow hall, entered by a portico at its south end. At the north end was the famous altar, built out of the horns of the victims, which was sometimes reckoned among the seven wonders of the world. The rest of the room is taken up by a paved space surrounded by a narrow gangway; and on this it is supposed that the *geranos*, or stork dance, took place. The most remarkable architectural feature of the building is the partition that separated the altar from this long gallery. This is distyle in antis, with capitals of a very peculiar form, consisting of the fore parts of bulls set back to back. From these the whole building is sometimes called the sanctuary of the bulls. Beyond it, on the east, was a sacred wood filling the space up to the wall of the precinct, and at the south end of this was a small open space with the altar of Zeus Polieus.

At the north of the precinct was a broad road, flanked with votive offerings and exedrae, and along the boundary were porticoes, reception chambers and two entrances through broad propylaea. At the northwest corner is a building of limestone, often mentioned in the inventories of treasures. South of it is the precinct of Artemis, containing within it the old temple of the goddess. Her more recent temple was to the south, opening into the precinct of Apollo. The older temple is mentioned in some of the inventories as "the temple in which were the seven statues"; and close beside it was found a series of Archaic draped female statues, the most important of its kind until the discovery of the finer and better preserved set from the Athenian acropolis. Outside the precinct of Apollo, on the south, was an open place; between this and the precinct was a house for the priests, and within it, in a kind of court, a set of small structures identified as the tombs of the Hyperborean maidens. To the east was the temple of Dionysus, of peculiar plan. On the other side of it was a large court, forming a commercial exchange, with a temple to Aphrodite and Hermes.

To the north, between the precinct and the sacred lake, are extensive ruins of the commercial town including a sort of club or exchange and the new and the old palaestra. The shore of the channel facing Rinia is lined with docks and warehouses, and behind them are private houses of the 2nd or 3rd century B.C. Each consists of a single court surrounded by columns and often paved with mosaic; various chambers open out of the court, including usually one of large proportions, the andron or dining room for guests. The theatre, set in the lower slope of Mt. Cynthus, has the wings of the auditorium supported by massive substructures. The skene consisted of an oblong building of two stories surrounded by a low portico reaching to the level of the first floor. This was supported by pillars, set closer together along the front than at the sides and back. An inscription showed that this portico, or at least the front portion of it, was called the proscenium or logeion, two terms the identity of which was previously disputed. On the summit of Mt. Cynthus, above the primitive cave-temple which has always been visible, is a small precinct dedicated to Zeus and Athena. Some way down the slope of the hill, between the cave-temple and the ravine of the Inopus, is a terrace with the temples of the foreign gods Isis and Sarapis, and a small odeum. Between the theatre and the harbour is the main excavated area of houses, many with fine mosaics. Near the northern tip of the island are the gymnasium, the stadium and an early synagogue. (*See* GREEK ART for works of art found on Delos.)

History.—Of the various traditions that were current among the ancient Greeks regarding the origin of Delos, the most popular describes it as drifting through the Aegean till moored by Zeus for the wandering Leto as a birthplace for Apollo and Artemis. Excavations have shown that the island was occupied in the Mycenaean period, possibly by "Carians." It first appears in history as the seat of a great Ionic festival to which the various Ionic states, including Athens, were accustomed annually to dispatch a sacred embassy, at the anniversary of the birth of Apollo on the 7th of Thargelion (about May). In the 6th century B.C. the influence of the Delian Apollo was at its height; Polycrates of Samos dedicated the island of Rinia to his service and Pisistratus of Athens caused all the area within sight of the temple to be cleared of the tombs by which its sanctity was impaired. After the Persian Wars the predominance of Athens led to the transformation of the Delian league into the Athenian empire. (*See* DELIAN LEAGUE.) In 426 B.C., in connection with a reorganization of the festival, which henceforth was celebrated in the third year of every Olympiad, the Athenians instituted a more elaborate lustration, caused every tomb to be removed from the island and established a law that ever after anyone who was about to die or to give birth to a child should be at once conveyed from its shores. Even this was not accounted sufficient, for in 422 they expelled all the secular inhabitants, who were, however, permitted to return in the following year.

At the close of the Peloponnesian War (*q.v.*) the Spartans gave to the people of Delos the management of their own affairs, but the Athenian predominance was soon after restored and survived an appeal to the amphictyony (*q.v.*) of Delphi in 345 B.C. During Macedonian times, from 322 to 166 B.C., Delos again became independent, and the temple and its possessions were administered by officials called *hieropoioi*. After 166 B.C. the Romans restored the control of Delian worship to Athens, but granted to the island various commercial privileges which brought it great prosperity. In 87 B.C. Menophanes, the general of Mithradates VI of Pontus

(*see* MITHRADATES), sacked the island, which had remained faithful to Rome. From this blow it never recovered. The Athenian control was resumed in 42 B.C., but Pausanias mentions Delos as deserted except for a few Athenian officials and several epigrams of the 1st or 2nd century A.D. attest the same fact, though the temple and worship were probably kept up until the official extinction of the ancient religion. *See* also references under "Delos" in the Index volume.

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(J. Bo.)

DELPHI, a place in ancient Greece in the territory of Phocis (near the modern village of the same name in the *nomos* of Phthiotis and Phocis), famous as the seat of the most important temple and oracle of Apollo (*see* ORACLE). It lies on the steep lower slope of Mt. Parnassus with the *Phaedriades* or "shining rocks" rising high above. From a cleft between these rocks, near the sanctuary, flows the Castalian spring. The site resembles a theatre, looking out southward across the valley of the Plistus river to Mt. Cirphis The Gulf of Corinth, 6 mi. away, is not visible from the sanctuary.

Delphi was considered by the Greeks to be the centre of the earth. The story was told of how Zeus released two eagles, one from the east, the other from the west and caused them to fly toward the centre. They met at Delphi, and the spot was marked by a stone in the temple known as the *omphalos* ("navel").

According to legend the Delphians originally lived on the plateau above the cliffs at a place called Lycorea near the Corycian cave and later moved down to Delphi, then called Pytho. The oracle originally belonged to the Earth Goddess and was guarded by a serpent, Python. It was later taken over by Apollo, who slew the Python.

Excavations have shown that Delphi has been continuously inhabited since the 14th century B.C., that is, from Late Mycenaean times, but remains of this and subsequent periods are scanty. The history of Delphi really begins in the 6th century B.C. The Sacred War of about 590 B.C. destroyed the nearby town of Crisa, which had been taxing pilgrims, and opened free access to Delphi (*see* AMPHICTYONY). Delphi joined the Amphictyonic league and soon became one of its chief centres. The Pythian games were reorganized in 582 B.C. and raised to Panhellenic status, being celebrated every four years, in the middle of each Olympiad (the four-year period between Olympic festivals). The prestige of the oracle was now at its height. It was consulted not only on private matters but on affairs of state, and its utterances often swayed national policy. It was also consulted whenever a colony was to be sent out, and so its fame spread to the limits of the Greek world. Between 356 and 346 B.C. the Phocians forcibly occupied Delphi, appropriated the temple treasure, and melted down many valuable offerings. They were driven out only when Philip II of Macedonia joined the coalition against them. This was Philip's first appearance on the Greek scene which he was soon to dominate. In early Roman times Delphi was frequently pillaged; Nero is said to have removed 500 statues.

With the triumph of Christianity the old pagan sanctuary fell into decay. Constantine the Great removed the tripod support of intertwined serpents dedicated by the Greek cities after the battle of Plataea (479 B.C.); this still exists in the Hippodrome in Constantinople. Julian the apostate (emperor A.D. 361–363) afterward sent his quaestor, the doctor Oribasius, to restore the temple, but the oracle responded to the emperor's enthusiasm with nothing but a wail over the glory that had departed.

The site of Delphi was occupied by the modern village of Castri until 1890, when the village was moved to a site nearby and renamed Delphi. Systematic excavation by the French school of archaeology began in 1892. The plan of the precinct is now easily traced, and with the help of Pausanias' travel-book of the 2nd century A.D. many of the buildings have been identified.

The sanctuary was a large, roughly rectangular area enclosed by a wall. The sacred way, lined with monuments and treasuries, wound up through it to the temple. The monuments were offerings to Apollo erected by states or individuals in thanks for favours bestowed by the god. Some celebrated victories of Greeks over barbarians: the trophies of Marathon were displayed beside the Athenian treasury; the cables of Xerxes' bridge over the Hellespont were hung on the great polygonal wall, protected by a *stoa* (colonnade). Other monuments celebrated victories of Greeks over Greeks: the Spartans over the Athenians at Aegospotami (405 B.C.); the Arcadians over the Spartans (369 B.C.).

TONI SCHNEIDERS

ANCIENT THEATRE AND TEMPLE OF APOLLO IN THE SACRED PRECINCT OF DELPHI. TO THE RIGHT IS THE VALLEY OF THE PLEISTUS

Treasuries, small temple-like buildings, were erected by many Greek states. The treasury of Siphnos, built about 525 B.C., was a richly decorated Ionic building with caryatids instead of columns and with a beautiful sculptured frieze most of which is preserved. The Athenian treasury is Doric and has been rebuilt with the original blocks. It has sculptured metopes depicting the adventures of Theseus and Heracles. The famous inscriptions with hymns to Apollo accompanied by musical notation are on the wall of this building.

At the heart of the sanctuary is the great temple of Apollo; its altar, given by the people of Chios, stands in front. The existing temple dates from the 4th century B.C. Only the foundations and some steps are preserved; a few columns have been re-erected. The temple had 6 columns across the ends and 15 along the sides. The oracle was in a chamber at the rear but the existing remains reveal nothing about its interior arrangement or working. Two earlier temples are known from actual remains. Of the first, about 600 B.C., some archaic capitals and wall blocks are preserved. This temple was burned in 548 B.C. The second temple was begun in limestone and finished in marble at the end of the 6th century by the Alcmaeonidae (*q.v.*) exiled from Athens. Pediment sculptures and many blocks of this temple are preserved. It was destroyed by an earthquake in 373 B.C. Above the temple is the theatre, and higher still is the stadium. The gymnasium lies below the Castalian spring to the east, and beyond it is the sanctuary of Athena Pronaia with two temples, two treasuries and the *tholos*, a remarkable round building of unknown purpose.

See also references under "Delphi" in the Index volume.

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the Greek States, iv, pp. 179–218 (1907); H. W. Parke and D. E. W. Wormell, *The Delphic Oracle* (1956); J. E. Fontenrose, *Python, a Study of Delphic Myth and its Origins* (1959). (E. Gr.; E. V.)

DELPHINIA, a festival of the Delphic Apollo (Delphinius) held annually on the 6th (or 7th) of the month Mounichion (April) at Athens. All that is known of the ceremonies is that a number of girls proceeded to Apollo's temple (the Delphinium) carrying suppliants' branches and seeking to propitiate him, probably as a god having influence on the sea. It was at this time of the year that navigation began again after the storms of winter. According to a story in Plutarch, the festival was instituted by Theseus to commemorate his voyage to Crete.

See L. Deubner, *Attische Feste*, p. 202 (1956). (H. W. Pa.)

DELPHINIUM: *see* Larkspur.

DELPHINUS, a small constellation appearing in the northern hemisphere not far from Altair, the brightest star of the constellation Aquila. As its name signifies, it was supposed by the ancients to represent a dolphin. γ Delphini is a double star, the yellowish component being of magnitude 4, and the bluish component of the 5th magnitude (*see* Constellation).

DELTA, the land form produced by deposition of alluvium where a stream enters a body of quiet water, the decrease in velocity causing the stream to drop its load of sediment. The name is derived from the shape; many deltas resemble the Greek (Δ) letter of that name. Most deltas are very flat, the highest points being less than 50 ft. above sea level. On many deltas because of extreme flatness the river develops several discharge channels called distributaries; commonly some of the distributaries are used only during flood periods.

The detailed form of a delta is determined partly by the character of the river and partly by conditions in the body of water into which the river discharges. In deltas where active deposition is occurring at the mouth of several distributaries, lobes are formed at each of the distributary mouths; the lobes and the main delta mass look on a map or aerial photograph like a bird's foot, and are called "bird's foot deltas." Where wave erosion is active the areas between the lobes develop a cuspate form. Rounded deltas develop where the delta edge is being continuously modified by waves and currents. Where marine erosion is extremely active no delta develops.

The Mississippi delta is the largest in the world. *See* also River and River Engineering. (W. C. C.)

DELTA AMACURO, federal territory in northeast Venezuela, area 15,521 sq.mi., pop. (1961) 33,979. It consists of the swampy Orinoco river (*q.v.*) delta. The American steel companies operating at El Pao and Cerro Bolívar transport iron ore to the Atlantic via the Río Grande del Orinoco and the Boca Grande, two of the Orinoco's distributaries, which are dredged and made usable 24 hr. a day for vessels drawing 30 ft. of water. The climate is hot and rain falls throughout the year. Several forest products are collected, including gum, balata, divi-divi and mangrove bark. A little farming is carried on: bananas, corn, rice, coconuts and sugar cane are produced. Native Indians ply the various distributaries, subsisting mainly on fish. The territorial capital is Tucupita (pop. 8,172). (L. We.)

DELTA RAYS, the name originally given by J. J. Thomson to a stream of slowly moving electrons emitted when alpha particles (*see* Radioactivity) impinge on matter.

DELUC, JEAN ANDRÉ (1727–1817), Swiss geologist, meteorologist and physicist especially remembered for his invention of the dry pile (a type of voltaic pile), was born on Feb. 8, 1727, at Geneva. For the first 46 years of his life he was engaged in local commerce and politics and in making scientific excursions among the Alps. In 1773, however, he settled in England, was made a fellow of the Royal society and appointed reader to Queen Charlotte; and this gave him means and leisure to pursue his scientific interests.

Deluc's principal geological work, *Lettres physiques et morales sur les montagnes et sur l'histoire de la terre et de l'homme* (1778; 6 vol., 1779), explained the six days of the Biblical account of creation as so many epochs preceding the actual state of the globe. In physics, Deluc discovered that water was more dense at about 40° F. (4° C.) than at higher and lower temperatures and that heat was required in the melting of ice—an observation on which Joseph Black founded, at about the same time (1761), his concept of latent heat. Deluc was also the originator of the theory, readvanced in 1801 by John Dalton and subsequently known under the latter's name, that the quantity of water vapour which any space can contain is independent of the presence of any other gas in the space. He invented a new hygrometer (though this was not of lasting importance) and advanced the first correct and most important rules for measuring height by means of the barometer, *i.e.*, that the logarithm of the pressure decreases proportionately with increase of height and with the inverse of the temperature of the air (see *Philosophical Transactions of the Royal Society*, p. 158, 1771).

Deluc's invention of the dry pile is a device consisting of a series of parallel plates, alternately of different material, between the ends of which there is developed a difference of voltage. The nature of the action of this pile was the subject of much controversy, but the pile itself was widely used in early electrical experiments by physicists and has been regarded as his chief discovery. Deluc died at Windsor, Eng., on Nov. 7, 1817.

Among Deluc's works are: *Recherches sur les modifications de l'atmosphère*, 2 vol. (1772), which contains accounts of many physical experiments; and *Traité élémentaire de géologie* (1810; Eng. trans. by H. de La Fite, *An Elementary Treatise on Geology*, 1809).

See also the *Philosophical Transactions of the Royal Society* and the *Philosophical Magazine* for papers by him. (P. A. Sh.)

DELUGE is the name given to a great flood of water submerging the whole or a large part of the earth's surface, legends of which occur in the traditions of many peoples. *See* Deucalion; Flood (in Religion and Myth); Genesis; Gilgamesh, Epic of.

DELUSION, a false belief that is not susceptible to correction by reason or logic. Paranoia and the paranoid states are characterized by fixed delusional systems. *See* Paranoid Reactions; Psychoses: *Symptoms of Psychosis;* Schizophrenia.

DEMADES (*c.* 380–318 B.C.), Athenian orator and diplomat. From humble beginnings he rose to a leading place in Athenian politics by his vigorous oratory and his shrewd understanding of the people's mood. He opposed the attempt of Demosthenes to arouse the Athenians in support of Olynthus against Philip II of Macedonia, and called the theoric fund, which Demosthenes hoped to use for war, "the glue which binds the democracy." He fought against the Macedonians at Chaeronea and was taken prisoner. On his release he helped to negotiate peace between Macedonia and Athens. He continued to be in the favour of Philip's successor Alexander the Great, and having been prompted by a bribe, saved Demosthenes and the other anti-Macedonian Athenian orators from his vengeance. It was also chiefly owing to him that Alexander, after the destruction of Thebes, treated Athens so leniently. In 324 he proposed divine honours for Alexander, but during the winter of 324–323 was found guilty of accepting bribes against Alexander from Harpalus; he was heavily fined and lost his citizenship. He remained in disfavour after Alexander's death, but was reinstated (322) to negotiate with Antipater after the Lamian War (323–322). Before setting out he persuaded the citizens to pass sentence of death upon Demosthenes and his followers, who had fled from Athens. The result of his embassy was the conclusion of a peace greatly to the disadvantage of the Athenians. In 319 he was again sent to the court of Antipater. Either Antipater or his son Cassander, learning that he had intrigued with Perdiccas, put him to death. None of Demades' speeches survive. (R. Me.)

DEMAND refers to the volume of consumer purchases that can be expected for a given commodity at each of a series of alternative prices. If the price of a commodity increases, individual consumers generally cannot continue to buy it in undiminished quantities without cutting into their expenditures for other goods so deeply as to sacrifice some of their relatively important uses. They will prefer to give up some relatively unimportant uses of the commodity which has increased in price and will therefore reduce their purchases of it. Given this proposition, it is possible

to draw up a so-called "demand schedule" relating, for any given commodity, a specific volume of sales to each price. Lower prices will be associated with higher sales, higher prices with lower sales. A graphical representation of this relationship would yield a "demand curve."

The demand schedule or curve clears up an ambiguity in the usage of the term "demand." The proposition that "a fall in price will increase demand" clearly refers to a given demand schedule. The higher demand corresponds to the increased sales which arise when the price is reduced. However, the proposition that "an increased demand will raise the price" is of a different nature. It does not relate to a single demand schedule and it is not possible here to substitute "sales" directly for "demand." Rather the increased demand must refer to an upward shift in the demand curve as a whole. It then follows that a greater volume of sales than before is associated with each price; and a higher price than before corresponds to each volume of sales. It is in this sense that an increased demand raises price.

Such a shift in the demand curve may be due to, *e.g.*, an increase in personal incomes, when consumers may feel they can afford greater quantities of a given commodity at any one price. Alternatively, a change in their tastes may cause them to purchase more of a given commodity in preference to another at any given set of prices. Or, an increase in the prices of other commodities may induce consumers to shift their purchases to a certain product. A given demand schedule must imply, therefore, that prices of other goods, tastes and incomes remain unchanged. If they vary, a new demand schedule will have to be drawn up after every change.

On any given demand curve, the extent to which a change of price affects the quantity of a commodity which can be sold is called the "price elasticity" of demand. The ratio of the proportionate change in potential sales volume to the proportionate change in price is called the coefficient of elasticity. In general, the demand for necessities—for goods for which there are no substitutes (salt) and for goods the use of which creates a habit (tobacco)—is relatively inelastic. A rise in price is not likely to reduce by much the quantity demanded and the coefficient of elasticity must therefore be small.

Similar coefficients can be worked out for shifts in the demand curve due to changes in incomes or in the prices of other goods. The ratio of the proportionate change in the quantity demanded to a proportionate change in income is called the "income elasticity" of demand, and the ratio of the proportionate change in the quantity demanded of one good to a proportionate change in the price of another, the "cross elasticity" of demand between them.

These propositions refer in the first instance to the behaviour of individuals only. It is often assumed that aggregate demand curves are simply the sum of the demand curves of individual consumers. This is true only as long as the consumption behaviour of one individual is not affected by the consumption of others. It may be, however, that as prices fall and consumption rises for some, others will find their tastes change against the commodity. Alternatively, as prices rise and consumption falls, "conformists" may shy away from the commodity. Such snowballing effects on the tastes of consumers make the derivation of aggregate demand curves difficult. *See* also Economics; Price; Supply and Demand. (H. O. Sc.)

DEMAND LOAN: *see* Call Money.

DEMANTOID, green gem variety of andradite. *See* Garnet.

DEMARATUS (6th–5th century B.C.), Spartan king of the Eurypontid line, succeeded his father Ariston at some date before 506 B.C. In this year the other king, Cleomenes I, led an army from all the states in the Peloponnese against Athens, intending to make Isagoras tyrant, but at Eleusis the Corinthians mutinied, and Demaratus supported them. He also frustrated Cleomenes' attempt to take hostages in 491 from the people of Aegina, who had offered submission to Darius I of Persia. Cleomenes then bribed the Delphic oracle to declare Demaratus illegitimate and he was replaced by his cousin Leotychides. Soon after, he fled to Persia and was given certain small cities in northwestern Asia Minor, which his descendants held in Xenophon's time. Herodotus has several stories of his advice and warnings to Xerxes, whom he accompanied on his expedition to Greece in 480.

See Herodotus, v, 75, vi, 50–70, vii; Xenophon, *Anabasis* ii, 1.3, vii, 8.17; *Hellenica,* iii, 1.3. *See* also bibliography to Cleomenes. (A. As.)

DEMAVEND, MOUNT (Qolleh-ye Damavand), an extinct volcano in the Elburz mountains (*q.v.*), about 40 mi. E. of Teheran, Iran. With its steep cone covered with ice and snow and an elevation of about 18,580 ft., it dominates the surrounding ranges by 3,000–8,000 ft. The cone is formed of andesitic lava flows and ash. On its top is a small crater with sulfuric deposits; a little lower are two small glaciers. Fumaroles, hot springs and travertine deposits occur. The Heraz (Lar) river skirts its eastern flank in a deep gorge and some villages (Pelur, Rehneh, Ab Garm, Ask) began to develop into summer resorts following construction of a motor road connecting them with Teheran. Demavend occurs in Persian legends. The first European to reach the summit was seemingly W. Taylor Thomson in 1837. It was later climbed many times.

The town of Demavend (Damavand) lies 17 mi. to the south in a pleasant and fertile valley with mineral springs, at an elevation of 7,500 ft., two or three miles from the Mazanderan road. Pop. (1956) 4,528. It is a popular summer resort with a lively bazaar. (H. Bo.)

DEMENTIA is a term used in medicine meaning a reduction in mental capacities, a permanent irreversible loss of intellectual efficiency due to structural disturbance or degeneration of cerebral tissue. This does not include the functional or temporary disorganizations which may simulate a dementia. It also is distinguished from amentia, which refers to a primary failure of normal mental development (*see* Mental Deficiency).

The causes of dementia may be grouped as follows: (1) atrophic changes of the brain resulting in senile dementia; (2) vascular disorders of the brain, including arteriosclerosis and hypertension; (3) inflammatory disorders of the brain, especially syphilis and encephalitis; (4) degenerative diseases of the brain, notably Alzheimer's disease, Pick's disease (lobar atrophy) and Huntington's chorea; (5) deficiency diseases, including Korsakoff's psychosis (usually based on chronic alcoholism), Wernicke's encephalitis (acute hemorrhagic polioencephalitis), pellagra, pernicious anemia and vitamin B-12 deficiency; (6) tumours of the brain; and (7) injuries.

Most dementias are also referred to as chronic organic brain disorders or chronic brain syndrome. They may be mild and may vary in degree and process, but some impairment of memory, orientation, judgment, intellectual function and affect persist permanently. From the usually mild senescent changes there is a sliding scale to the extreme impoverishment of mental reserves that characterizes dementia.

One clinical picture applies to all forms of dementia, and they are often difficult to differentiate as far as cause is concerned. The presenile psychoses such as Alzheimer's and Pick's disease are relatively rare forms which may occur in the fourth decade. As a result of public health measures, inflammatory diseases of the brain, as well as deficiency diseases, are much less prevalent now than they once were. The arteriosclerotic dementias may be seen from the age of 50 upward, while uncomplicated senile dementias seldom appear before the age of 60. Persons with the last two forms constitute the bulk of the total group of patients with dementia. With the increase in the number of older people that is characteristic of modern western society the problems of this group have become vitally important. Treatment once was almost solely custodial, but as the significance of psychotherapy has been re-evaluated attitudes have changed. In determining the prognosis, current therapeutics take into account the interplay of brain damage, the life pattern of adaptational strivings and the exigencies of the environment.

Biological, social and psychological factors contribute to the personality changes of old age. In the normal aging process there is a gradual wearing down of energy, a decline in responsiveness, a waning of initiative and of creative imagination, a narrowing of interests and increase in egocentricity and a certain warping of

personality. With advancing age there is a progressive loss of physical and mental resources, a loss which tends to arouse feelings of helplessness. These feelings serve to create anxiety which the person tries to overcome by methods which he has long employed in making his adjustments. As a person grows older, therefore, he "grows more like himself." The stress of increasing physical and mental limitations, loneliness resulting from the loss of friends and relatives and perhaps rejection by children produce an anxiety which may evoke various protective mechanisms. Among these may be a turning to and perhaps embellishment of the past, paranoid feelings or self-assertiveness to the point of being domineering. Other old people, through feelings of insecurity or inadequacy, become irritable and contentious and regress to a dependent state. All these, in turn, increase the distance between the person and his environment, friends and family.

These changes may begin even toward the end of the fourth decade. The physical agility, endurance and strength of people in such occupations as athletics, truck driving and mining begin to lessen, accounting for early retirement. There is difficulty in assimilating new information or decreased keenness of memory. Constriction and preoccupation with the past account for frequent misplacing of belongings and forgetting of recent events. Apathy, irritability, rigidity, stubbornness and unwillingness to deviate from accustomed patterns all become manifest in varying degrees. Unresolved interpersonal and intrapersonal problems of infancy, childhood, adolescence and early adulthood reappear in new guises, such as May–December marriages, food idiosyncracies, etc.

The dividing line between the process of normal aging and more pathological changes is often a matter of individual opinion. The patient with senile or arteriosclerotic dementia frequently is a person who has never felt secure and whose pattern of life has always been constricted. In general, the predementia personality is characterized by rigid and static habits; these are people who always have had difficulty in adjusting to the demands of life and who react very strongly to such situations as retirement from business or profession, deaths of friends and relatives, and the loosening of family and social ties that accompanies old age.

The general changes in the brain associated with dementias are a result of deficiency in blood flow to the brain, with associated decrease in available oxygen and metabolic function. In many cases, intracellular chemical changes are not related to interference with blood supply. There may be predisposing constitutional factors and, of course, the psychological trends noted above. One of the most significant changes is reduction in the number of cells. Severe brain changes may be seen in patients who have had no dementia, however, indicating that there is not always a correlation between degree of anatomical change and degree of intellectual impairment.

A number of changes in intellectual function are revealed in the chronic brain syndrome of dementia. There is a loss of memory for recent events and difficulty in establishing new memory of material recently presented. The person cannot focus attention on the past, and there is lack of full awareness of events going on in the environment. If the impoverishment is only slight it may be manifested by defective self-criticism, impairment of fine discrimination in decisions involving delicate moral issues and inability to employ abstract ideas. As dementia progresses, there is an increasing poverty of initiative, restriction of interests and blunting of concern. Impressions are taken in and assimilated slowly, with difficulty and often inexactly; there is, therefore, a failure to profit from experience. Aptitude and learning capacity are reduced. It becomes increasingly difficult, even impossible, for the patient to understand and follow conversations. Questions are not answered or answered only after several repetitions. Disorientation and confusion may exist. There is poverty of the imagination. The content of consciousness is reduced, both in number and in variety of associations, with the result that new associations are formed with difficulty, imperfectly or not at all. The person's capacity for integrating his past experience with his present is reduced, and judgment becomes defective. Emotions are unstable, and previously unacceptable impulses can no longer be inhibited. There is a tendency toward lability of mood, with vacillation from tears to laughter within seconds or minutes. Personality is altered, and traits such as suspiciousness, worrisomeness and pessimism may dominate the patient's behaviour. Moral and social values may be abandoned, creating numerous legal and social difficulties. There is resentment of interference by younger persons, and feeling of great neglect. Some patients show a hostile but anxious and fearful dependence. Affections become blunted and may turn to hatred, and a tendency to isolation is seen. The person is careless in habits of toilet and dress, and pride of appearance is forgotten. Hoarding and delusions of theft, poisoning, poverty and not being wanted are common.

When orientation becomes defective, the patient may, in his confusion, wander away and become lost. Hazards of traffic and other situations are not recognized. Frequently the patient forgets where he has placed articles, and accuses other persons of having stolen them. Gas jets may be left burning, and there is much carelessness with matches and fire. Night restlessness and wanderings may lead to destructive results. Sleep reversals are quite common, particularly when there is much confusion as to time and place.

As these situations prevail there are physical changes in accordance. The skin is often thin, atrophic and wrinkled, the special senses may change in acuity, weight is lost, the muscles are wasted, the gait becomes unsteady and shuffling, the voice harsh and speech slow. The handwriting becomes tremulous, while tremors of head and hands are common. Neurological changes such as paralysis, speech disturbances or paresthesias depend upon associated involvement of special structures within the nervous system.

A number of various clinical types may be noted, such as simple deterioration, delirious and confused states, depressed and agitated states, paranoid episodes or a mixture of all of them. In the latter stages of dementia the person is quite helpless and unable to look after personal hygiene and needs. Loss of control of excretory functions is a late development and usually an ominous sign.

Patients with dementia show deterioration or decompensation of ego function. Ego function represents the capacity to organize and control thinking and behaving and to perceive, test, anticipate and interpret reality. The tragedy in the older person is that he must meet new demands and changes at a time when his ego capacity is failing because of some form of brain change.

The demented or psychotic reaction often represents a regression to some degree of infantile magic control, and thus serves as a defense against overwhelming anxiety. Cerebral frailty and inimical life situations act together to upset psychologic balance. The dilemma lies in the fact that the combined symptoms help the patient to deny reality in order to avoid the anxiety that reality produces. At the same time, he is separated from the life in which he has invested his mental and emotional energies. The basic progressive organic pathology diminishes the control of anxiety, reactivating latent fears concerned with separation, loss of familiar objects and loss of self-esteem. The patient's personal disorganization is hastened by that feeling of futility and panic which comes from some appreciation that he is slipping, losing his grip and is no longer a useful, effective member of society. Many early dementias are speeded by such factors as cessation of work. This may mean the loss of personal usefulness and importance in living, as well as loss of opportunity to gratify many instinctual needs in an acceptable manner. Loss of relatives and friends further threatens the equilibrium. Changes in the physical environment mean loss of familiar objects which serve as guides and reminders of the past. Reversal of roles with children means an increased and intolerable awareness of unconscious resentment of the children, who may encourage regression by insisting that patients do nothing but vegetate and await death. Diminished perceptual acuity, intellectual capacity and sexual potency, and intercurrent physical disease, are all evidences of decline and approaching death. The patient becomes increasingly dependent on what seems to him a hostile environment.

The outlook for the advanced dementia patient is manifestly hopeless, and the course is progressive. However, it is highly desirable that the person be accorded a feeling of emotional security and attention. Patients with the milder forms can be cared for in

the home if it is there that the patient's roots are deeply planted. Unless circumstances are such that the safety of either the patient or the family is endangered, it is well to attempt to care for him in the familiar environment. Hospital care becomes necessary when such situations arise as nocturnal restlessness, disturbing responses to paranoid delusions, assaultiveness, sexual play with children, exhibitionism or ill-considered plans for the future. Impaired judgment in business affairs may make the appointment of a legal guardian necessary. Care must be exercised to prevent the confused patient from setting fire to clothes or furniture, or to prevent wandering from the home or falling with subsequent injury. Depressed, agitated or suicidal patients should receive hospital care. Nursing care and the judicious use of drugs may make the patient more comfortable and allay many symptoms. *See* also GERONTOLOGY AND GERIATRICS. For the condition formerly called dementia praecox, *see* SCHIZOPHRENIA.

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(L. P. L.)

DEMERARA, a river of British Guiana, rises in the central forested area and flows without important tributaries 215 mi. to the Atlantic at Georgetown. Its narrow estuary and rapid flow (about seven knots with the ebb) keep clear a 16–20 ft. channel over the bar. Ocean-going steamers ascend 65 mi. to Mackenzie for bauxite; smaller ships reach Malali, 105 mi. up. Beyond are numerous rapids.

The old Dutch colony of Demerara was part of Essequibo until 1773 and was reunited with it in 1784. The joint colony united with Berbice in 1831 to become British Guiana. Demerara county, or region, has no modern political significance; the name Demerara is often applied to British Guiana as a whole. (G. LN.)

DEMESNE, that portion of a manor not granted to freehold tenants but (1) retained by the lord for his own use and occupation or (2) occupied by his villeins or leasehold tenants. When villein tenure developed into copyhold (*q.v.*) and leaseholders became protected against premature eviction, the "lord's demesne" came to be restricted to sense (1) and usually denoted the lord's house and the park and surrounding lands. Demesne of the crown, or royal demesne, was that part of the crown lands not granted to feudal tenants but managed by crown stewards until it was surrendered to parliament in return for an annual sum (*see* CROWN LAND).

Ancient demesne was land vested in the crown in 1066, the tenants of such land having a number of privileges, such as freedom from tolls and duties and from sitting on juries.

See also MANOR. (R. E. My.)

DEMETER, in Greek mythology, daughter of Cronus and Rhea, sister of Zeus and goddess of agriculture. Her name has been explained as (1) "grain mother," from *dēai*, the Cretan form of *zeiai*, "barley," or (2) "earth-mother," or rather "mother earth," *da* being regarded as a pre-Hellenic name of Ge, the earth-goddess. She is rarely mentioned in Homer, nor is she included among the Olympian gods, but she must have been very old; her name appears to occur on a tablet from Pylos of the 13th century B.C.

The centre of her legend was the story of her daughter Persephone. After Persephone was carried off by Hades (*see* PERSEPHONE), Demeter revealed to the people of Eleusis, where she had been hospitably received, her secret rites (*see* TRIPTOLEMUS). This is the legendary origin of the famous Eleusinian mysteries (*see* MYSTERY). The Eleusinia, sometimes confused with them, were a distinct festival.

Demeter is a mother goddess. Besides Zeus, she has a consort Iasion, who, says Homer, "lay with her in a thrice-plowed field" and to whom she bore Plutus, "Wealth" (*i.e.*, abundant produce of the soil). The story is compared by Sir James Frazer in *The Golden Bough* with the West Prussian custom of the mock birth of a child on the harvest field, the object being to ensure a plentiful crop for the coming year. In Hesiod the scene is laid in Crete, and may well represent part of the ritual or mythology of the Cretan goddess.

It is as a corn goddess that Demeter appears most commonly. The name Ioulō (? at Delos), from *ioulos*, "corn sheaf," has been regarded as identifying the goddess with the sheaf, and as proving that the cult of Demeter originated in the worship of the corn mother or corn spirit, the last sheaf having a more or less divine character for the primitive husbandman. According to this view, held by Frazer, the prototypes of Demeter and Persephone are the corn mother and harvest maiden of northern Europe, the corn fetishes of the field. The influence of Demeter, however, was not limited to grain but extended to vegetation generally and to all the fruits of the earth, with the curious exception of the bean (the use of which was forbidden at Eleusis, and for the protection of which a special patron was invented). In this wider sense Demeter is akin to Ge, with whom she has several epithets in common, and is sometimes identified with Rhea-Cybele; thus Pindar speaks of Demeter the Bronze-Rattling, an epithet more suitable to Rhea-Cybele than to Demeter (*see* CORYBANT).

Another important aspect of Demeter was that of a divinity of the underworld; as such she is *chthonia* (earth-goddess) at Sparta and especially at Hermione in Argolis, where, at the festival Chthonia, a cow (representing perhaps the spirit of vegetation) that voluntarily presented itself was sacrificed by three old women. Those joining in the procession wore garlands of the flower called *hyakinthos*. The remarkable epithets Erinys ("avenger") and Melaina ("the black one"), as applied to Demeter, were both localized in Arcadia, the first at Thelpusa (or rather Onkeion, close by), the second at Phigalia. According to the Thelpusan story, Demeter, during her wanderings in search of Persephone, changed herself into a mare to avoid the persecution of Poseidon. The god, however, assumed the form of a stallion, and the fruit of the union was a daughter of mystic name and the horse Arion. Demeter, at first enraged, afterward calmed down and washed herself in the river Ladon by way of purification. A similar story was current at Phigalia where, in a cave still called Mavrospelya ("black cave"), there was an image of the goddess as a female form seated on a rock, but with a horse's head and mane, to which were attached snakes and other wild animals. It was clothed in a black garment reaching to the feet and held in one hand a dolphin, in the other a dove.

Both Melaina and Erinys, according to L. R. Farnell, are epithets of Demeter as an earth-goddess of the underworld. The first has been explained as referring to the gloom of her abode or the blackness of the withered corn. According to Farnell, the meaning of the epithet is to be looked for in the original conception of Erinys, which was that of an earth-goddess akin to Ge, thus naturally associated with Demeter, rather than that of a wrathful avenging deity.

Various interpretations have been given of the horse-headed form of the Black Demeter: (1) that the horse was one of the forms of the corn spirit in ancient Greece; (2) that it was an animal "devoted" to the chthonian goddess; (3) that it is totemistic; (4) that the form was adopted from Poseidon Hippios, who is frequently associated with the earth-goddess and is said to have received the name Hippios first at Thelpusa, in order that Demeter might figure as the mother of Arion. In any case the association of Poseidon, representing the fertilizing element of moisture, with Demeter, who causes the plants and seeds to grow, is quite natural and it is possible that by derivation his name means literally "husband of Da."

Demeter also appears as a goddess of health, of birth and of marriage; and a certain number of political and ethnic titles are assigned to her, the most important being Amphiktyonis, at Anthela near Thermopylae, as patron goddess of the Amphictyonic league, subsequently so well known in connection with the temple at Delphi.

Brief mention may here be made of certain agrarian festivals held in honour of Demeter.

1. Haloa, apparently derived from *halōs* ("threshing floor"), begun at Athens and finished at Eleusis, where there was a threshing floor of Triptolemus, in the month Poseideon (December).

This date, which is confirmed by historical and epigraphical evidence, seems inappropriate, and it has been suggested that the festival, originally held in autumn, was subsequently placed later so as to synchronize with the winter Dionysia. Dionysus, as the god of vines, and (in a special procession) Poseidon as god of vegetation were associated with Demeter. In addition to being a harvest festival, marked by the ordinary popular rejoicings, the Haloa had a religious character. The first fruits were conveyed to Eleusis where sacrifice was offered by a priestess, men being prohibited from undertaking the duty. An initiatory ceremony of women by a woman also took place at Eleusis, characterized by obscene jests and the use of phallic emblems. The sacramental meal on this occasion consisted of the produce of land and sea, certain things (pomegranates, honey, eggs) being forbidden for mystical reasons. Although the offerings at the festival were bloodless, the ceremony of the presentation of the first fruits was probably acccompanied by animal sacrifice; the offerings, however, may have been pastry imitations. Certain games, of which nothing is known, terminated the proceedings. In Roman imperial times the ephebi (*q.v.*) had to deliver a speech at the Haloa.

2. Chloia, the festival of the corn beginning to sprout, held at Eleusis in the early spring (Anthesterion) in honour of Demeter Chloë, "the green," the goddess of growing vegetation. This is to be distinguished from the later sacrifice of a ram to the same goddess on the 6th of the month Thargelion, probably intended as an act of propitiation. It has been identified with the Procharisteria (sometimes called Proschaireteria), another spring festival, but this is doubtful.

3. Proerosia, at which prayers were offered for an abundant harvest, before the land was plowed for sowing. It was also called Proarktouria, an indication that it was held before the rising of Arcturus. According to the traditional account, when Greece was threatened with famine the Delphic oracle ordered first fruits to be brought to Athens from all parts of the country, to be offered by the Athenians to the goddess Deo (Demeter) on behalf of all the contributors. The most important part of the festival was the three sacred plowings—the Athenian, the Eleusinian on the Rarian plain, and the Scirian (a compromise between Athens and Eleusis). The festival itself took place, probably sometime in September, at Eleusis. In later times the ephebi also took part in the Proerosia.

4. Thalusia, a thanksgiving festival, held in autumn after the harvest in the island of Cos.

5. The Thesmophoria (*q.v.*), a women's festival meant to improve the fruitfulness of the seed corn.

6. The Skirophoria held in midsummer was a companion festival.

The attributes of Demeter are chiefly connected with her character as goddess of agriculture and vegetation—ears of corn, the poppy, the mystic basket (*kalathos*) filled with flowers, corn and fruit of all kinds, the pomegranate being especially common. Of animals, the pig is her favourite, owing to its productivity and the cathartic properties of its blood. As a chthonian divinity she is accompanied by a snake; the myrtle, asphodel and narcissus (which Persephone was gathering when carried off by Hades, and which were commonly associated with death) also are sacred to her.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

DEMETER OF CNIDUS. MID-4TH CENTURY B.C. IN THE BRITISH MUSEUM

In Greek art, Demeter resembles Hera, but she is more matronly and of milder expression; her form is broader and fuller. She is sometimes riding in a chariot drawn by horses or dragons, sometimes walking, sometimes seated upon a throne, alone or with her daughter. The Demeter of Cnidus in the British museum, a masterpiece of the mid-4th century B.C., apparently shows her mourning the loss of her daughter. The Italians identified Demeter with their own Ceres (*q.v.*). *See* also references under "Demeter" in the Index.

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DEMETRIA, an obscure festival or rite of Demeter, probably Athenian, in which the participants beat each other with whips of twisted bark, a well-known fertility charm. Also a name given to the Attic Dionysia in compliment to Demetrius I Poliorcetes, king of Macedonia, 294–283 B.C.

See Pauly-Wissowa, "Demetria," *Realencyklopädie* (1901).

DEMETRIUS (2nd century B.C.), king of Bactria, son of Euthydemus (*q.v.*). The historical evidence for his reign is slight and is open to varying interpretations. In the reconstruction proposed by W. W. Tarn he ruled from about 190 to 167 B.C., when he met his death at the hands of Eucratides (*q.v.*), having earlier made such extensive conquests in northern India that he for a brief time virtually re-formed the great Mauryan empire which had collapsed in about 184 (*see* INDIA-PAKISTAN, SUBCONTINENT OF: *History: Ancient History*). But according to A. K. Narain it was a younger Demetrius (likewise a Bactrian king but not directly related to the son of Euthydemus) who made conquests in India, of a less extensive kind, and lost his kingdom to Eucratides after a reign extending approximately from 180 to 165. The fact that one of these two men was the first to strike coins with a bilingual inscription in Greek and Prakrit suggests that he pursued a policy of treating the Indian peoples as equal subjects alongside the Bactrian Greeks. The foundations of Demetrias in Arachosia (on the road between Kandahar and Ghazni in southern and eastern Afghanistan respectively) and perhaps Demetrias in Sind may be cited to illustrate the spread of the Bactrian kingdom at this time.

See works cited under BACTRIA. (R. H. Si.)

DEMETRIUS I POLIORCETES (336–283 B.C.), king of Macedonia 294–288, son of Antigonus I Monophthalmus (*q.v.*) in whose campaigns he commanded with distinction and whose empire he attempted to rebuild. In 321 or shortly afterward he married Phila, a daughter of Antipater, regent of Macedonia. His first important command was in defending the southern boundaries of his father's territory against Ptolemy, the satrap of Egypt (*see* PTOLEMIES). In this he had the support of specially chosen senior officers; but he suffered a heavy defeat at Gaza (312). In the same year he led unsuccessful expeditions against the Nabataeans (*q.v.*) of Arabia and Seleucus in Babylonia (*see* SELEUCID DYNASTY). In 307 he was sent against Athens and liberated it from the garrison of Cassander (*q.v.*). For this he received from the Athenians the most extravagant honours, including deification. The next year he defeated Ptolemy by land and sea at Salamis (Cyprus), a victory which at last persuaded Antigonus to take the royal title for himself and Demetrius; but their expedition against Egypt, which followed at once, was a failure since gales prevented the fleet (commanded by Demetrius) from effecting a landing. In 305 Demetrius was sent to compel Rhodes to join his father's alliance. The siege which ensued became famous for the vigour and ingenuity with which Demetrius conducted it, as well as for the valour of the defense; though unsuccessful, he became known thereafter as "the Besieger" (*Poliorcetes*). In 304 he landed in Greece, where he won important successes against Cassander in 303 and 302 and organized a new Greek league (League of Corinth). Before he could force a decision he was recalled by his father to Asia to take part in the campaign which culminated in the battle of Ipsus (301). Surviving the defeat, he sought to rebuild his father's empire. All that remained was the fleet and a few bases; but the disunity among the victors allowed him to nurse his strength and re-emerge after a few years as a major power. In 294 he reoccupied Athens and established himself as king in Macedonia. In the following years he fought many campaigns in Greece, successfully for the most part. It appeared that he had built up a strong kingdom. But in 288 the concerted

invasions of Pyrrhus and Lysimachus (*qq.v.*) drove him out of Macedonia. Instead of attempting its recapture from Greece, he passed into Asia Minor with a small force of mercenaries with the bold design of disrupting from within the kingdoms of Lysimachus and Seleucus. In the end, deserted by his followers and having lost contact with his fleet, he surrendered to Seleucus in Cilicia (285). He was retained in honourable captivity in Syria and died there two years later.

His soldierly qualities made Demetrius an invaluable assistant to his father, who relied heavily upon him. But after Ipsus he showed himself to be an adventurer rather than a responsible ruler (not unlike his younger contemporary and rival, Pyrrhus, another brilliant darling of fortune). In a life full of scandal he collected numerous wives and mistresses and gaily defied all convention in the pursuit of his pleasures.

See also references under "Demetrius I" in the Index volume.

See Diodorus Siculus, xix–xx; Plutarch, *Life of Demetrius*, with commentary by E. Manni (1953). (R. H. Si.)

DEMETRIUS II (*c.* 276–229 B.C.), king of Macedonia from 239 B.C., son of Antigonus Gonatas and Phila, had already gained distinction as a boy by defeating and dethroning Alexander of Epirus at Derdia during his father's lifetime, thus saving Macedonia (*c.* 263). His marriage to Nicaea, the widow of Alexander of Corinth, in 245 was a device to recover Acrocorinth for Antigonus and probably remained unconsummated. On his accession (239) he divorced his second wife, Antiochus I's daughter Stratonice, who had borne him no sons, and married the Epirote princess Phthia (also called Chryseis). In the same year he was faced by a coalition between the Aetolians, who were trying to annex Epirote Acarnania, and the Achaeans, who were set on expelling the Macedonians from the Peloponnese (*see* Achaean League; Aetolian League). His general Bithys defeated Aratus of Sicyon at Phylacia, and he himself entered Boeotia, detached it from the Aetolians and occupied Megara (237–236). In 231, however, a revolution in Epirus, which substituted a republican league for a monarchy and an alliance with the Aetolian and Achaean leagues for that with Macedonia, gravely weakened his position. He had scarcely formed an alliance with Agron of Illyria to defend Acarnania when a Dardanian invasion drew him northward. After a defeat there he died, leaving his son by Phthia, Philip, still a child. His failure seriously weakened both kingdom and monarchy.

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DEMETRIUS, the name of three kings of the Seleucid dynasty.

Demetrius I, called Soter (*c.* 187–150 B.C.), king from 160 B.C., was sent to Rome as a hostage during the reign of his father Seleucus IV. There he was befriended by the Greek statesman and historian Polybius. When his uncle Antiochus IV Epiphanes died in 163, he sought permission of the Roman senate to return to Syria and assert his claim to the throne. Permission was refused; whereupon Demetrius, aided by Polybius, escaped and made his way home. A circumstantial account of the escape is recorded in the *History* of Polybius (xxxi, 11–15).

In Syria the people and the army welcomed Demetrius as the legitimate king. In Babylonia and Media, however, the satrap Timarchus had set himself up as king, and had even secured recognition from the senate in Rome. In his campaign against Timarchus (winter 161–160) Demetrius was completely successful, and took the title of *Soter* ("Saviour") for his victory. The senate now recognised him as king. In 160 the Jewish rebellion was also crushed, although some resistance continued in outlying districts under the surviving Maccabees (*q.v.*); but later in the reign the forces of secession in Judaea revived, and the Seleucid government compromised with them as before (*i.e.* by maintaining garrisons in Judaea but allowing freedom of worship).

In his foreign relations Demetrius incurred the enmity of the kings of both Pergamum and Egypt. With the connivance of the Roman senate, they gave their support to the pretender Alexander Balas. With their help, he was eventually able to supplant Demetrius, who lost his life fighting bravely in the final battle.

Demetrius II, called Nicator ("Victor") (*c.* 161–126 or 125 B.C.), king 145–139 and from 129, was the son of the above. Returning from exile to Syria in 147 with an army of Cretan mercenaries, he challenged Alexander Balas; in 145, having won the support of Ptolemy VI of Egypt, he became king. With both Balas and Ptolemy killed in the battle of Oenoparas in that year, Demetrius had a free hand; but he was faced with serious disorder throughout the kingdom, and he was too young to govern effectively. In 140, despite a civil war raging in Syria, he turned upon the Parthian invaders and drove them out of Babylonia; in the next year he was defeated and made prisoner by them (*see* Mithradates). In 129 he was released and returned to Syria. During his short second reign he never obtained more than a partial control of the kingdom. He was assassinated.

Demetrius III had a brief reign (95–88 B.C.) in the chaotic final period of the Seleucid kingdom, and died as a prisoner of the Parthians.

See H. Willrich in Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, vol. iv, 2795–2802 (1901); *see* also works cited under Seleucid Dynasty. (R. H. Si.)

DEMETRIUS, a Greek sculptor of the early part of the 4th century B.C., who is said by ancient critics to have been notable for the life-like realism of his statues. His portrait of Pellichus, a Corinthian general, was admired by Lucian. He was contrasted with Cresilas (*q.v.*), an idealizing sculptor of the generation before. Since, however, the peculiarities mentioned by Lucian do not appear in Greek portraits before the 3rd century B.C., and since the Greek art of the 4th century consistently idealizes, there would seem to be a difficulty to explain. The date of Demetrius is confirmed by inscriptions found on the Athenian Acropolis. (P. G.)

DEMETRIUS (fl. 1st century A.D.), a Cynic philosopher with leanings, characteristic of his time, to Stoicism, taught in Rome during the reigns of Caligula, Nero and Vespasian, the last of whom deported him to an island. He was an intimate friend of Thrasea Paetus and much admired by Seneca. He was remarkable for personal austerity and for brutal outspokenness rather than for comprehensive or original thought. (F. H. Sh.)

DEMETRIUS PHALEREUS or of Phaleron (born at Phaleron, near Athens, *c.* 350 B.C.), Athenian orator, statesman and philosopher, was a pupil of Theophrastus and an adherent of the Peripatetic school. In 317 he was appointed by Cassander (*q.v.*) governor of Athens, enjoying much independent authority, though dependent in the last resort upon the Macedonian garrison. His administration favoured the upper classes, but he ruled with moderation. In the many new laws he introduced he gave effect to the ideas of earlier political theorists such as Aristotle; extravagance in funerals and entertainment and by women was curbed; a committee of seven "guardians of the laws" was set up to prevent the passing by the assembly of undesirable legislation; the liturgies (public services) which had borne so heavily upon the rich since the time of Pericles were transferred to the public account; and many minor uncontroversial improvements were made in Attic law. On the restoration of the old democracy in 307 Demetrius escaped to Thebes and later went to Egypt where he became prominent at the court of Ptolemy I; he is connected in tradition with both the library and the museum at Alexandria. He enjoyed a high reputation as an orator. Numerous philosophical, historical and miscellaneous writings, all lost, are attributed to him.

See W. S. Ferguson, *Hellenistic Athens* (1911). (R. H. Si.)

DEMIDOV, the name of a famous Russian family several members of which were outstanding benefactors and patrons of science, learning and art and remarkable travelers and collectors. Nikita Demidych Demidov (1656–1725), the founder of the family's wealth and fame, originally a blacksmith serf, made his fortune by his skill in the manufacture of weapons and established at Tula an iron foundry for the government. Peter the Great, with whom he was a favourite, ennobled him in 1720. His son, Akinfi Demidov (1678–1745), increased his inherited wealth by

the discovery and working of gold, silver and copper mines. The latter's nephew, PAVEL GRIGORIEVICH DEMIDOV (1738–1821), a great traveler and benefactor of Russian scientific education, was the founder of the Demidov lyceum in Yaroslavl (1805). Pavel's nephew, COUNT NIKOLAI NIKITICH DEMIDOV (1773–1828), raised and commanded a regiment to oppose Napoleon's invasion and carried on the accumulation of the family wealth from mining; he contributed liberally to scientific education in Moscow. His elder son, PAVEL NIKOLAEVICH DEMIDOV (1798–1840), founded an annual prize for Russian literature, awarded by the Academy of Sciences. The latter's brother, ANATOLI NIKOLAEVICH DEMIDOV (1812–1870), was a well-known traveler and patron of art; he lived many years in Italy, received the Tuscan title of principe di San Donato and married the princess Mathilde, Jérôme Bonaparte's daughter, in 1840.

DEMILLE, CECIL BLOUNT (1881–1959), U.S. motion-picture producer-director, best known for films with historical and religious themes, was born at Ashfield, Mass., Aug. 12, 1881, son of the playwright Henry Churchill DeMille (1853–93), a collaborator of David Belasco (*q.v.*). Educated at Pennsylvania Military college and the American Academy of Dramatic Arts, deMille began his career in the theatre as an actor in 1900. In 1902 he married Constance Adams. After appearing in several plays, notably with E. H. Sothern, he collaborated in playwriting with his brother William Churchill deMille (*see* below) and with Belasco.

In 1913 deMille entered the field of motion pictures, producing *The Squaw Man,* one of the early films that helped to establish motion pictures as a serious dramatic form. At first deMille drew largely upon stage plays for his material, never copying stage technique, however, but utilizing the flexibility of cinematic techniques around a core of sound dramatic construction. After World War I he produced and directed a cycle of sociological problem pictures, whose influence upon U.S. mores has often been noted. His first biblical film was *The Ten Commandments* (1923). In 1927 he produced and directed *The King of Kings,* which was seen by an estimated 800,000,000 persons. In later decades he concentrated upon large productions, usually historical or religious in theme, beginning with *The Sign of the Cross* (1932) and culminating in *The Greatest Show on Earth* (which won the award of the Academy of Motion Picture Arts and Sciences for the best picture of 1952) and the 1956 version of *The Ten Commandments,* his 70th film. DeMille also was active in banking and other businesses. His Mercury Aviation company (1919) was one of the first commercial airlines in the world, and from 1936 to 1945 he conducted the "Lux Radio Theatre." In the latter year he became president of the DeMille Foundation for Political Freedom, which campaigned for legislation to prohibit the union shop. He declined nomination to the United States senate in 1938. DeMille died at his home in Hollywood, Calif., Jan. 21, 1959.

Critical estimates of deMille's work vary; but his conspicuous success in the genre that he made distinctively his own brought to his films a vast audience, larger than that of any other single producer-director.

DeMille's *Autobiography* was published in 1959.

His brother, WILLIAM CHURCHILL DEMILLE (1878–1955), was a well-known playwright, among his plays being *Strongheart, The Warrens of Virginia* and *The Land of the Free.*

The choreographer AGNES DEMILLE was the daughter of William Churchill deMille. (D. HE.)

DEMISE, an Anglo-French legal term for a transfer of an estate, especially by lease (*see* LANDLORD AND TENANT). The phrase "demise of the crown" is used in English law to signify the immediate transfer of the sovereignty, with all its attributes and prerogatives, to the successor in accordance with the maxim "the king never dies." At common law the death of the sovereign dissolved parliament, but this was abolished in 1867 by the Representation of the People act. Similarly the common-law doctrine that all offices held under the crown terminated at its demise was abrogated by the Demise of the Crown act, 1901.

DEMIURGE (Gr. *demiourgos,* "artisan" or "craftsman"). In Homer the term includes manual workers, heralds and physicians. In Attica the *demiourgoi* formed one of the three classes, with the eupatridae (*q.v.*) and the *geomoroi* or *agroikoi,* into which the early population was divided.

The word was used in the Peloponnese, with the exception of Sparta, for a higher magistrate. The *demiourgoi* represented Elis and Mantinea at the treaty of peace between Athens, Argos, Elis and Mantinea in 420 B.C. In the Achaean league (*q.v.*) the name is given to ten officers who presided over the assembly, and the Corinthians sent *epidemiourgoi* annually to their colony Potidaea.

Plato in *Timaeus* uses *demiourgos* of the "creator of the world," and the word was so adopted by the Gnostics with reference to the creator of the material universe, when they wished to distinguish him from the supreme God. *See* GNOSTICISM.

DEMOCHARES (*c.* 355–*c.* 270 B.C.), Athenian historian, orator and statesman, was a nephew of Demosthenes (*q.v.*) and a supporter of the Demosthenic ideal of freedom. He is first recorded as having spoken, in vain, in 322 against the surrender of Demosthenes and of the anti-Macedonian orators, which Antipater was demanding. On the restoration of the democracy by Demetrius Poliorcetes (*q.v.*) in 307, he occupied a prominent position and favoured the suppression of the schools of philosophy. He was banished as hostile to Demetrius either in 303 or, according to K. J. Beloch's hypothesis, about 292. Recalled in 290 or 289 he took charge of the administration of the city of Athens. He dislodged the Macedonians from Eleusis.

In later years he retired from active politics and apparently spent some time cultivating the acquaintance of Zeno the Stoic. He died before 270 and was honoured by the citizens with a statue.

Demochares was the author of a history of his own times, written in an oratorical style; as a speaker he was noted for his freedom of language. Violently attacked by his contemporary the historian Timaeus, he was later defended by Polybius.

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(A. D. Mo.)

DEMOCRACY. The term democracy is used in several different senses. (1) In its original meaning, it is a form of government where the right to make political decisions is exercised directly by the whole body of citizens, acting under procedures of majority rule. This is usually known as direct democracy. (2) It is a form of government where the citizens exercise the same right not in person but through representatives chosen by and responsible to them. This is known as representative democracy. (3) It is a form of government, usually a representative democracy, where the powers of the majority are exercised within a framework of constitutional restraints designed to guarantee the minority in the enjoyment of certain individual or collective rights, such as freedom of speech and religion. This is known as liberal or constitutional democracy. (4) Finally, the word democratic is often used to characterize any political or social system which, regardless of whether or not the form of government is democratic in any of the first three senses, tends to minimize social and economic differences, especially differences arising out of the unequal distribution of private property. This is known as social or economic democracy.

To avoid misunderstandings, these various uses of the term should be carefully distinguished.

This article is divided into the following sections: *Ancient Greece; Origins of Modern Democracy; The United States; The French Revolution; Great Britain; Other European Countries; Totalitarian Democracy;* and *The 20th Century.*

Ancient Greece.—Direct democracy is one of the most obvious ways of organizing a political community. It is found in many of the primitive societies known to modern anthropologists, and its origins undoubtedly go back to prehistoric times. In the political tradition of the west, however, the beginnings of the idea of democracy are associated with the city-states of ancient Greece. The word itself is derived from the Greek *demokratia,* from *demos,* "the people," and *kratos,* "rule." Plato and Aristotle, in their pio-

neering attempts to create a systematic theory of politics, both recognized democracy as one of the five or six main types of government. The best definition is given by Aristotle:

> A democracy is a state where the freemen and the poor, being in the majority, are invested with the power of the state . . . The most pure democracy is that which is so called principally from that equality which prevails in it; for this is what the law in that state directs; that the poor shall be in no greater subjection than the rich; nor that the supreme power shall be lodged in either of these, but that both shall share it. For if liberty and equality, as some persons suppose, are chiefly to be found in a democracy, it must be so by every department of government being alike open to all; but as the people are the majority, and what they vote is law, it follows that such a state must be a democracy. (*Politics*, book iv, ch. 4, 1290b, 1291b.)

The democracy to which this definition refers was in many ways fundamentally different from that of modern times. It was direct democracy in which the whole citizen body formed the legislature, and in which the representative system was unknown. This was possible because of the limited size of the ancient state, which was generally confined to a city and its rural surroundings and seldom had more than 10,000 citizens. Furthermore, the citizen body was not identical with the whole adult population. Women were disfranchised and there was a numerous class of slaves who enjoyed no rights at all. Ancient democracy was not only compatible with slavery, it presupposed slavery, which alone permitted the necessary leisure for the citizens to devote themselves to public affairs. It recognized the equality of citizens, but failed to develop a general conception of the equality of all mankind.

In the ancient democracies, all citizens were entitled to attend the legislative assembly and to vote. They were also eligible for a large variety of executive and judicial offices, some of which were filled by election and others, in the interests of absolute equality, assigned by lot. The use of sortition (casting of lots) in preference to election was regarded by Aristotle as one of the characteristic features of democracy. There was no separation of powers, and all officials were fully responsible to the popular assembly, which was itself qualified to act in executive and judicial as well as in legislative matters.

The failure of the ancients to develop a representative system made it impossible for them to create large democratic states. The limited size of the ancient polis (city) enabled it, on the other hand, to develop a very intense and concentrated form of political life. All citizens had the opportunity to become actively interested in and highly conversant with every aspect of public affairs. As far as the citizen body was concerned, this was direct democracy in the fullest sense of the term. The nearest modern parallel is to be found in the New England town meetings and in some of the smaller Swiss cantons.

Democracy was widespread in ancient Greece, especially during the 5th century B.C. The political history of this period was largely occupied with the struggle between democratic and oligarchic states, of which Athens and Sparta were the representative examples. The Athenians were the first people to try to form a democratic empire, a league of free cities united under Athenian leadership in common devotion to the democratic way of life. As time went on, methods of voluntary co-operation broke down, and in the course of the Peloponnesian War Athenian relations with the empire became increasingly coercive. The experiment ended with the victory of Sparta. Although Greek democracy survived the fall of Athens, it never fully recovered from the blow. After a long period of decline, it finally disappeared with the triumph of Rome.

Greek democracy was a brief historical episode which had little direct influence on the theory or practice of modern democratic states. There is some evidence that democratic theories of politics were well developed at the time, anticipating many of the ideas put forth by the utilitarians, the social contract theorists and other exponents of modern democratic thought from the 17th century on. These ancient writings did not survive to become a part of the western political tradition. The leading philosophers of the 4th century, to whom we owe most of our knowledge of the political thought of antiquity, were strongly antidemocratic. Plato's *Republic* pictures democracy as being second only to tyranny in the scale of political corruption. Although Aristotle's *Politics*, being more encyclopaedic in character, presents a more balanced view, and repeats some of the standard arguments for democracy, his final verdict is hardly more favourable. The classical tradition, in its most influential form, did little to encourage any future resumption of democratic experiments.

Origins of Modern Democracy.—From the fall of the Greek city-state to the rise of modern constitutionalism, there is a gap of about 2,000 years in the theory and practice of democracy. Rome was an oligarchic republic which gradually turned into an autocratic empire. The successor states were tribal or feudal kingdoms which, in the course of the 16th and 17th centuries, became largely transformed into absolute monarchies. It is true that this general pattern of government was not universally followed. The English monarchy failed, in the course of the 17th century, to make good its claim to absolutism, and fell under the control of the landed gentry. The middle ages also saw the rise of a number of independent republics, but these generally were oligarchic rather than democratic in character. Although medieval and early modern writers, in deference to the authority of Aristotle, continued to list democracy as one of the three basic forms of government, it had long ceased to be a matter of anything more than theoretical or antiquarian interest. This was the situation down to the time of the American and French revolutions.

Poor as the period was, however, in actual democratic developments, it gave rise to ideas and institutions which did much to determine the distinctive character of modern democratic governments. Unlike the direct democracies of ancient Greece, the democratic states of our own day are all representative and constitutional states with a marked leaning toward economic democracy. Their basic organ of government is the representative legislature, or parliament. Their underlying ethical basis is the conception that all men are created equal, and that governments exist for the purpose of protecting them in the exercise of certain basic rights. All this would have seemed quite incomprehensible to the slave-owning, self-ruling citizens of ancient Athens. The difference can be understood only as the outgrowth of new ideas and institutions which gradually emerged in the course of the middle ages.

One of the most important of these new ideas is the modern conception of a constitution (*see* CONSTITUTION AND CONSTITUTIONAL LAW). The ancients generally regarded law as an expression of rather than as a restraint upon the exercise of political power. But for the barbarian successor kingdoms, as for many primitive peoples, law was immemorial custom which no one had the power to alter. The function of kings was not to legislate, but to enforce existing laws, laws binding on the king no less than on his subjects. This idea was reinforced by the concept of natural law, as developed by the Stoic and Christian thinkers of late antiquity. To the Christian theologians, the universe was the creation of an omnipotent God whose perfect and unchanging will was binding on all his creatures. This will was known to men partly through revelation, as interpreted by the church, and partly through natural reason. Throughout the middle ages, therefore, kings were subject to three different kinds of law, the revealed law of God, the natural law of reason and the customary law of the land. These laws were not the product but the source of legitimate authority, and anyone who violated them was regarded as a tyrant, not as a lawful ruler. The modern view of the supremacy of constitutional law is directly inherited from this medieval conception.

The modern practice of representation is also medieval in origin, arising as a consequence of the disintegration of state authority which followed the fall of Rome. The Roman empire had been a strongly centralized state, fully capable of imposing its will on the subject population. In the tribal and feudal monarchies which replaced it, power was much more widely dispersed. Feudal magnates, ecclesiastical authorities and chartered cities all acquired a power and authority of their own. For many purposes, especially for the raising of new taxes, kings could act only with the consent of their subjects. The normal device for securing this consent was to summon a great council of the realm. At first the subjects thus assembled were temporal lords and ecclesiastics

rich and powerful enough in their own right to make important contributions. But there were also corporate groups, especially chartered cities, whose wealth was well worth tapping. Gradually it became customary to ask them to join the great council by sending representatives with authority to make financial commitments on their behalf. These gatherings ("estates") were the origin of modern parliaments.

This medieval political order disintegrated in the course of the 15th and 16th centuries as the power of monarchs increased and legal restrictions gave way to the idea of absolute sovereignty. This development naturally encountered a good deal of resistance. In the course of the 16th century there was even a brief revival of the medieval concept of politics. Many Christians, both Protestant and Catholic, reacted to the religious troubles of the period by denouncing all kings of the opposing faith as tyrants, and calling for their deposition at the hands of the lawfully constituted estates of the realm. Some of the adherents of this position, known as the monarchomachists, produced writings which subsequently played some part in the development of theories of popular sovereignty. In their own time, however, they were generally unsuccessful, and by the middle of the 17th century absolute monarchy was firmly established as the prevailing form of western European government.

The only important exception was England, where the tradition of medieval parliamentarianism was particularly strong. When, in the mid-17th century, conflict over religious and constitutional issues led to an open break between king and parliament, parliament won and beheaded the king. Although the attempt to found a republican commonwealth proved unsuccessful, the restoration monarchy was weaker than before. When a fresh assertion of royal authority went down before the Glorious Revolution of 1688, the power of the English monarchy was finally broken. Parliament thereafter exercised complete control in matters of legislation and finance. With the development of the principle of parliamentary responsibility, it also extended its authority into the field of executive action. By the middle of the 18th century it had become customary for the king, in choosing his cabinet, to confine himself to members of parliament who enjoyed the support of a parliamentary majority, and to dismiss them as soon as they lost that support. This deprived the monarchy of all effective power, and established the supremacy of parliament.

Seventeenth-century England produced many political writings, some of which rank among the classics of modern liberal thought. The most influential of these was John Locke's second treatise *Of Civil Government* (1690). This stated that property, defined as life, liberty and estate, is a natural right of man. (*See* also NATURAL RIGHTS.) Governments are created by a social contract designed for the preservation of that right, and when rulers violate the terms of the contract, society has a right to depose and replace them. The best way to prevent governments from becoming abusive is to separate the powers of government in such a way that the legislative and the executive powers can never fall into the same hands. Although this theory was obviously adapted to the particular needs of the English revolutionary movement, it was couched in such general terms that it was easy to apply it anywhere. Locke's theory of the separation of powers was popularized on the continent through the writings of Montesquieu, who added a third power, the judicial, to those that ought to be kept separate. These doctrines also gained wide currency in the British North American colonies, and provided much of the theoretical foundation for the American system of government.

Both in theory and in practice, the example of 17th-century England was destined ultimately to play a major part in the development of modern constitutional democracy. In its immediate consequences, however, the parliamentary revolution was in no sense democratic. Although the balance of power shifted from king to parliament, parliament itself was an oligarchic rather than a democratic institution. The landed gentry was the controlling force not only in the hereditary house of lords but also, because of a narrowly limited franchise and marked inequalities of representation, in the house of commons. During the Civil War there had been some protests against this situation. Many of the independents who, unlike the Presbyterians and Anglicans, had adopted democratic principles of church government, tried for a time to effect a similar democratization of parliamentary institutions. Starting from the principle that all government rests on the consent of the governed, they concluded that all Englishmen, or at least all property owners including the smallest, should have an equal voice in public affairs. The Levellers (*q.v.*), as this group was called, succeeded for a time in gaining considerable support, particularly in the lower ranks of the Cromwellian army. They also produced an interesting body of democratic thought. But the Levellers were quickly and thoroughly suppressed, and their ideas soon forgotten. Locke remained as the typical exponent of English revolutionary thought. Although his theory of natural rights could be, and ultimately was, interpreted as a defense of democratic equality, he himself did not intend it, nor did his contemporaries understand it, as a challenge to the existing parliamentary order. The oligarchic character of British politics was firmly established, and continued without substantial modification until the Reform act of 1832.

Down to the time of the American and French revolutions, there was only one major theorist who maintained a strictly democratic position, Jean Jacques Rousseau, whose work *The Social Contract* (1762) stands apart from all other writings of the period. A Genevan by birth and early upbringing, he was a proudly self-conscious republican at a time when absolute monarchy was still in the ascendant. Profoundly discontented with his own age, he turned for inspiration to the example of classical antiquity, although his preference there, curiously enough, was not for the democracies. Sparta and Rome, rather than Athens, were his models of political excellence. In his special terminology, however, monarchy, aristocracy and democracy were simply alternative ways of organizing the executive branch of government. When he expressed his doubts about democracy he was simply saying that a mass meeting is rarely capable of settling all the day-to-day problems of public administration. But when it came to the exercise of sovereign authority, Rousseau was a thoroughgoing exponent of direct democracy, though the term is one which he himself never used.

According to *The Social Contract*, no law is legitimate unless it is an expression of the general will, a consensus of the whole community. No man can enjoy full moral responsibility, and so be really a man, unless he participates in the formation of the consensus by which he is legally bound. This means that he must assemble with his fellow citizens at periodic intervals, and personally vote on each and every act of legislation. He must also assume the responsibility of voting for a government to carry out the laws. The government thus created must be wholly subordinate to the general will, as expressed in the popular assembly.

This conception of the nature and function of legislative assemblies was clearly a reversion to the practices of Greek democracy. Appropriate only to city-states, it was wholly unsuited to modern conditions. But even though Rousseau's proposed applications of the principle of the general will were unrealistic, the principle itself was important. If the assumption of moral responsibilities is of the essence of human dignity, it follows that no man can, without degrading himself beneath the level of humanity, be denied a personal share in the making of basic political decisions. Rousseau's eloquent and uncompromising defense of this proposition was a decisive contribution to the theory of modern democracy.

The United States.—The first major experiment in constitutional democracy was inaugurated as a consequence of the American Revolution, although this was not the primary purpose of the revolutionary movement. The grievances which led the colonies to separate from the home country were essentially the same as those which had led to the break between king and parliament in 17th-century England. The colonies had legislative assemblies which started out with very modest pretensions, but came in the course of time to demand a parliamentary plenitude of legislative and fiscal powers. When these claims were rejected by royal governors who tried, as agents of the British government, to enforce the Stamp act and other measures authorized by the British parliament, the result was a typically 17th-century constitutional

crisis. Taxation without representation was denounced as a tyrannical denial both of the natural rights of man and of the traditional rights of Englishmen. The political theory of the Declaration of Independence is strikingly similar to that of Locke's second treatise. Clearly it was a demand for constitutional, not for democratic government, and the colonial assemblies of the period, though based on a somewhat broader franchise than the British parliament, were far from being democratic bodies. It is hard, however, to maintain special privileges under the equalizing conditions of a pioneer society. The colonial gentry were much less firmly established than the gentry of the home country, and much more vulnerable to democratic pressures. When the controlling hand of Britain was removed, the democratic forces in American life were free to seek expression. What most Americans wanted in the long run was a government that was not only constitutional, but also democratic, and this was the ultimate significance of the American Revolution.

The democratic tendencies of the revolutionary movement were apparent from the beginning. One of the first acts of most of the newly independent states was to adopt new constitutions. Having long lived under colonial charters, Americans were familiar with the idea of governments limited by a written constitution. The reason for the change was that most of the states wanted constitutional documents less narrowly restrictive than the older charters had been. Although property qualifications were retained, the franchise was generally broadened, and the powers of the popularly elected assemblies were extended at the expense of the executive. The forces of democracy were beginning to be heard.

A desire to counteract this movement was one of the leading motives of the Constitutional Convention of 1787. Its immediate object was to replace the Articles of Confederation (*q.v.*) with a more effective form of federal union. But a majority of the delegates were conservative, some even aristocratic in temper. Disturbed by what had been going on around them, they tried not only to create a strong central government to counterbalance the power of the states, but also to limit the power of popular majorities to control that central government.

The constitution which emerged from these deliberations was a compromise between democratic and antidemocratic ideas. Although the states were left free in general to be as democratic as they liked, their capacity to interfere with property rights was restricted by giving a number of important economic powers exclusively to the federal government. The democratic principle was recognized in the house of representatives, directly chosen by the same voters who were qualified to vote in state elections, but the principle of indirect election was adopted for the presidency and the senate. Majority rule was also limited by the principle of the separation of powers (*q.v.*), and by an elaborate system of checks and balances. The permanence of these restrictions was guaranteed by the establishment of an uncommonly difficult amending procedure.

The best theoretical justification of these arrangements appears in *The Federalist* by James Madison, Alexander Hamilton and John Jay, all men of importance in the early history of the republic. Though not intended as a systematic theory of politics, it is the most comprehensive statement of the political thought of the period. While recognizing that all legitimate government must rest on popular consent, its authors were much concerned with the dangers of unlimited majority rule and the need for constitutional restraints.

The adoption of the constitution served to modify rather than to arrest the progress of American democracy, for with the emergence of the two-party system, which soon established itself as one of the basic traditions of American politics, some of the constitution's more restrictive features were wholly or partly overcome. The electoral college, designed to ensure the indirect election of presidents, became a meaningless formality when the parties began nominating electors committed in advance to the election of a designated party candidate.

Although the separation of powers was harder to overcome, its significance as a restraint on majority rule was considerably reduced on those occasions, by no means unusual, when a single political party was able to capture both the presidency and the two houses of congress. Party discipline in the United States has never been strong, and conflict between the legislative and executive branches remains a regular feature of American life. But with all its limitations, common party leadership had done much to give unified direction to the various organs of American government, and to make the complex constitutional system a reasonably effective vehicle for the expression of public preferences.

Of the two parties which first competed for the favour of the American electorate, the Democratic Republican or, as it later came to be known, the Democratic party (*q.v.*) soon won the upper hand. The Federalists (*see* FEDERALIST PARTY), who continued to reflect the predominantly antidemocratic mood of the Constitutional Convention, had many able leaders and a number of powerful theorists, but their fear and suspicion of the people as "a great beast" proved uncongenial to the American public. The ideas of Thomas Jefferson, with his confidence in the innate goodness and reliability of the common man, were more in tune with American sentiments. This attitude, though it never found expression in any one outstanding work of political philosophy, was the dominant force in American politics.

By the middle of the 19th century, the outcome of the American Revolution had been to create the first successful example of modern constitutional democracy. It is true that slavery still existed, and that the rise of the Negro to a position of full equality was destined to be a slow and painful process extending far into the future. At this time women's suffrage, too, was practically unknown. With these exceptions, however, the battle for political equality had already been won. By 1845 adult male suffrage was the rule in all but one of the states, which did not abandon property qualifications until 11 years later. There was also a strong atmosphere of social equality which gave American life a quite distinctive flavour.

That the United States had succeeded in creating a new type of civilization was the burden of Alexis de Tocqueville's *De la démocratie en Amérique*, which appeared in two parts, in 1835 and 1840. Although displeased with some aspects of that civilization, which he thought to be unduly ridden by mediocrity and the pressure for social conformity, he recognized American democracy as a rising force which soon would be of decisive world significance. This work, which attracted wide attention in England and on the continent of Europe, was a milestone in the history of democratic thought.

From 1850 onward the main changes in American democracy, apart from the emancipation of the Negro and the acceptance of women's suffrage, had to do with the rise of economic democracy. Although *laissez faire* liberalism, modified by tariff protectionism, had been the prevailing economic doctrine, the free market led, especially after the Civil War, to inequalities of fortune which struck many people as being basically undemocratic. Jefferson's belief in the superior virtues of the small property owner had long been a part of the American political tradition. When this tradition was threatened, Populism (*see* POPULIST PARTY), Progressivism (*see* PROGRESSIVE PARTY, U.S.) and other protest movements arose to denounce the evils of big business.

Unlike the social democrats of Europe, the leaders of American radicalism rarely went to the extreme of rejecting private property. What they did was to insist on equality of economic opportunity and on the duty of government to guarantee minimum standards of economic welfare. Antitrust legislation and regulation of the railroads were typical early products of the movement, which culminated in the New Deal and Fair Deal administrations of Franklin D. Roosevelt and Harry S. Truman and the rise of the so-called welfare state.

The effect of these developments was to place a considerable strain on the American tradition of constitutional government. In a time of rapid economic change, economic democracy produced ever new demands for government action, demands which could not be satisfied quickly within the existing constitutional system. This situation led to a certain amount of impatience with the whole idea of constitutional restraints. The supreme court (*q.v.*) was frequently attacked for its invalidation of legislative measures,

and state and federal legislatures and even the political parties on occasion suffered unpopularity for their slowness in responding to popular pressures. For a time there was a tendency to look to the methods of direct democracy as a radical solution to the problem. The adoption of various types of initiative and referendum, institution of the direct popular election of senators and the establishment of party primaries all reflected disillusionment with the traditional institutions of American democracy. (*See* RECALL; REFERENDUM AND INITIATIVE.)

In general, however, the American people showed little disposition to make radical changes in their established form of government, being generally willing to see the claims of democracy and majority rule asserted within a framework of powerful constitutional restraints. Despite the hindrances which it placed in the way of rapid majority action, the constitution of 1787 remained in the 20th century the basic symbol of American political loyalties. The United States is a constitutional democracy, with the accent on the word constitutional.

The French Revolution.—The second great landmark in the history of modern democracy was the French Revolution. Unlike its American counterpart, this was not a movement based on an established constitutional tradition. Ever since the 16th century France had been an absolute monarchy and although a few districts had retained their provincial states-general, little remained of the medieval parliamentary tradition and few of the revolutionists had any interest in reviving it. Their inspiration came from the philosophy of the Enlightenment, with its radical new conception of the rights of man.

Throughout the 18th century the leaders of French intellectual life, notably Voltaire and the Encyclopaedists, had been asserting the principle of natural equality and denouncing the legal privileges enjoyed by the aristocrats and other favoured classes as a violation of the law of reason. Except for Rousseau, who stood apart from the mainstream of the Enlightenment, they were not much interested in political democracy, but wanted only legal equality. They were perfectly content with absolute monarchy as long as they believed that monarchs could be persuaded to use their powers in the interests of enlightened reform. When that hope was disappointed, the reformers transferred their attention to the people and began supporting the principle of popular sovereignty. But this was only an expedient. Basically the revolutionists were legal reformers, passionately interested in liberty, fraternity and equality and indifferent as to the political means used to accomplish that end. This accounts both for the extraordinary reformatory vigour of the French Revolution and for the extraordinary difficulties it encountered in founding a stable tradition of democratic politics.

The political instability of the movement was reflected in the rapid succession of regimes which followed one another from 1789 to 1804. In 15 years France ran the gamut from absolute monarchy to constitutional monarchy to absolute democracy to imperial dictatorship. The movement began with the calling of the estates-general. This was an attempt to revive the medieval parliamentary tradition, but the reformers immediately started changing the character of the institution. Although the three estates, like the two chambers of the British parliament, were supposed to exercise equal and concurrent powers, the reformers insisted on their meeting as a single assembly in which the popularly elected third estate, with twice the normal number of delegates, was able to outweigh the representatives of the nobility and clergy. This violation of the traditional constitution was justified on grounds of democracy, it being held that the third estate, which represented about 90% of the population, was the authentic representative of the French people and was therefore entitled to the decisive voice in French politics. This claim was quickly made good. When the monarchy, the last remaining restraint on the powers of the popular assembly, seemed obstructive to the cause of enlightened reform, it too was eliminated. Absolute majority rule did not long prove satisfactory, however, as a basis for enlightened action. When differences of opinion broke out in the assembly, the Jacobins, as representatives of the extreme reformist position, felt no hesitation in setting up a revolutionary dictatorship. The Jacobins were replaced in turn by the Directory, which gave way to Napoleon. All during this period the revolutionists acknowledged the people in theory as the true source of legitimate authority, and even the empire was confirmed by a plebiscite based on universal male suffrage. But although everyone spoke in the name of the people, it was impossible to reach any lasting agreement on concrete political institutions through which the people might be allowed to speak for themselves.

The French Revolution had a curiously mixed effect on the development of modern democracy. It was successful in undermining the traditions of the *ancien régime* and in fostering the ideal of a society based on liberty, fraternity and equality. This ideal was embodied in a series of basic legal reforms, from the Declaration of the Rights of Man to the Napoleonic code, which permanently altered the face of Europe. The philosophers of the Enlightenment, whose main interest, as has been pointed out, had always been in legal equality, were thereby vindicated. By proclaiming the sovereignty of the people and by holding occasional elections and plebiscites based on universal male suffrage, the Revolution also gave powerful impetus to the idea of popular participation in government. But by associating this idea with the practices of Jacobin and Napoleonic dictatorship, the movement also served to inhibit the growth of democratic institutions. Although the Revolution, in its earlier stages, had shown a certain preference for absolute majority rule exercised through democratically elected assemblies, it had made no serious or lasting commitment to any particular form of government. Most revolutionists believed that legal and social equality was an end which justified the use of any political means, and this idea was one of the most powerful and persistent legacies of the French Revolution.

Great Britain.—Although France inaugurated the movement toward modern democracy, Great Britain was the country which provided the old world with its first and most widely influential model of an effective democratic state. At the time of the French Revolution, the British constitution was still the oligarchic system established by the revolution of 1688. But the British constitutional tradition, unlike the *ancien régime* of France, proved to be strong and flexible enough to adapt itself to democratic pressures without loss of continuity. The United States, starting from its own version of that tradition, had already shown how much could be done to develop it in a democratic direction, and in the course of the 19th century the British did likewise.

The resulting system of parliamentary democracy was quite different from but no less successful than the American system. Except in South and Central America, where democratic constitutions generally tended, as in the United States, to follow the presidential pattern, Britain was almost everywhere taken as the model of modern constitutional democracy, no country in history being thus so widely imitated.

The movement to democratize the British constitution was inaugurated and sustained by the ideas of political theorists, many of whom, especially the earlier ones, were very close to the philosophy of the Enlightenment. Like the French Encyclopaedists, Jeremy Bentham was primarily a legal reformer. Approaching problems from a standpoint of rationalistic hedonism, he tended to justify majority rule simply as the most expedient means of achieving desirable social ends, an argument characteristic of the first generation of English utilitarians. As time went on, however, English theorists began to place their defense of democracy on a rather broader basis. John Stuart Mill, the most influential of the later utilitarians, was less fully convinced than his predecessors of the inevitable rationality and wisdom of majority rule. In his *Representative Government* he justified it primarily as an institution indispensable to the moral self-education of mankind, and one which ought therefore to be encouraged in the face of a great variety of practical difficulties. Members of the idealist school went further in ascribing inherent moral value to the democratic process. Thomas Hill Green, whose *Lectures on the Principles of Political Obligation* acknowledged an important debt to Rousseau, was the exponent of a balanced rationalistic humanism which not only justified democracy as a logical consequence of the general human right to moral self-determination, but also laid the grounds

for acceptance of the 20th-century welfare state. Throughout the course of the 19th century, English writers played a leading role in the formulation of modern democratic thought.

In Great Britain the democratic movement was able, as it had not been in 18th-century France, to find expression through existing institutions. Parliamentary supremacy having already been established, the obvious course for political reformers was to gain control of parliament. This was not easy. The hereditary character of the house of lords and the limited electoral basis of the house of commons gave preponderant power to the landed gentry, who were generally opposed to the reformist movement. But the British tradition of civil liberties, though far from perfect, made it relatively safe to engage in political agitation. The haphazard nature of the existing representative system meant, moreover, that the franchise was much more widely extended in some constituencies than in others. Radical candidates were able to contest these seats successfully, thus gaining admission to parliament. Some members of the ruling class, particularly the more prosperous merchants, were favourable to radical ideas, and others could be made to give way in the face of popular pressures. The progress of the radical movement was slow, but never wholly discouraging. Its persistence was finally rewarded by the passage of the Reform act of 1832.

Even after 1832 the democratization of the British constitution still had a long way to go. The Reform act itself did no more than rationalize the basis of parliamentary representation and enfranchise a limited number of new voters, leaving untouched the still formidable powers of the hereditary house of lords. Democratization could not be regarded as complete until the suffrage was made universal and full powers were concentrated in the house of commons. These changes came about by a succession of gradual stages which continued well into the 20th century. Although the franchise was greatly extended in 1867 and again in 1884, recognition of the right of all adult males to vote did not come until 1918, full women's suffrage was adopted only in 1928 and some minor anomalies, such as the right of plural voting, continued until 1948. Although the powers of the house of lords declined in practice during the course of the 19th century, its equality with the house of commons remained legally unimpaired until the Parliament act of 1911, which reduced it to a distinctly subordinate position, and its powers were still further reduced in 1948. All this took more than a century.

Partly as a result of its unusually gradual character, this long course of development ended in the firm establishment of one of the most unqualifiedly democratic of all modern constitutional states. In America belief in the principle of majority rule is counterbalanced by the belief that no agency of government can be trusted to exercise unlimited authority. The British constitution, on the other hand, recognizes no distinction between ordinary and constitutional law and insists on the complete legislative sovereignty of the king in parliament. The effect of this doctrine, under modern conditions, is to give practically unlimited powers to the leader of any party that is able to win an absolute parliamentary majority in a general election. Constitutional custom decrees that the king must invite him to form a cabinet with full control over the executive branch of government. Since the bonds of party discipline in England are exceptionally strong, the fact that the members of the cabinet are leaders of the majority party means that they will also be able to control the legislative branch, limited only by the almost negligible powers which still remain with the king or the house of lords. When the British electorate votes, therefore, it does so with the well-founded expectation that the government of its choice will have full power to carry out its mandate. No country has ever gone further toward accepting the principle of absolute majority rule.

This does not mean that England ceased to be a constitutional state. In Britain no less than in the United States, commonly shared respect for the constitution has always been a major force in the life of the country. Had they not considered it constitutional, and therefore deserving of loyal acceptance, the British people would hardly have adjusted themselves so peaceably to the enormous social change involved in their own particular version of the modern welfare state. But the constitutional tradition of Britain, though comparable with that of other constitutional states, has one distinguishing feature: having long been associated with the idea of parliamentary sovereignty, it is conceived in moral rather than in legal terms. Most Englishmen would agree that the majority, acting through proper parliamentary channels, has a legal right to do anything it wishes, but would also agree that there are many things a majority has no moral right to do, and that if those things were attempted, even by act of parliament, they would still be in violation of the principles of the constitution. Civil liberties, for example, are at least as secure in England as in any other country, not because they are legally guaranteed against infringement by parliamentary majorities, but because the tradition of respect for British liberties is so widely shared that it would be morally unthinkable for a majority to violate them. The principles of the British constitution are so deeply engrained in the moral consensus of the community, without legal safeguards, that it has been possible for England fully to accept the democratic principle of majority rule without sacrificing its devotion to constitutional government.

Other European Countries.—The main impetus to the establishment of democracy in Europe came from the ideas of the French Revolution and from the various nationalist movements which followed in its wake. Since the revolutionists had failed, however, to establish a political tradition of their own, it was to the model of the British constitution that the continent generally turned in its search for democratic institutions. To this general rule Switzerland was the only notable exception. Before the French Revolution the Swiss had been governed by a loose confederation of small republics, most of which had been oligarchic in character. Their response at mid-19th century to the democratic and nationalist forces of the times was to create a more strongly centralized federal state which, in its organization of federal-cantonal relations, owed something to the American example and, in its conception of legislative-executive relations, struck out on original and effective lines of its own. The result was one of the stablest and most efficient of modern constitutional democracies. But the Swiss example, though widely admired, was little imitated. Until World War I monarchy remained the normal form of government throughout the continent. As the British example showed that a monarchy could be both constitutional and democratic, the British constitution became the primary inspiration for European democratic government.

Paradoxically, the imitation of British institutions was initiated not by the supporters but by the opponents of the democratic movement. Although the purpose of the 1815 congress of Vienna was to restore the prerevolutionary and pre-Napoleonic system of royal legitimacy, after nearly a generation of revolutionary experience the ideas of revolutionary democracy were too strong to be disregarded. Realizing the impossibility of any total reversion to the practices of the *ancien régime*, the restoration monarchies tried to find a formula which would allow some concessions to popular feeling without impairing the power of the older ruling classes. The oligarchic constitution of Great Britain, which up to that time had successfully resisted the pressure of democratic forces, seemed to provide the answer. When Louis XVIII returned to France, he issued a constitution, the charter of 1814. Although he carefully maintained the position that this document was an expression of his own absolute authority, with no concession to the principle of popular sovereignty, this was little more than a legal fiction. The practical consequence was to convert France into a constitutional monarchy, with institutions closely modeled on those of contemporary Britain. Similar charters were adopted by most of the other restoration monarchies.

Although differing from country to country, the course of events thereafter was much the same as in Britain itself, leading through parallel stages to the increasing democratization of European politics. The fiction of absolute monarchy was gradually replaced, sometimes as a result of further revolutionary disturbances, by the principle that the people are the source of all constitutional authority. There was also a general tendency to move in the direction of universal suffrage, and to concentrate legislative and

executive powers in the hands of cabinets responsible to the popularly elected branch of the legislature.

The tempo of these developments was quite uneven, and often it was the continent rather than England that took the lead. When it came to broadening the franchise and to the adoption of social welfare measures, the continent was apt to move more rapidly, while in the establishment of cabinet responsibility it lagged behind. Even under the French charter of 1814, for example, the right to vote was less narrowly restricted than in pre-Reform act England, and the principle of universal male suffrage was adopted in the fundamental laws which formally established the third French republic in 1875. In this France had been anticipated by the constitution of the new German empire, which also soon proceeded to outdistance the world in welfare legislation. It was only in 1875, on the other hand, that the principle of parliamentary responsibility became finally established in France, and in some countries, such as Germany and Denmark, it was not fully accepted until the early 20th century.

By the 1920s these inequalities of development had been largely evened out. The constitutional states of Europe were all democratic monarchies or republics with political institutions fully comparable with those of Great Britain. There was one important respect, indeed, in which they conformed to the American rather than to the British example: rejecting the idea of absolute legislative sovereignty, they all had written constitutions that to some extent restricted the powers of parliamentary majorities. The process of constitutional amendment, though never as difficult as in the United States, was distinguished from ordinary legislation by the requirement of special majorities, and often by provisions calling for some sort of direct popular vote.

In other respects, however, the system of government was British rather than American in character. Based not on the separation but on the fusion of legislative and executive powers, it entrusted executive responsibilities to a cabinet of party leaders backed by a parliamentary majority. The democratic character of parliament itself was guaranteed by periodic general elections in which all adult citizens, usually including women, possessed the right to vote. This became the standard form of modern European constitutional democracy.

But in spite of these close similarities of governmental structure, democracy on the continent proved in practice to be quite unlike democracy in Britain, as a consequence mainly of quite different systems of party organization. The British voter normally gives his support to one of two major parties. When he goes to the polls, therefore, he is reasonably certain that one or the other of them will win a majority and form the next government. When voting in a presidential election the American voter likewise knows that the successful presidential candidate, though subject to congressional opposition, will at least exercise the powers of the presidency for the next four years. In both cases, the existence of a two-party system ensures a direct connection between the expressed preference of the electorate and the actual control of government. The European voter has no such assurance. The loyalties of the electorate are traditionally divided between so many different parties that it is rarely possible for any one party to win an absolute majority. By establishing various systems of proportional representation, many European constitutions helped to encourage and perpetuate this fragmentation of the electorate.

There were, of course, exceptions. Following World War II social-democratic and Christian-socialist parties occasionally acquired majorities of their own, and some signs even appeared in west Germany of a polarization of voter preferences into something resembling a two-party system. But as a general rule governments in Europe have always had to be formed by the coalition of two or more parties. Coalitions between rivals are hard to form, and even harder to hold together. Thus the voter, no matter how successful his party may be at the polls, cannot be sure that it will be included in the next government or that, being included, it will stay in office long enough to carry out any substantial part of its mandate.

The experience of many European countries showed, however, that the difficulties of the multiparty system are not insuperable. If the leaders of the several parties are reasonably co-operative, and if their followers are willing to moderate their claims in the interests of collaboration, coalition cabinets may provide a stable and effective form of democratic leadership. This is not impossible. Some of the smaller constitutional monarchies, most notably the Netherlands and the Scandinavian countries, were especially successful in combining effective constitutional democracy with a multiparty system.

The difficulties encountered, however, have kept a large part of the continent from ever being won over completely to the cause of constitutional democracy. Democracy was, in the second half of the 20th century, a powerful force in Europe, but it remained haunted by the spirit of the French Revolution, strong in ideas and weak in institutions. The Jacobin tradition still found expression in a widespread tendency to vote for ideologically congenial parties, whether their programs had a chance of being realized or not, and to encourage them to maintain intransigent positions without regard for the practical consequences. This is one of the reasons for the multiplicity of parties in most European countries. But when cabinet after cabinet is voted out of office without having had a chance to accomplish anything, the voter is apt to lose faith in the significance of parliamentary elections and to look elsewhere for the satisfaction of his political needs. Both before and after World War II an appreciable minority and even, on occasion, an actual majority of the electorate in many countries regularly expressed disaffection by voting for totalitarian parties. Constitutional democracy was still a long way from having won general acceptance.

Totalitarian Democracy.—During the 19th and early 20th centuries the idea of democracy was associated primarily with liberal constitutionalism. That is what Pres. Woodrow Wilson had in mind when he stated that "making the world safe for democracy" was the object of United States participation in World War I. One of the principal consequences of that war, however, was the establishment of the communist regime in Russia. Although the U.S.S.R. did not aspire to be a liberal state, it laid great emphasis on what it claimed was its popular and democratic character, a claim which was held to be spurious by upholders of traditional types of democracy. The satellite governments it set up after World War II were officially designated "people's democracies," and it was in this rigorously restricted form that "democracy" became familiar at mid-20th century to much of the human race.

The theoretical origins of this new conception of democracy go back to the period of the French Revolution, and the ideas of economic democracy which emerged as a minor but persistent phase of the revolutionary movement. Although the revolutionists were mainly preoccupied with the problem of legal equality, there was a minority wing which claimed that economic equality was also one of the basic rights of man, and that the Revolution would be meaningless unless its legal reforms were accompanied by a drastic reformation of the existing economic order. The outstanding proponents of this position were the Société des Égaux, a group of dissident Jacobins under the leadership of François Babeuf. Having conspired against the Directory, they were detected and thoroughly suppressed in 1796. Their ideas were not forgotten, however. Socialism continued throughout the 19th century as a living part of the revolutionary tradition, especially in France. Expounded in a variety of versions by many notable writers, including Étienne Cabet, Louis Blanc and Pierre Joseph Proudhon (*qq.v.*), it attracted wide attention and played some part in the revolutionary movements of 1848.

This tradition found its most effective expression in the works of Karl Marx. A German profoundly influenced by the French revolutionary tradition, he developed a social and economic theory which soon gained wide currency. Marxism, as presented in *Das Kapital* and other major writings, is a much elaborated development of the earlier socialist position. Starting from the assumption that all men have a right to enjoy the fruits of their own labour, it tries to demonstrate, by abstruse and largely fallacious economic arguments, that capitalism rests on the expropriation of the surplus values created by and properly belonging to labour.

Private ownership of the instruments of production is therefore intrinsically incompatible with economic justice.

Marx believed that economic relationships are the decisive factor in human life. Politics, law and religion are but superstructures erected on the basis of economic power in the interests of the propertied classes. From this it follows that liberal constitutionalism is not in fact democratic in any meaningful sense of the term. Although legal and political rights may, as a matter of form, be extended to the unpropertied masses, decisive power will always rest with the owners of the instruments of production. As long as this economic inequality continues, democracy is impossible. The historic function of the proletariat is to overthrow the bourgeois state and, by liquidating the capitalist class, to lay the foundations of a truly just and classless society. This is the great unfinished business of the democratic revolution. (*See* SOCIALISM; COMMUNISM; PROLETARIAT.)

In his attitude toward the problem of politics, Marx clearly belongs in the Jacobin tradition. To his way of thinking, equality, conceived now in economic rather than in legal terms, is the essence of democracy, and he pays little attention to the political means used for the attainment of that end. He believes that the proletariat, at the time of the proletarian revolution, will be vastly more numerous than the capitalists. To that extent his theory of revolution is majoritarian. But he allows for the existence of other classes which are neither capitalist nor proletarian, and his theory never specifies whether the revolutionary activists, the "vanguard of the proletariat," ought to secure the support of a majority of the whole population, or even a majority of the proletariat, before beginning the revolution. Nor do his writings throw much light on the question of the political institutions to be established during and after the revolution. Passionately concerned with the achievement of economic democracy as he conceived it, he had no real interest in or comprehension of the problems of democratic politics.

Because of Marx's silence on most of the basic questions of political theory, his followers were free to adopt a wide variety of political positions. In western Europe most Marxists gradually adjusted themselves to the prevailing standards of constitutional government and pursued the ends of economic democracy by parliamentary means. Socialist parties were able, under conditions of universal suffrage, to send many representatives to parliament in various western European countries and to press successfully toward the adoption of socialist reforms. Since this was hard to reconcile with Marx's theory of inevitable revolution, orthodox Marxists long resisted the idea of collaborating fully in the parliamentary process. The Marxist attitude of Jacobin intransigence, though much modified in the course of time, was never wholly lost. By the end of the 19th century, however, the possibility of achieving socialist reforms by parliamentary rather than by insurrectionary action had become too clear in practice to be denied in theory. The revisionist movement, which included such figures as the German socialist Eduard Bernstein and the French socialist leader Jean Jaurès, was an attempt to persuade Marxists that earlier ideas of revolution were out of date, and that socialism under modern conditions could best be achieved within a framework of constitutional democracy. Although revisionism was not immediately accepted, it was widely influential, and provided a theoretical justification for the practice of social-democratic parties. These parties played an important part in the evolution of the modern welfare state.

In Russia the development of Marxist political theory took a radically different turn. At the beginning of the 20th century the tsarist empire was still an absolute monarchy, and it never developed very far in the direction of modern constitutional democracy. This, together with the numerical weakness of the industrial proletariat in an as yet unindustrialized country, meant that Russia offered little scope for social-democratic action. Lenin, the leader of the Bolshevik faction of Russian Marxists, refused to be discouraged (*see* BOLSHEVIKS). Stressing the revolutionary side of Marxist theory, he reinterpreted it in such a way as to emphasize the role of minorities as the true agents of revolutionary action. He developed the idea of the dictatorship of the proletariat, a phrase rarely used by Marx himself, to show that even a small and undeveloped proletariat would be justified, under certain circumstances, in taking over power.

Lenin's theory of democracy was essentially the same as that of the Jacobin dictatorship. For him, as for his French predecessors, the revolution was so important to the furtherance of popular interests as to outweigh all considerations of popular consent. The true spokesman of the revolution was not the nonproletarian majority, or even the proletariat itself, but the "vanguard of the proletariat," a group of properly qualified revolutionary leaders. The role of vanguard was reserved for Lenin's own party, which was converted, under his leadership, into a small but highly efficient and disciplined body of professional revolutionaries. In 1917 it succeeded in gaining control over the greater part of the former Russian empire.

The result was the creation of a new type of political regime, one best described as totalitarian democracy. It is exemplified, in its fully perfected form, by the Soviet constitution of 1936. Many of its features are derived from the standard repertory of constitutional democracy. Promulgated in the name of the people, designated as "the working people of town and country," it provides for a bicameral legislature elected by universal suffrage, a federal distribution of powers between the union government and member republics and many other familiar features. It also includes a very complete bill of rights.

The peculiarity of the constitution does not lie in such formal provisions, which in many cases reflected an ideal of legality rather than practice, but in the position which it ascribes to the Communist party. This position is such as actually to negate traditional western concepts of democracy. Instead of being, like a political party in a constitutional democracy, one association among many competing for popular acceptance, the Communist party of the U.S.S.R. is constitutionally recognized as the only legitimate source of political action. No candidates may stand for election without its approval, and no civil or political rights are valid except insofar as they coincide with its purposes. The leading role of the party is total, being exercised not only in strictly political contexts, but also in trade unions, cultural organizations and all other forms of association. The party itself, moreover, is entirely exempt from popular control. A self-perpetuating and highly selective elite, whose membership usually fluctuated at mid-20th century at somewhere around 5% of the population, it is kept under close supervision and discipline by a still narrower elite of party leaders. The purpose of this whole system is to guarantee the continuing success of the revolution by placing total authority in the hands of a small minority of its most ardent and able supporters.

In any normal sense of the word democracy, a form of government which provides no opportunity for the legitimate expression of popular preferences and which confines the right of significant political action to a small minority of the population is the reverse of democratic. The communists insist, however, that the constitution of 1936 is the most democratic in the world, and that liberal constitutions by comparison are nothing more than façades masking the realities of a basically undemocratic society. This conclusion follows logically from the premises of the Marxist conception of democracy. If democracy is primarily a question of political rights, the democratic claims of the U.S.S.R. are nonsense. Even if democracy is primarily a question of economic equality, those claims are still dubious, since many other countries, including Britain and the United States, have gone a good deal further than communist Russia in equalizing incomes. In the special terminology of Marxism, however, the necessary and sufficient condition of democracy lies simply in the elimination of private ownership of the instruments of production. There is no private capital in the U.S.S.R. From this it follows that, in the very special Marxist sense of the word, the U.S.S.R. is far more democratic than any liberal state.

The 20th Century.—One of the most striking features of the 20th century was the rapid diffusion of the idea of democracy. Totalitarians and constitutionalists may differ as to the proper meaning of the term, but it was in the mid-20th century a rare

government which would admit that it was not democratic in some sense or other, or striving to become so. Down to World War I the incidence of governments claiming to be democratic was much more restricted, being confined almost entirely to Europe and to those parts of the world, notably the two Americas and Australia, which had been settled by populations preponderantly European in origin. After World Wars I and II the number of self-styled democracies, whether totalitarian or constitutional, steadily increased. It is true that, in the period between the two wars, ideological movements based on the denial of democratic principles of equality enjoyed a temporary popularity in western Europe, culminating in the short-lived triumphs of Nazi Germany, and antidemocratic tendencies also appeared elsewhere, notably in the Union of South Africa. By the middle of the 20th century, however, there were few parts of the globe where democracy of one sort or another was not the generally recognized principle of political legitimacy. Few concepts had ever moved so rapidly from obscurity to all but universal acceptance.

This development was the outgrowth of two separate but closely associated phenomena, the decline of colonialism and the rise of nationalism. Prior to World War I the spread of western civilization had characteristically involved the division of the rest of the world into colonial empires or, as in the case of China, into western-dominated spheres of influence. Although the more successful colonial powers were constitutional democracies, they did not immediately or fully extend their own principles of government to their overseas possessions, but ruled them as subordinate dependencies. In the western world itself, however, the rise of democracy soon became associated with the principle of national self-determination and, like all western ideas, this principle spread to the colonial world and became a powerful revolutionary force.

Rapid population growth and rising urbanization did much to upset the traditional bases of colonial society and to foster the dissemination of western influences, including nationalism. Before long, the more westernized sections of the native populations everywhere were challenging colonialism in its name. The result was a progressive disintegration of the various colonial empires, a process much accelerated by the World War II Japanese conquest of southeast Asia. Soon after the end of the war the greater part of Asia broke loose from the colonial system, and the movement toward independence in all colonial areas was greatly stimulated. By this time, however, the westernization of the non-European world had progressed so far that there was rarely any question of restoring the precolonial forms of native government. What the nationalists wanted, with rare exceptions, were modern governmental regimes capable of raising their countries to a position of equality with other modern nations. That meant democracy.

But what form of democracy? The modern world offered two working models, the constitutional and the totalitarian. The first was the older and better established form, and the one which was still characteristically associated with the more advanced types of industrial society. The second was exemplified by the U.S.S.R., which had become an object of emulation and inspiration to all economically underdeveloped nations by its unprecedentedly rapid growth as an industrial and military power. The question of which model the newly liberated nations would follow was one of the most momentous issues of 20th-century politics.

The choice was not wholly free. Almost immediately after the end of World War II, rivalry between the western world, led by the United States, and the communist world, led by the U.S.S.R., became the outstanding factor in world affairs. This rivalry expressed itself in an attempt by both the principals to draw the largest possible number of allies and dependencies into their respective camps. Such efforts did not necessarily include an attempt to dictate the form of government adopted by the country in question. U.S. aid, for example, went to Arab principalities that were far from being constitutional democracies, while the U.S.S.R. lent its support to countries which, like Gamal Abdel Nasser's Egypt, were in no sense communist. Whenever possible, however, it was tempting to strengthen the bonds of association by imposing a congenial type of political regime. This could most effectively be done in those areas which, in the years following World War II, were under military occupation. The governments of eastern and central Europe were accordingly rapidly transformed into people's democracies, while west Germany and Japan were remodeled as constitutional governments. Even in the absence of direct military control, moreover, pressures could still be exerted. Interventions of this sort undoubtedly played a large part in determining the political complexion of the postwar world.

But when all due allowance had been made for the effect of external pressures, the fact remained that many countries of the one-time colonial world showed a marked affinity for one or the other of the two rival systems. As a general rule, areas which, under the tutelage of a preceding colonial authority, had been long and conscientiously schooled in the exercise of political responsibilities tended to opt for constitutional democracy, while others gravitated to totalitarianism. Thus China, which had never been fully subjected to colonial control and had recently been ruled by a nationalist government with strong totalitarian leanings, became a full-fledged communist state shortly after the end of World War II. This was accomplished with a minimum of Russian intervention, and in the face of substantial U.S. support for the opposing nationalists. The Philippine republic, on the other hand, adopted a democratic constitution closely patterned after that of the United States, and began operating it with considerable success.

Especially notable were the developments which took place within the overseas territories of Great Britain. In the second half of the 19th century Britain had already begun the process of converting its colonies into a commonwealth of freely associated nations (*see* COMMONWEALTH OF NATIONS). This process was completed, so far as the English-speaking dominions were concerned, with the passage of the Statute of Westminster in 1931. After the end of World War II the policy was rapidly extended to other parts of the empire, beginning with India, Pakistan and other Asiatic possessions and continuing in such areas as Ghana and the British West Indies. All of these new countries adopted forms of government based more or less closely on the British model. From the standpoint of constitutional democracy, this was one of the most promising developments of the postwar period.

At the middle of the 20th century, however, constitutional and totalitarian democracies were still very far from having reached a state of stable equilibrium. In the 1950s serious popular uprisings in Hungary and east Germany, though quickly suppressed by Russian military intervention, were evidence that the people's democracies had yet to succeed in winning general acceptance among the nations of central and eastern Europe. The electoral successes of the Communist party in India and the long persistence of communist-inspired guerrilla movements in the Philippines and Burma were typical of the difficulties that many of the new constitutional democracies were likewise encountering. Nations which have long been agitating for independence usually develop unified nationalist parties which come in the course of time to regard themselves as the only true representatives of the national interest. Such parties find it easier to slip into totalitarian ways of government than to adjust themselves to the constitutional pattern of party competition. Although many nationalist groups, such as the Congress party of India, made serious and generally successful efforts to behave like constitutional parties, it was by no means certain that all of the newly established constitutional states would remain true to constitutional principles. In the face of popular discontents, on the other hand, the stability of many totalitarian states was also open to question. Thus the political situation, in many parts of the world, remained in a highly fluid state. Democracy was in the ascendant everywhere, but only the future could tell whether the prevailing form of democracy would prove to be constitutional or totalitarian.

See NATURAL RIGHTS; *see* also references under "Democracy" in the Index volume. (F. M. W.)

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(W. PAS.; F. M. W.)

DEMOCRATIC PARTY (U.S.). The party began in 1792 as a national group of voters supporting Thomas Jefferson and using at times the title "Republican," derived in part from their emphasis on the newly established "republic" as contrasted with "monarchy." The party continued under various designations with such leaders as James Madison and James Monroe until, during the presidency of Andrew Jackson, it came to be known under its present name. The basis for its appeal was laid in the Constitutional Convention of 1787 and in the ensuing debate upon the powers of the national government. In accord with Jeffersonian philosophy, there was eventually established a party which adopted the following political principles: popular control of government; wide extension of suffrage and the fullest measure of personal liberty consistent with law and order; strict interpretation of the constitution and preservation of the rights of the states; opposition to centralized power in the federal government; religious liberty, free speech and a free press.

Although from the outset this party was a strong opposition force in the congress, it did not win control of the administration until Jefferson became president in 1801. Throughout the next 40 years, except in 1825–29 during the administration of John Quincy Adams, the party was in control. Madison and Monroe, both close friends and disciples of Jefferson, served in the presidency a total of 16 years.

Although Jefferson had established the Democratic party on the principle of popular government, as opposed to the Hamiltonian idea of direction by national economic groups, the members of the so-called Virginia school of presidents were aristocrats in birth, breeding, education and environment. It was not until the election in 1828 of Andrew Jackson, a frontiersman from Tennessee, that a "man of the people" entered the White House to become the second great figure in the party's annals. The Jeffersonians in effect had held the party in trust for the people, whereas Jackson would turn it over to them.

Jackson emphasized Jefferson's original principle of strict interpretation of the constitution. His great political battle, which he won, was to deny a renewal of charter to the United States bank, inasmuch as he feared the weight of its influence in national affairs. He also asserted the authority of the national government in strong terms. When South Carolina threatened to nullify federal tariff legislation and if necessary to secede from the union, Jackson issued a proclamation declaring that no state had a constitutional right to withdraw from the federal union.

Between 1837, when Jackson retired, and 1860, four Democratic presidents were elected—Martin Van Buren, James K. Polk, Franklin Pierce and James Buchanan. Although the Democrats lost to the Whigs in 1840, the death of Pres. William Henry Harrison in 1841 brought to the presidency John Tyler, who had been and was more of a Democrat than a Whig.

The real party history of this period is concerned with the futile struggle of politicians and statesmen to ignore or compromise the slavery issue. The Democratic party during the Van Buren administration came to be more completely under the dominance of the south, which was unshakably convinced that its economic, social and political interests were bound up in the preservation and extension of slavery. The south demanded the right to extend slavery into new territories and states as the only way to prevent the great industrial states of the north from becoming too strong in the federal government.

By 1850 the slavery issue had assumed such aggravated form that working out a compromise, such as the Missouri compromise of 1820, had become extremely difficult. A final effort, however, was made in the compromise of 1850, which was proposed by Henry Clay and accepted by majorities in both the Whig and the Democratic parties. On the basis of this arrangement, the Democratic conventions of 1852 and 1856 assumed that the issue had been settled.

Such an assumption was proved erroneous by subsequent events. No matter how the politicians sidestepped the question in their speeches and platforms, the absorbing issue nevertheless was slavery. The final crack-up came in 1860, when the delegates assembled for the Democratic convention in Charleston, S.C.

The majority of the platform committee of this convention proposed a plank stating that each new state or territory must have the right to enter the federal union on its own terms, as expressed in a constitution adopted by vote of its residents, whether prohibiting or recognizing slavery. Pending adoption of a local constitution, the platform declared for free settlement in new states and territories, which meant that southerners could establish themselves there with their "property," including slaves.

When the convention rejected this resolution and adopted a minority report ignoring any specific slavery declaration, the southern delegates withdrew. The northern Democrats adjourned to Baltimore, Md., and nominated Stephen A. Douglas of Illinois as presidential candidate. The southern faction, reconvening in Richmond, Va., adopted the rejected majority report on slavery and then met in Baltimore where it nominated John C. Breckinridge of Kentucky as its presidential candidate.

Inevitably, this north-south split was disastrous to the Democrats. The newly formed Republican party, which had been organized in 1854 on an antislavery basis, won its first national victory in 1860. Although its nominee, Abraham Lincoln, did not obtain a majority of the popular vote, he received a majority in the electoral college because of the Democratic split. Not until 1884 did the Democrats again elect their candidate.

From 1860 to 1932, the Democratic party was in administrative power for only 16 years. Its defeat in 1876, however, when Samuel J. Tilden of New York, an anti-Tammany reformer, was the nominee, was questioned by those who believed that he had actually defeated Rutherford B. Hayes (*q.v.*). In 1884 the Democrats elected Gov. Grover Cleveland of New York to the presidency. They lost with him in 1888, but elected him again in 1892. In 1896 the party once more split disastrously, this time on the free and unlimited coinage of silver as advocated by their candidate, William Jennings Bryan of Nebraska. Through their addiction to economic radicalism under the Bryan leadership, the Democrats after 1896 became again a minority party in the nation. The large business, industrial and financial interests developing at the time preferred the party of William McKinley at the turn of the century.

The Democrats returned to power in 1913 with Woodrow Wilson, former governor of New Jersey, mainly because the 1912 Republican vote was divided between William Howard Taft and the Progressive party candidate, Theodore Roosevelt. (*See* PROGRESSIVE PARTY, U.S.) Wilson, under the slogan of the New Freedom, urged and obtained legislation for more complete federal regulation of banking and industry, including establishment of the federal reserve system and the Federal Trade commission, strengthening of the antitrust statutes and a drastic revision of the tariff laws. Under the 19th amendment, women gained the right to vote during Wilson's second administration. Wilson had been reelected in 1916 in a closely contested election. In his second term, he mobilized the country's resources for the defeat of Germany in World War I and was hailed throughout the world as the saviour of democracy. He inspired the creation of the League of Nations.

A Democratic setback occurred in 1920 with the election of the Republican nominees, Warren G. Harding and Calvin Coolidge,

Democratic Presidential Candidates

Election date	Democratic candidate*	Popular vote		Electoral	
		Democrat	Major Opponent	Dem.	Opp.
1796	Thomas Jefferson	(†)	(†)	68	71
1800	Thomas Jefferson	(†)	(†)	73‡	73‡
1804	Thomas Jefferson	(†)	(†)	162	14
1808	James Madison	(†)	(†)	122	47
1812	James Madison	(†)	(†)	128	89
1816	James Monroe	(†)	(†)	183	34
1820	James Monroe	(†)	(†)	231	1
1824	Andrew Jackson	153,544	108,740	99‡	84‡
1828	Andrew Jackson	647,286	508,064	178	83
1832	Andrew Jackson	687,502	530,189	219	49
1836	Martin Van Buren	762,678	735,651	170	73
1840	Martin Van Buren	1,129,102	1,275,016	60	234
1844	James K. Polk	1,337,243	1,299,062	170	105
1848	Lewis Cass	1,220,544	1,360,099	127	163
1852	Franklin B. Pierce	1,601,274	1,386,580	254	42
1856	James Buchanan	1,838,169	1,341,264	174	114
1860	Stephen A. Douglas	1,375,157	1,866,452	12	180
1864	George B. McClellan	1,805,237	2,213,665	21	212
1868	Horatio Seymour	2,703,249	3,012,833	80	214
1872	Horace Greeley	2,834,125	3,597,132	§	286
1876	Samuel J. Tilden	4,300,590	4,036,298	184	185
1880	Winfield S. Hancock	4,444,952	4,454,416	155	214
1884	Grover Cleveland	4,874,986	4,851,981	219	182
1888	Grover Cleveland	5,540,309	5,439,853	168	233
1892	Grover Cleveland	5,556,918	5,176,108	277	145
1896	William J. Bryan	6,502,925	7,104,779	176	271
1900	William J. Bryan	6,358,133	7,207,923	155	292
1904	Alton B. Parker	5,077,911	7,623,486	140	336
1908	William J. Bryan	6,409,104	7,678,908	162	321
1912	Woodrow Wilson	6,293,454	4,119,538	435	88
1916	Woodrow Wilson	9,129,606	8,538,221	277	254
1920	James M. Cox	9,147,353	16,152,200	127	404
1924	John W. Davis	8,386,503	15,725,016	136	382
1928	Alfred E. Smith	15,016,443	21,391,381	87	444
1932	Franklin D. Roosevelt	22,821,857	15,761,841	472	59
1936	Franklin D. Roosevelt	27,751,597	16,679,583	523	8
1940	Franklin D. Roosevelt	27,244,160	22,305,198	449	82
1944	Franklin D. Roosevelt	25,602,504	22,006,285	432	99
1948	Harry S. Truman	24,105,695	21,969,170	303	189
1952	Adlai E. Stevenson	27,314,992	33,778,963	89	442
1956	Adlai E. Stevenson	26,028,887	35,582,236	73¶	457
1960	John F. Kennedy	34,227,096♀	34,107,646♀	303♁	219♁
1964	Lyndon B. Johnson	42,300,000□	26,600,000□	486◇	52◇

*Popularly called "Republicans" up to the time of Andrew Jackson. †Electors chosen by legislatures in many states. ‡Contest decided in house of representatives §Because of the death of Horace Greeley before electoral votes were cast, Democratic electors scattered their votes. ‖Elected. ¶One Alabama elector cast his vote for a third person. ♀Based on *Statistics of the Presidential and Congressional Election of November 8, 1960*, compiled under direction of the clerk of the house of representatives. ♁15 electoral votes were cast for Sen. Harry F. Byrd of Virginia. □Preliminary, Nov. 1964. ◇Unofficial, based on preliminary reports of popular vote.

Note: Authorities differ on the popular vote for president in some elections, particularly during the 19th century. For a discussion of the problems involved, see Edgar E. Robinson, *The Presidential Vote, 1896–1932* (1934) and *They Voted For Roosevelt, 1932–1944* (1947); W. D. Burnham, *Presidential Ballots, 1836–1892* (1955).

over the James M. Cox-Franklin D. Roosevelt ticket. The voters had become disillusioned with the war's sacrifices, division among the victorious Allies and the bitter debate over the entrance of the United States into the League of Nations, which had ended in defeat for the League's advocates. The Democrats had found no inspiring leadership after the illness and virtual retirement of Wilson in 1919, and lacked unity on national problems at the end of the war. The issue of prohibition, provided in the 18th amendment adopted in 1919, split the party into urban and rural factions. The backwash of war and the temporary but spectacular prosperity of the 1920s kept the party out of power for 12 years.

In 1932, however, the Democrats rode to victory with Gov. Franklin D. Roosevelt of New York. Hard times under Herbert Hoover contributed to a triumph in which Roosevelt carried all but six states. In 1936 the party's victory was overwhelming, only Maine and Vermont voting Republican. Roosevelt in 1940 was elected for an unprecedented third term, carrying all but ten states against Wendell L. Willkie, the Republican candidate, and he won a fourth time in 1944, defeating Gov. Thomas E. Dewey of New York by 432 electoral votes to 99.

Roosevelt's domestic program, known as the New Deal, provided collective bargaining for labour unions under federal protection, subsidy payments to farmers in return for government control of production, stricter regulation of banking and investments, increasing government ownership and operation of utilities, a social security and unemployment insurance system, guarantee of bank deposits and federal loans for home building. Two factors in the Democratic successes were the heavy relief expenditures throughout the depression and the large federal expenditures for World War II—all of which stimulated the economy.

Domestic reform was pushed aside for the time being when the Japanese attack on Pearl Harbor on Dec. 7, 1941, brought the United States into World War II. Roosevelt had already transformed the U.S. into an "arsenal of democracy," and he now became one of the leaders of the Allied forces. Roosevelt died on April 12, 1945, before the end of the war, and was succeeded by Vice-Pres. Harry S. Truman, former senator from Missouri.

On his accession to the presidency, Truman proposed an expansion of the New Deal into what he described as the Fair Deal. He proposed that congress enact compulsory health insurance, an enlarged farm program, a broad civil rights program and federal aid to education. On most of these issues he was thwarted by a conservative coalition of Republicans and southern Democrats.

Foreign problems, especially Soviet expansion and aggression, occupied President Truman from 1947 on. Accepting the Soviet challenge in what was described as a "cold war," he sponsored loans and grants to restore Europe's war-ravaged economy and to rearm the members of the North Atlantic Treaty organization. In June 1950 he ordered U.S. forces in Japan to resist the Communist invasion of South Korea that led to the Korean War.

Meanwhile, having served out Roosevelt's unfinished term, Truman was elected president in 1948, defeating Republican candidate Thomas E. Dewey by 303 electoral votes to 189 in a remarkable upset victory. After President Truman declined to run for reelection in 1952 the Democrats nominated Gov. Adlai E. Stevenson of Illinois, a choice that was not satisfactory to many elements of the party. Stevenson waged an aggressive campaign but won only 89 electoral votes to 442 for Dwight D. Eisenhower, the Republican candidate.

The Democrats throughout the four years 1952–56 were divided, particularly on the question of civil rights. The 1954 U.S. supreme court decision that declared racial segregation in public schools to be unconstitutional became an issue that widened the breach between the southern and northern wings of the party.

Former President Truman continued to share leadership honours with Stevenson after the latter announced that he would be a candidate in the 1956 campaign. Sen. Estes Kefauver of Tennessee and Gov. Averell Harriman of New York also became candidates for the nomination. In spite of Truman's declaration in favour of Harriman, Stevenson was renominated by the party's national convention.

During the campaign that followed, Stevenson issued several policy statements dealing with education and social services under the general title "New America," and advocated an end to the testing of nuclear weapons and termination of the Selective Service draft. Successive crises in foreign relations weakened Stevenson's appeal and he was overwhelmingly defeated. The Democrats, however, won control of both houses of congress, and in 1958 increased their control.

In 1960 the party nominated Sen. John F. Kennedy of Massachusetts for president and Sen. Lyndon B. Johnson of Texas for vice-president. In a vigorous campaign—highlighted by televised debates with the Republican candidate, Vice-Pres. Richard M. Nixon—Kennedy attacked the Republican administration for lack of leadership and won the election, though by a very close popular vote. The Kennedy New Frontier administration was marked by recurring foreign crises and by a reluctance on the part of a heavily Democratic congress to pass administration-sponsored legislation, particularly in the fields of welfare, civil rights and foreign aid (*see* KENNEDY, JOHN FITZGERALD: *Presidency*). After Kennedy's assassination on Nov. 22, 1963, Pres. Lyndon B. Johnson was able to marshal sufficient bipartisan congressional support to overcome the coalition of southern Democrats and conservative Republicans and to pass some of the more important legislation proposed by Kennedy. Included were a bill to reduce individual income taxes

and, after breaking a senate filibuster, a comprehensive civil rights bill. In Aug. 1964 the Democratic national convention nominated Johnson to run for president in his own right with Sen. Hubert H. Humphrey of Minnesota as his vice-presidential running mate. The two candidates urged a continuation of the policies of the Kennedy-Johnson administration. They charged that the Republican presidential candidate was imprudent in foreign affairs and that he opposed many social reforms adopted in the 20th century. The Democratic candidates won a sweeping victory in the Nov. 3 election, carrying all but six states (five of which were in the traditionally Democratic deep south). The party also strengthened its majority in both houses of congress.

See also references under "Democratic Party (U.S.)" in the Index.

See Wilfred E. Binkley, *American Political Parties: Their Natural History*, 2nd ed. (1945). (E. E. R.; X.)

DEMOCRITUS, probably the greatest of the Greek physical philosophers, one of the founders of the atomic theory, was a native of Abdera in Thrace, or as some say—probably wrongly—of Miletus. Knowledge of his life is based almost entirely on tradition of an untrustworthy kind. The date of his birth is disputed: some writers place it as early as 470 B.C., others at 460, others even later. Diodorus Siculus says that he died at the age of 90; others make him as much as 20 years older. He inherited considerable property, which enabled him to travel widely in the east in search of information; in Egypt he studied the mathematical and physical systems of the ancient schools. The extent to which he was influenced by the Magi and the eastern astrologists is a matter of pure conjecture. His works, according to Diogenes Laërtius, numbered 72 and were characterized by a purity of style which compares favourably with that of Plato. In the variety of his knowledge and in the importance of his influence on both Greek and modern speculation, Democritus was the Aristotle of the 5th century, while the sanity of his metaphysical theory has led many to regard him as the equal, if not the superior, of Plato.

His chief views may be treated as follows:

The Atoms and Cosmology.—The physical and cosmological doctrines of Democritus were elaborated and systematized from those of Leucippus (*q.v.*). While agreeing with the Eleatics on the eternal sameness of Being (nothing can arise out of nothing; nothing can be reduced to nothing), Democritus followed the physicists in denying its oneness and immobility. Movement and plurality being necessary to explain the phenomena of the universe and impossible without space (not-Being), he asserted that the latter had an equal right with Being to be considered existent. Being is the Full (*pleres* or *plenum*); not-Being is the Void (*kenon* or *vacuum*), the infinite space in which moved the infinite number of atoms which in his system replaced the single Being of the Eleatics. These atoms are eternal and invisible; absolutely small, so small that their size cannot be diminished (hence the name *atomon*, or "indivisible"); absolutely full and incompressible, they are without pores and entirely fill the space they occupy; and homogeneous, differing only in shape (as A from N), arrangement (as AN from NA), position (as N is Z on its side) and magnitude (and consequently in weight, although some authorities dispute this). But while atoms thus differ in quantity, differences of quality are only apparent, due to the impressions caused on our senses by different configurations and combinations of atoms. A thing is hot or cold, sweet or bitter, hard or soft only by convention; the only things that exist in reality are the atoms and the void. John Locke's distinction between primary and secondary qualities is here anticipated. Thus, the atoms of water and iron are the same, but those of water, being smooth and round and therefore unable to hook onto one another, roll over and over like small globes, whereas those of iron, being rough, jagged and uneven, cling together and form a solid body. Since all phenomena are composed of the same eternal atoms it may be said that nothing comes into being or perishes in the absolute sense of the words (compare later ideas of the "indestructibility of matter" and "conservation of energy"), although the compounds made out of the atoms are liable to increase and decrease—appearance and disappearance—in other words, to birth and death. As the atoms are eternal and uncaused, so is motion. For the love and hate of Empedocles and the *nous* (intelligence) of Anaxagoras, Democritus substituted fixed and "necessary" laws (not chance; that is a misrepresentation due chiefly to Cicero). Everything can be explained by a purely mechanical (but not fortuitous) system, in which there is no room for the idea of a providence or an intelligent cause working with a view to an end. The origin of the universe was explained as follows. The original motion of the atoms was in all directions; it was a sort of "vibration"; hence collisions came about, and in particular a whirling movement (*dine*) resembling the rotation of Anaxagoras, whereby similar atoms were brought together (as in the winnowing of grain) and united to form larger bodies and worlds. This happened not as the result of any purpose or design, and thus resembles the working of "chance," but actually it is merely the result of "necessity"; *i.e.*, it is the normal manifestation of the nature of the atoms themselves. Weight was a derivative quality of the atoms, depending upon their size, and it came into play only through the action of the *dine:* the "heavier" atoms were those which could resist the force of the rotation and so move toward the centre. Atoms and void being infinite in number and extent, and motion having always existed, there must always have been an infinite number of worlds, all consisting of similar atoms, in various stages of growth and decay.

The Soul.—Democritus devoted considerable attention to the structure of the human body, the noblest portion of which he considered to be the soul, which everywhere pervades it, a soul atom being intercalated between two corporeal atoms.

Although, in accordance with his principles, Democritus was bound to regard the soul as material (composed of round, smooth, specially mobile atoms, identical with the atoms of which fire consisted), he admitted a distinction between it and the body. These all-pervading soul atoms exercise different functions in different organs: the head is the seat of reason, the heart of anger, the liver of desire. Life is maintained by the inhalation of fresh atoms to replace those lost by exhalation, and when respiration, and consequently the supply of atoms, ceases, the result is death. It follows that the soul perishes with, and in the same sense as, the body.

Three books by Democritus on zoology and physiology are recorded, and there is a good deal of evidence for his views on these subjects. Men, he believed, originally arose from "water and mud"; he compared the production of worms from moist earth. There remain records of his views on embryology, and on various matters relating to animals; *e.g.*, the growth of horns, spiders and spiders' webs, the eyes of owls, etc. Another treatise was entitled *The Causes of Seeds, Plants and Fruits.*

Perception and Knowledge.—Sensations are changes produced in the soul by external objects and are the result of contact, for the atoms of the soul can be affected only by the contact of other atoms. But sensations such as sweet and bitter are not as such inherent in the atoms, for they result from effects caused merely by the size and shape of the atoms; *e.g.*, sweet taste is due to round and not excessively small atoms. Such sensations are therefore subjective. In the case of sight, *eidola* or effluences (*aporrhoiai*), thrown off from the surfaces of objects, produced an impression or "stamp" in the air, and entered the eye as an "image" (*emphasis*).

It is in Democritus that we find a first real attempt to explain colour, which again is not an objective quality as such: it is due, he thinks, to the "position" rather than to the shape of the constituent atoms of compounds. He regards black, red, white and green as primary. The sensation of white is caused by atoms which are smooth and flat so as to cast no shadow; in crumbling white objects the atoms are aslant; the sensation of black is caused by rough, uneven atoms. The other colours are derived from various mixtures of the primary four and are infinite in number. Thought is fundamentally the same as sensation; it is caused by change or alteration. The mind consists of closely packed soul atoms, and in consequence can be affected by certain very subtle *eidola* which penetrate directly to it without having disturbed the soul atoms in the sense organs. Democritus distinguished between obscure or bastard cognition, obtained through the senses only, and genuine cognition, obtained through the mind though the data were pro-

vided by the senses; the latter is concerned with atoms and the void exclusively, which are the only real existences.

Theology.—The popular belief in gods was attributed by Democritus to the desire to explain extraordinary phenomena (thunder, lightning, earthquakes) by reference to superhuman agency. The origin of the belief he accounted for by the entry into men's minds of *eidola*, some beneficial, some harmful, which were visible and audible, and foretold the future: the ancients thought these indicated the existence of gods. The notion of *eidola* was adopted by Epicurus, who asserted that they emanated from divine beings; but it is doubtful whether Democritus believed this.

Ethics.—Democritus' collection of ethical precepts is the first which deserves the name of a moral system, though it appears to be founded upon a practical rather than a theoretical basis. Just as there is in the field of knowledge an ultimate truth (namely atoms and the void), as contrasted with the "conventional" objects of sensation such as sweet and bitter, so there is in the moral field an ultimate good, namely "cheerfulness," as contrasted with "the pleasant." "Cheerfulness" is "a state in which the soul lives peacefully and tranquilly, undisturbed by fear or superstition or any other feeling." In this, Democritus differs from Epicurus, who made the bodily pleasures his starting point, though he anticipates Epicurus' "imperturbability." The right choice of pleasures can conduce to "cheerfulness"; these will be pleasures of the soul, not sensual pleasures. True pleasure is a mean between excess and defect, and "cheerfulness" comes through moderation. Prudence, which is the outcome of nature and education, enables the right choice to be made.

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DEMOGRAPHY. This word has become current, with rising interest in population studies, as a name for this field of inquiry. In its French form the word (from the Greek "people" and "to write") was first used by Achille Guillard in his *Éléments de statistique humaine ou démographie comparée* (1855). It was applied in French academic circles to statistics concerning the life conditions of people, especially those affecting health and mortality. In modern usage it is sometimes restricted to the more formal aspects of population study; *i.e.*, the quantitative analysis of population structure and trends. *See* Population.

(F. Lo.)

DE MOIVRE, ABRAHAM (1667–1754), English mathematician of French Huguenot extraction, was a pioneer in the development of analytic trigonometry and in the theory of probability. He was born at Vitry, Champagne, on May 26, 1667. Upon the revocation of the Edict of Nantes he was jailed as a Protestant; upon his release he left for England. In London he became a close friend of Sir Isaac Newton and Edmund Halley; in 1697 he was elected to the Royal society and later to the Berlin and Paris academies. Despite his distinction as a mathematician, De Moivre never succeeded in securing a permanent position but eked out a precarious living by tutoring and consultations on gambling and insurance. He died, nearly blind, on Nov. 27, 1754.

The majority of his papers appeared in *Philosophical Transactions*. A fundamental theorem in trigonometry (*q.v.*) bears his name. His first work in probability, *De Mensura Sortis* (1711), was later expanded into *The Doctrine of Chances* (1717), which appeared in several editions. His contributions to actuarial mathematics are found in *Annuities on Lives* (1724).

De Moivre was the discoverer of the normal probability curve, *Approximatio ad Summam Terminorum Binomii* (1733), often erroneously ascribed to Karl Friedrich Gauss.

See also *Histoire de l'Académie Royale des Sciences* (1754); H. M. Walker, "Abraham de Moivre," *Scr. Math., N.Y.*, vol. 2 (1934).

(O. Oe.)

DEMON (from Gr. *daimon*, "supernatural being" or "spirit") has come to mean an evil or hostile spirit below the rank of a god, although originally the word had a good as well as a bad connotation (*see* Daemon). Socrates, for example, was thought to have a *daimon* or familiar spirit that warned him when he was about to make a wrong decision. Among primitive peoples the line between good and evil spirits is not clearly drawn; even the usually benevolent spirits may have their malicious moments, and those that are generally hostile may be persuaded by appropriate rites to become friendly.

In the history of the west a shift of meaning came with the rise of Christianity, which condemned the spirits of the pagan world as evil and in league with the Devil. It is therefore common English usage to confine the word demon to spirits that bring upon men the evils they most dread. It is well therefore to distinguish, as most languages do, between the souls or ghosts of the dead, supernatural beings of a higher and nobler order such as the gods, and malevolent spirits such as devils and demons. (*See* further Animism; Ancestor Worship; Devil.)

Demons of Europe.—In European countries with Celtic, Teutonic and Slavic backgrounds, the coming of Christianity caused the suppression of belief in innumerable supernatural beings; yet many of these survived in popular belief as demons or evil spirits. Generally nameless and shifty of movement, these appeared in forests and dark places or by night, and often took bodily form in animals and birds; some were goblins and could assume male or female shape; others were wraiths or ghosts and specters. The leprechauns of Ireland were rather fairies than demons, but alongside them were other phantoms that were malevolent. The belief of the ancient Teutons that the souls of the dead often returned by night or in wind and storm to harass the living as incubi (demonic spirits tormenting people in sleep) led to the survival in central Europe during medieval times of terrifying "night-riders" or "night-mares" (Ger. *mahre;* Scand. *mara*) that rode on animals, swayed in trees and sat suffocatingly on human breasts or sucked the milk of women and cows. They were part of a group of *hexen* (witches) that had an "evil eye," cast spells upon people and caused animals to sweat unaccountably, wheeze and lose blood; they could also assume the forms of toads, ravens and bears. Their male counterparts were the werewolves (man-wolves) so famous in European legend (*see* Lycanthropy). Besides these evil spirits of human origin were the nonhuman demons that lived in forests, on mountains and in lakes, streams and wells, such as the Teutonic nix and the Slavic *rusalkas*. The Slavic demons hid in the growing crops, kidnaped children, hung on branches and bushes, and frightened or put spells on passers-by; they crouched on men's shoulders, unseen, and brought them bad luck.

Greek and Roman Beliefs.—Among the ancient Greeks it was believed that the ghosts of the dead who had come by death tragically sought vengeance; one must pass their tombs in silence or attract their fury. Other avenging demons afflicted generation after generation of families that had come under a curse; such were the Furies (*Erinyes; q.v.*), fearful winged maidens, often considered to have been commissioned by the gods to exact justice on erring men. More clearly malicious were the Harpies (*q.v.*), revolting monsters with bird bodies and the heads of women, who darted down to snatch away or defile food and to carry away persons and destroy them. Illness and insanity were explained as demonic possession, and Hippocrates, the great physician, had to counter this erroneous notion. The Romans regarded the spirits (numina) as helpful to mankind if correctly approached and held in honour, but they feared the larvae, a species of lemures (ghosts), for they were the souls of wicked men that now wandered about

at night in the dreaded form of spectres.

Judaeo-Christian Tradition.—The early Hebrews feared few of the spirits except the demons of the "waste places" and of the thickets where wild beasts lurked. Among these were Azazel, a wilderness demon, to whom on the Day of Atonement a goat laden with the sins of the people was sent, and Lilith (*q.v.*), a vampirish female night spirit. But when the Jews became acquainted with Zoroastrian conceptions of the spirit world, especially during the Babylonian exile, they elaborated their earlier notion that God had an "adversary" into a belief that an archdemon, Satan, had under his direction many lesser demons. (*See* SATAN.)

Oriental Conceptions.—India and the far east provide countless examples of hostile spirits of many kinds. In India, the *nagas* are snake spirits, the *pisachas* demons haunting the scenes of violent death, the *yakshas* fairies whose women are often malevolent, the *asuras* true lords of mischief on the level of deity, and the *rakshasas* goblins or ogres of a multiheaded sort, most dangerous to men because of their great strength and ability to take on rapidly many differing shapes. A special class of demon is the *vetala* or vampire. *Bhutas* and *pretas* are neglected souls of the dead become violent and unruly. The Buddhists have added to these dread powers Mara, a Satanlike tempter, who with his enticing daughters, Desire, Pleasure and Restlessness, sorely tempted Gautama at the time of his attainment of buddhahood. To these the Tibetans have added still other demons, beyond count, haunting every corner of their forbidding land.

The demons of historic China are numberless. To the Chinese of all periods the night hours were made fearsome by multitudes of *kuei*, the general name given to evil spirits. These thronged about every human dwelling after the fall of night, and infested all roads. There were demons in water, soil, air, forest, mountains; demons in many wolves, tigers, foxes, dogs, cats, birds, fish, snakes; demons even in plants and inanimate things. Horrible were the man-eating spectres, the ghouls and vampires, and the gigantic devils with horned foreheads, long fangs and fuzzy red hair. Fortunately these demons dreaded light and fled to their hiding places at the rise of the sun. The Chinese used bonfires, candles, torches and especially firecrackers to scare off the *kuei* and by these means effected a house cleaning of their homes and villages on New Year's day.

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DEMONETIZATION, a term in economics that denotes either the divestment of a coin or metal of its standard monetary value or its withdrawal from circulation. When demonetization has occurred in the former sense, it has been associated frequently with a bimetallic monetary standard where one or the other of the metals identified with the standard of value has lost this equivalence. (*See* BIMETALLISM.)

Two illustrations will suffice, both involving the demonetization of silver. This metal was the standard of value in England from 1663 to 1717, during which period gold coins were exchanged at their market value. Debasement of the silver coinage, however, resulted in the substitution of gold for silver as the standard of value.

A more recent suspension of silver from its role as a monetary standard of value came on a broader scale during the latter half of the 19th century. A general oversupply of this metal in relation to gold developed in both Europe and America with the result that the price of silver as expressed in terms of gold declined. Silver coins therefore became mere token moneys. In the United States the Coinage act of 1873 demonetized silver and was denounced by its opponents as "the crime of '73." (J. W. HA.)

DEMONSTRATION. According to Aristotle, a demonstration (*apodeixis*) is a valid argument, the premisses of which are true, necessary, immediately evident, better known than the conclusion and expressive of the grounds for the conclusion. He regarded such arguments as productive of knowledge. The Stoics, similarly, defined a demonstration as a valid argument which has true premisses and reveals a nonevident conclusion. In modern times the word has become virtually synonymous with "proof" or "exact proof," as these terms are employed in mathematics. (*See* LOGIC; MATHEMATICS, FOUNDATIONS OF.) (B. MS.)

In the natural sciences, demonstration is the manipulation, in a laboratory, of certain substances under certain conditions in order to show that they have in fact the properties ascribed to them by physicists and chemists. In jurisprudence, the demonstration is the preliminary exposition of a plaintiff's case as the basis on which a suit is to be argued (Lat. *demonstratio*, "that part of the *formula* in which the plaintiff advanced his facts"; *see* ROMAN LAW: *Procedure*). In practical politics, a demonstration is a show of force or of indignation, as when warships are sent to take up a menacing position off a coast controlled by an unfriendly or unco-operative government; or when large crowds are assembled to protest against some official action or attitude.

DEMOPHON, the son of Celeus, king of Eleusis. The goddess Demeter, wandering in search of her daughter Persephone under the guise of an old woman, became Demophon's nurse. As an act of kindness to those who had sheltered her, she attempted to immortalize him by burning out his mortal parts, but was surprised in the act by his mother, who thought that the nurse was harming the boy. In some accounts Demophon died as a result of the interruption of the ordeal. (H. W. PA.)

DE MORGAN, AUGUSTUS (1806–1871), English mathematician, logician and bibliographer, whose name is given to De Morgan's law in logic, was born in June 1806 at Madura, Madras presidency, India, and educated at Trinity college, Cambridge. His scruples concerning theological tests prevented him from proceeding to a fellowship. In 1828 he became professor of mathematics at the newly established University college in London. He taught there until 1866, except for a break of five years from 1831 to 1836. He was the first president of the London Mathematical society, which was founded in 1866.

De Morgan's aim as a mathematician was to place the subject on a more rigorous foundation. As a teacher he was unrivaled, and no topic was too insignificant to receive his careful attention. One of his earliest works was his *Elements of Arithmetic* (1831), which was distinguished by a simple yet thoroughly philosophical treatment of the ideas of number and magnitude. In 1838 he introduced the term "mathematical induction" to differentiate between the hypothetical induction of empirical science and the rigorous method, often used in mathematical proofs, for advancing from n to $n+1$.

De Morgan was in general sympathy with those Cambridge mathematicians, led by George Peacock, who recognized the purely symbolic nature of algebra; and he was aware of the possibility of algebras which differ from ordinary algebra. His treatise *The Elements of Algebra* appeared in 1835, and his memoirs "On the Foundation of Algebra" were published in the *Transactions of the Cambridge Philosophical Society* between 1841 and 1847. He made a useful contribution to mathematical symbolism by proposing the use of the solidus (oblique stroke) for the printing of fractions.

It was as a reformer of logic, however, that De Morgan made his greatest contributions to knowledge. Indeed, the renaissance of logical studies which began in the first half of the 19th century was due almost entirely to the writings of the two British mathematicians De Morgan and G. Boole. De Morgan always laid much stress upon the importance of logical training. His importance in the history of logic is, however, primarily due to his realization that the subject as it had come down from Aristotle was unnecessarily restricted in scope. By reflecting on the processes of mathematics, he was led, like Boole, to the conviction that a far larger number of valid inferences were possible than had hitherto been recognized. His most notable achievements were to lay the

foundation for the theory of relations and to prepare the way for the rise of modern symbolic, or mathematical, logic. His name is commemorated in De Morgan's law, which is usually presented in the concise alternative forms: $\sim (p \vee q) = \sim p \wedge \sim q$; and $\sim (p \wedge q) = \sim p \vee \sim q$. These may be read: not (p or q) equals not p and not q; and not (p and q) equals not p or not q. These statements assert that the negative (or contradictory) of an alternative proposition is a conjunction in which the conjuncts are the contradictions of the corresponding alternants; and that the negative of a conjunctive is an alternative proposition in which the alternants are the contradictories of the corresponding conjuncts.

De Morgan's witty *Budget of Paradoxes* (1872; 2nd ed., ed. by D. E. Smith with new introduction by E. Nagel, 1954), a classic collection and exposure of the writings of circle-squarers and similar cranks, remains popular. This unique work reveals his immense erudition. He was a true bibliophile who treated bibliography as an important science. His views on cataloguing, presented to the royal commission on the British museum in 1850, correspond with those afterward adopted by A. Panizzi in the *British Museum Catalogue*.

In 1866 De Morgan left University college owing to a dispute involving sectarian freedom. He died in London on March 18, 1871. *See* also LOGIC, HISTORY OF: *The Algebra of Logic*.

See also Sophia E. De Morgan, *Memoirs of Augustus De Morgan* (1882). (G. J. Ww.)

DE MORGAN, WILLIAM FREND (1839–1917), English ceramic artist and novelist whose power to create character and convey atmosphere ensure him a continued, if minor, literary popularity, was born in London, Nov. 16, 1839, son of Augustus de Morgan (*q.v.*). Educated at University College school, University college and the Academy art schools, he became a member of the Pre-Raphaelite circle and experimented with various forms of decorative art. He set up his own kiln, and, rediscovering the secret of the brilliant blue and green glazes of earlier potters, formed a firm to make tiles and other pottery. A talented inventor, he designed most of the appliances for the factory, and although it was not a commercial success, it produced work of great beauty, much of it preserved in the Victoria and Albert museum, London.

After retiring in 1905, De Morgan began a second career as a writer. *Joseph Vance* (1906), *Alice for Short* (1907), *Somehow Good* (1908), *It Never Can Happen Again* (1909), *An Affair of Dishonour* (1910), *A Likely Story* (1911), *When Ghost Meets Ghost* (1914) and two unfinished works, published posthumously by his wife, *The Old Madhouse* (1919) and *The Old Man's Youth* (1921), brought him financial success and considerable literary reputation. He died in London, Jan. 15, 1917.

DEMOSTHENES (d. 413 B.C.), son of Alcisthenes, Athenian general, was an imaginative strategist and not closely tied to any political group. In 426 B.C. he attacked the Corinthian colony of Leukas; but he abandoned the siege for an attempt to invade Boeotia through Aetolia. His allies, the Ozolian Locrians, who knew the country, failed him, but he advanced without them. The result was the collapse of his hoplites on ground completely unsuited to them and a severe defeat, in which he lost 120 Athenians. He was able, however, to defend successfully Naupactus, the Athenian naval base in the Gulf of Corinth, against a Spartan land attack, though he could not prevent the Spartans from joining the Ambraciots who had invaded the territory of Amphilochian Argos on the southeastern shore of the Gulf of Arta. Demosthenes, summoned by the Acarnanians, won two decisive victories, at Olpae near Argos and Idomene in the hills to the north of it, which ended Peloponnesian campaigning in northwestern Greece. Having redeemed his early failure, he could now return to Athens. In 425 he was authorized to use the fleet sailing to Sicily on operations round the Peloponnese, and fortified the promontory of Pylos (*q.v.*) in Messenia. While the fleet sailed on Demosthenes remained with five ships at Pylos and successfully resisted Spartan attacks. The Spartans occupied Sphacteria, but when the Athenian fleet returned the Spartan fleet was driven off and the Spartans on Sphacteria were besieged. Their defeat and capture was the joint work of Cleon (*q.v.*) and Demosthenes.

The year 424 saw him engaged in the abortive attack on Megara and the equally unsuccessful invasion of Boeotia, which resulted in the defeat of Delium. In 413 he was sent with Eurymedon to reinforce Nicias before Syracuse. As soon as he arrived he conducted a night attack on Epipolae, the high ground overlooking Syracuse. When this failed he advised immediate retreat, but was overruled by Nicias. When at last the retreat began, the division under Demosthenes fell behind, was cornered in an orchard and surrendered. Demosthenes was put to death by the Syracusans. (R. ME.)

DEMOSTHENES (384/383–322 B.C.), the Athenian statesman who stirred the Greeks to resistance against Philip II of Macedonia and whose speeches provide valuable information on the political, social and economic life of 4th century Athens, has been universally recognized in ancient and modern times as the greatest of the Greek orators. His father, also called Demosthenes, was a prosperous industrialist of the deme (township) Paiania. His mother, Cleobule, was alleged to have Scythian blood, and Demosthenes was taunted by political opponents with being a "barbarian." When he was seven years old his father died, and his father's two nephews, Aphobus and Demophon, and a friend Therippides were appointed his guardians and trustees of the estate. They took unscrupulous advantage of their position, and when Demosthenes came of age and claimed his patrimony, they employed various pretexts to frustrate him. Attempts at arbitration were followed by protracted legal processes in which Demosthenes pleaded his own case. He was eventually successful, but by this time the estate had been largely dissipated. From these actions three speeches by Demosthenes against Aphobus (the authenticity of one has been questioned) and two against Onetor, Aphobus' brother-in-law, have survived.

Speeches in Private Suits.—Having lost the greater part of his patrimony Demosthenes was compelled to earn a living. He became a professional speech-writer for contestants in private suits, in some cases appearing himself in the courts. He had had a hard struggle to become a speaker. Various stories survive of the measures he took to overcome physical infirmities. There can be no doubt about the resolute determination which enabled him to triumph over natural weaknesses and the difficult circumstances of his early life. According to ancient tradition he learned the theory of legal oratory from Isaeus (*q.v.*) whose influence is apparent in his works. The report that he taught rhetoric himself may not be true; he certainly had no formal school.

Over 30 private speeches are extant under Demosthenes' name, but many of these are spurious. Eight are concerned with a certain Apollodorus, son of the banker Pasion; not more than two of these can have been written by Demosthenes. The private speeches deal with a wide range of topics which include business contracts, bankers' loans, testamentary claims, and various points of civil law. Somewhat surprisingly Demosthenes continued to write speeches for private cases after he had become a leading politician.

Early Political Life, 355–352 B.C.—Demosthenes started his political career by writing speeches for the prosecution in important state trials. These trials were closely connected with the political life of Athens. In particular, indictment of an unconstitutional proposal (*graphe paranomon*) was an instrument often used to weaken or discredit political opponents. Demosthenes' public forensic speeches during this period were all concerned with such suits. The first of these trials was the prosecution of Androtion in 355 for illegally proposing the award of a golden crown to the outgoing council (*boule*). The plaintiffs were two comparatively obscure men, Euctemon and Diodorus; Demosthenes composed the speech *Against Androtion* for Diodorus. Apart from its personal attack on Androtion it was a scathing denunciation of Athenian financial policy.

In the following year he is said to have himself delivered the speech *Against the Law of Leptines* in a suit brought against Leptines who had introduced a law to abolish the hereditary exemption from taxation granted to public benefactors. In 352 Demosthenes again wrote a speech for Diodorus, *Against Timocrates*, in a sequel to the earlier action against Androtion. A group

of men which included Androtion had embezzled money belonging to the state. When Timocrates proposed that they should be allowed an extended period for repayment, he was prosecuted by Diodorus on the grounds that his proposal was unconstitutional.

In the meantime Demosthenes had started to take part in the deliberations of the assembly (*ecclesia*). In 354 rumours were rife at Athens that Artaxerxes III of Persia was preparing to attack Greece, and the people were eager for war. In his speech *On the Symmories* (naval-taxation panels) Demosthenes belittled the immediate danger and deprecated any acts of provocation. To safeguard the future he urged that the efficiency of the fleet should be improved by reforming the system of taxation which provided funds for its upkeep. This policy of caution and moderation must have been influenced by his future opponent Eubulus (*q.v.*). In addressing the assembly two years later Demosthenes appears to have been acting more independently. In 352 Megalopolis, founded by Epaminondas of Thebes about 369 as the centre of the Arcadian league, was threatened by the Spartans, and appealed to Athens for help. Both sides sent embassies to put their case before the Athenian assembly. In his speech *For the Megalopolitans* Demosthenes supported the case for Megalopolis, although Athens was bound by treaty to Sparta. Probably during the same year in his speech *On the Freedom of the Rhodians* he supported a request by a deputation of exiled Rhodian democrats for assistance in making Rhodes independent of the dynasts of Caria. The cause he pleaded was unpopular at Athens because the Rhodians had been partly responsible for the break-up of the Athenian confederacy. In both these debates Demosthenes must have been opposing the noninterventionist policy of Eubulus. In neither case was his advice followed. About the same time he was concerned in a public trial which affected Athenian policy in northern Greece. A motion had been passed at the instigation of Aristocrates that special measures should be taken by Athens to ensure the personal security of Charidemus, a well-known mercenary leader and brother-in-law of the Thracian king Cersobleptes. *Against Aristocrates* was written by Demosthenes for Euthycles who prosecuted Aristocrates for the illegality of his proposal. Charidemus (*q.v.*) was an undesirable character who had served several powers, and Demosthenes made a strong case against him, but the wider political implications of this speech are not clear, and scholars differ widely in their attempts to assess them.

Too little is known about the intricacies of Athenian politics for Demosthenes' early political activity to be properly understood, but it is possible to see the main trends. He entered political life at an early age without wealth or influence. At first he appears to have supported Eubulus' policy of financial reform at home and nonintervention abroad. He soon rebelled against Eubulus' cautious moderation, and his speeches before the assembly in 352 show a growing independence.

Demosthenes and Philip II of Macedonia.—The Athenians had been half-heartedly at war with Philip since his seizure of Amphipolis in 357. By a series of rapid conquests Philip had deprived Athens of one ally after another. In 352 he advanced into southern Thessaly against Onomarchus of Phocis and threatened to pass through Thermopylae into central Greece. The Athenians, stirred to action, sent troops to Thermopylae to bar his advance. Philip thereupon overran Thrace and marched to Heraeum on or near the Propontis (Sea of Marmara), thus endangering Athenian interests at a vital point, as the Athenian corn supply came largely from the Black sea area. It is difficult to say at what point Demosthenes realized the seriousness of the Macedonian threat. Not until the *First Philippic* speech do we find Philip treated as the real enemy of Athens; henceforth Demosthenes' energies and oratory were passionately devoted to combating Philip. This speech is traditionally dated 352–351, immediately after Philip's advance into the Propontis, but many scholars now ascribe it to 349 because of an apparent reference to Philip's attack on Olynthus in that year. It is an eloquent appeal to the Athenians to rouse themselves from their lethargy and make vigorous preparations for war, and it gives detailed and practical advice on how this should be done.

The speech *On the New Order* (*peri syntaxeos*), which proposes changes in financial and administrative organization, belongs roughly to this period. It was rejected as spurious by 19th-century scholars, but there is now a tendency to regard it as authentic. The three *Olynthiac* speeches were written in 349–348. Having recovered from an illness incurred while besieging Heraeum, Philip now threatened the Greek cities of Chalcidice, particularly Olynthus which appealed for help to Athens. In these speeches Demosthenes urged the Athenians to save Olynthus and advised them how Philip could most effectively be opposed. The Athenians did in fact send an expeditionary force, but it arrived too late to save Olynthus which was ruthlessly destroyed by Philip. The traditional order of the three speeches, which was disputed in the past, is now accepted by most scholars. It is however an open question whether they were ever delivered in anything like the form in which they have survived.

The bitter hostility which now existed between Demosthenes and Eubulus' peace party was reflected in an incident at the Dionysiac festival of 348. On this occasion Midias, a supporter of Eubulus, struck Demosthenes in the face. Demosthenes prepared to prosecute, and the speech *Against Midias*, which was written for the trial, survives. It was never delivered because a compromise was reached, presumably because the political parties realized the need for unity. The recent military efforts had exhausted the Athenians financially and the necessity for peace was generally recognized. A mission with this end in view, of which Demosthenes, Eubulus, and Aeschines were members, was sent to Philip in 346. The resulting peace of Philocrates was ratified later that year. Demosthenes condemned its terms, but in his speech *On the Peace* maintained that they must be observed.

The peace lasted nominally for six years during which Philip extended his influence to the west and north of Macedonia. In 344 Demosthenes led a mission to the Peloponnese to counter Macedonian intrigues there. Philip sent an embassy to Athens to protest against this misconstruction of his motives. Demosthenes used the occasion to deliver his *Second Philippic* speech in which he uncompromisingly attacked Philip as the enemy of Greece. In 343, when the war party dominated the assembly, Demosthenes brought an action against Aeschines, which had been pending for three years, for treacherous conduct in the negotiations which led to the peace of Philocrates. *On the False Embassy*, Demosthenes' long speech in prosecution, like Aeschines' speech in defense, reflects the wild passions and unscrupulous misrepresentations which characterized these public trials. Aeschines, supported by Eubulus, was acquitted by a narrow majority. *On Halonnesus* (342), which asserts Athenian rights over this small island south of Lemnos, held by Philip, is of doubtful authenticity. About 342 at Demosthenes' instigation the Athenians sent a force under Diopithes to the Thracian Chersonese (Gallipoli peninsula). Diopithes, using this peninsula as a base, attacked some of Philip's possessions in the area, thus violating the terms of the peace. When Philip remonstrated with the Athenians, the pro-Macedonian party wished to recall Diopithes. Demosthenes in the speech *On the Affairs in the Chersonese* (341) vigorously opposed his recall on the grounds that it would leave Athenian interests in this area at Philip's mercy. In the same year he delivered his famous *Third Philippic* speech. This is unquestionably the greatest of all his political orations. Speaking with burning passion in the name of the whole Greek world he called upon the Athenians as the hereditary champions of Greek liberty to prepare for war, send a force to the Chersonese, and unite the Greek states in the common cause. The speech has been preserved in a longer and a shorter form; the modern tendency is to regard both versions as the work of Demosthenes. The *Fourth Philippic* speech, which advises the Athenians to seek help from the king of Persia, is regarded by many as a later work of compilation and forgery. It has several imitations and repetitions of passages from Demosthenes' earlier speeches, particularly *On the Affairs in the Chersonese.* If the fourth is not genuine, the *Third Philippic* is Demosthenes' last recorded political speech.

Between the time of its delivery and the defeat of Chaeronea were the great years of Demosthenes' political life. He was the leading politician at Athens and at last succeeded in infecting

his fellow-citizens with his own passionate zeal. Byzantium and Perinthus were won over and Philip's designs in this area were checked. Athenian influence was re-established in Euboea. Envoys were sent to various parts of Greece and a confederacy of Greek states formed. At home Demosthenes carried out two reforms which he had long cherished—a more equitable distribution of the taxes which paid for equipping the fleet and the diversion of the theoric fund, which provided free seats at public spectacles, to purposes of war. This revival of patriotic enthusiasm was not to succeed, however. Open war between the Athenians and Philip broke out in 340 over Philip's seizure of 230 Athenian cargo ships; in 338 Philip, taking advantage of the Amphictyonic War (*see* AMPHICTYONY) against the Locrians of Amphissa, pushed through Thermopylae and entered Elatea in Phocis on the road to Thebes and Athens. At this critical moment Demosthenes himself led a mission to Thebes and secured the alliance of this long-standing enemy. It was his last achievement against Philip. Later in the same year came the disaster at Chaeronea (*q.v.*).

After Chaeronea (338 B.C.).—It was a mark of the people's confidence in Demosthenes that he was chosen to deliver the official funeral oration for the Athenians who had fallen in the battle. The extant speech supposed to have been delivered by Demosthenes on this occasion is conventional and commonplace, and in no way characteristic of his oratory. Its authenticity was denied even in ancient times. Some modern scholars, however, are inclined to think it genuine on the grounds that ceremonial oratory necessarily differed from that of the assembly.

Demosthenes continued to serve Athens, even in an official capacity. In 337 he was a member of a commission appointed to repair the fortifications of Athens and about the same time he was entrusted with the administration of the theoric fund. In 336 Philip was murdered. Hopes for a Greek revival were soon dashed by the energy and brilliance of his son Alexander III (the Great). A speech ascribed to Demosthenes, *On the Treaty with Alexander,* is certainly spurious and is now generally assigned to an unknown political adherent of Demosthenes. In 336 Ctesiphon proposed that the state should award Demosthenes a golden crown. Aeschines, Demosthenes' bitter opponent, thereupon indicted Ctesiphon for making an illegal proposal. The trial did not take place until 330. Demosthenes' magnificent speech *On the Crown,* ostensibly delivered in defense of Ctesiphon, is in fact a vindication of his own political life. In it he views in retrospect the whole drama of his campaign against Philip. His eloquence won over the jury and Aeschines was overwhelmingly defeated.

The last phase of Demosthenes' life was overshadowed by an incident connected with Harpalus, Alexander's chief treasurer in Asia. This man, hearing a rumour that Alexander had died in India, fled to Athens in 324 taking with him a mercenary force and a large sum of money. When Alexander's representatives demanded his surrender, the Athenians temporized. On Demosthenes' proposal Harpalus was imprisoned and the money kept in trust for Alexander. Harpalus, however, escaped and it was discovered that about half the money had disappeared. At Demosthenes' instigation the council of the Areopagus was asked to inquire into the scandal. When its findings were published Demosthenes was himself declared guilty of having received 20 talents. We are ill informed about the political intrigues which formed the background to this affair. If, as seems likely, Demosthenes did take this money, he may reasonably be supposed to have done so from patriotic or party motives rather than for his personal gain. He was fined 50 talents and being unable to pay went into exile at Troezen and Aegina.

On Alexander's death in 323 Demosthenes used his eloquence to win support against Macedonia in the Peloponnese. He was recalled from exile and his fine was paid from public funds. Athens and other Greek states revolted from Macedonian rule. After some initial successes the Greek forces were defeated by Antipater at Crannon in Thessaly in 322. Under pressure from Antipater the Athenians condemned Demosthenes and others to death. He had already taken refuge in the temple of Poseidon on the island of Calauria (Poros, 7 mi. S. of Aegina). Pursued there by Antipater's agent he killed himself by taking poison.

Demosthenes' Statesmanship.—No statesman of ancient times has been so variously estimated by the modern world as Demosthenes. For the greater part of the 19th century, when interest and admiration were centred on the classical period of Greek history and its ideal of the small, independent city-state, Demosthenes was regarded as a far-sighted statesman who failed gloriously in a heroic effort to revive the spirit of 5th-century Athens. In the late 19th and the 20th century there was a tendency to view Greek history in a wider perspective, and admiration for Demosthenes waned. Many have seen him as a narrow nationalist who made a suicidal attempt to stem the natural evolution of the Greek peoples. Some have completely discredited his personal integrity. Unbiased judgment is probably impossible, but there can be no doubt about the sincerity and single-minded purpose of his resistance to Macedonia.

Demosthenes' Oratory.—Demosthenes' oratorical qualities can only be studied from the extant speeches which represent versions revised and edited for publication. It is impossible to say how far they differed from the spoken speeches, but scholars have shown that they contain several elements which must have been inserted after the occasion of the actual debate. He prepared his speeches with a care which was considered remarkable by his contemporaries, and he was criticized on this account. This did not, however, lessen the effectiveness of his oratory. In his two greatest speeches, the *Third Philippic* and *On the Crown,* he reaches heights of eloquence without parallel in the ancient world. Passionate conviction in the rightness of his cause finds a natural outlet of expression in the artistry of his oratory. With Demosthenes stylistic embellishment was never a superimposed adornment, as it was with Isocrates (*q.v.*). It was the instrument used to achieve the practical purpose of persuading his hearers. He was well aware of the limitations of his audience and did not hesitate to take advantage of their ignorance or weaknesses. He employed various devices to sustain their interest and attention; paradoxical arguments, dramatic outbursts, supposed objections sometimes expanded into a dialogue with an imaginary opponent, repetition of salient points, avoidance of complex reasoning all served this purpose. The wit which he used to discredit his opponents in public trials was bitter and, to modern taste, crude; of genuine humour there is no trace. The scurrility of his invective was extravagant even by Athenian standards.

His language is for the most part simple, sometimes even colloquial, although striking phrases and poetical words appear in an appropriate context. He occasionally used bold metaphors, but rarely the expanded simile. His sentence structure has an infinite variety. He shows the Greek love of antithesis, in his more elaborate passages even interlacing two or more pairs of antithetical phrases or clauses. The complex period is, however, used with restraint and varied with short, simple sentences. Beyond all other Greek orators he succeeded in adapting the rhetorical figures to suit his specific purpose or context. He evidently had a delicate ear for sound, but attempts at rhythmical analysis of his sentences have been inconclusive. All that can safely be deduced is a tendency to avoid hiatus and an apparent dislike of three or more consecutive short syllables. The speeches have a formal introduction and a peroration, but otherwise he disregarded structural conventions. In general he avoids long, unbroken narrative, preferring to intersperse narrative with argument.

Demosthenes' supremacy among the Greek orators was acknowledged in his own day and has never since been seriously challenged. Cicero, Dionysius of Halicarnassus, and the author of the essay *On the Sublime* (formerly attributed to Longinus) all give him superlative praise. For the Greek rhetoricians of the 2nd and 3rd centuries A.D. he was the one great master. Even in modern times, when many would discredit his statesmanship, the brilliance and power of his eloquence is universally admitted.

Works.—Of the 61 speeches attributed to Demosthenes, the following are usually considered genuine.

Private Speeches: Against Aphobus i and ii (363); *Reply to Aphobus* (362); *Against Onetor* i and ii (361); *On the Crown for Trierarchs* (*c.* 360); *For Phormio* (350/349); *Against Stephanus*

(*c.* 349); *Against Boeotus* (348); *Against Pantaenetus* (346); *Appeal against Eubulides* (345); *Against Nausimachus and Xenopithes; Against Spudias; Against Conon; Against Callicles* (all undated).

Public Speeches: Against Androtion (355); *On the Symmories* (354); *Against the Law of Leptines* (354); *Against Timocrates* (352); *For the Megalopolitans* (352); *On the Freedom of the Rhodians* (probably 352); *Against Aristocrates* (*c.* 352); *Philippics* i–iii (349 probably, 344, 341); *On the New Order* (*peri syntaxeos*) (*c.* 350); *Olynthiacs* i–iii (349/348); *Against Midias* (348/347); *On the Peace* (346); *On the False Embassy* (343); *On the Affairs in the Chersonese* (341); *On the Crown* (330).

Among the works wrongly ascribed to Demosthenes, the *Eroticus*, an encomium of a handsome boy, must almost certainly also be included, and all, or at any rate most, of the six *Letters*. The collection of *prooimia*, introductions to political speeches, appears to be a compilation, consisting partly of genuine passages from Demosthenes, partly of later imitations.

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(H. L. H.-W.)

DEMOTIC LANGUAGE AND WRITING. The name demotic, "popular," is taken from Herodotus to denote the ordinary Egyptian handwriting of late times. The script first appeared on papyri and potsherds ("ostraca") of the early 7th century B.C., after the re-unification of Egypt under the Ethiopian 25th dynasty. It had probably developed from business hieratic in the ports and commercial cities of lower Egypt during the two previous centuries. With the establishment at Saïs in the delta of a native dynasty and a strong centralized administration by Psamtik (Psammetichos) I in 663 B.C., demotic began to displace the corrupted form of hieratic ("abnormal hieratic") still in use in upper Egypt. By the time of Darius I (522–486 B.C.), who apparently encouraged the reorganization of the writing schools, a neat demotic script was everywhere in use for business and literary purposes; classical hieratic continued to be employed for religious texts. Before the Macedonian conquest the cursive ligatures of the early demotic gave birth to new symbols which were carefully and distinctly formed. In the Ptolemaic period an epigraphic variety appeared, priestly decrees being engraved on stelae (such as the Rosetta stone) in triple hieroglyphic, demotic and Greek versions; under the Romans, while religious texts continued to be written in hieratic, literary texts were in demotic, but Greek was almost universal for business documents. The use of demotic went out with or shortly before paganism, but priests of Isis continued to use it in their graffiti at Philae as late as A.D. 452.

Demotic is written from right to left in horizontal lines; the signs comprise phonograms, word signs and determinatives, and a single demotic sign is often in origin a ligature of several hieroglyphic signs. It is difficult to transcribe with precision into hieroglyphic, and the result of such a transcription looks absurd because of the unetymological spellings and the number of otiose signs included in the ligatures. The language of demotic may represent approximately the speech of the 26th dynasty; it approximates to Coptic (*q.v.*), but employs fewer auxiliaries and periphrastic forms, and even in its latest stages its loans from Greek are confined to a few technical words which do not affect the grammar. In the Ptolemaic age it first distinguished *l* from *r*, and in very late texts vocalization may be indicated to some extent.

The great bulk of extant demotic papyri and ostraca are legal documents. Outstanding among these are the long petition of Peteese (in the time of Darius) recounting the alleged wrongs done to his family by the priests of El Hibeh over a period of more than a century and a half, and the record of a trial before the native court at Syut (upper Egypt) in 170 B.C. Accounts, letters and other ephemera also abound. The chief literary compositions in demotic are stories (*The Stories of Sethon Khamois, The Romance of King Petubastis, The Myth of the Eye of Re*, etc.); a prophetic work, the so-called *Demotic Chronicle;* and collections of apophthegms (*The Insinger Wisdom Book, The Instructions of Onchsheshonqy*). Scientific works include medico-magical compilations, astronomical texts and dream interpretations. In the Roman period a few ritual and funerary texts were written in demotic. *See* also EGYPTIAN LANGUAGE; HIEROGLYPHS.

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DEMPSEY, JACK (WILLIAM HARRISON DEMPSEY) (1895–), world heavyweight boxing champion from 1919 to 1926, was born June 24, 1895, at Manassa, Colo. His second bout with Gene Tunney, known as "The Battle of the Long Count," was one of the most controversial in boxing history. Dempsey stood 6 ft. 1 in., weighed 189 lb. He started fighting in 1914 as Kid Blackie and took the championship from Jess Willard in 1919. His fight with Tom Gibbons, July 4, 1923, at Shelby, Mont., was the only one of his championship fights to go 15 rounds. Dempsey dropped the heavyweight title to Tunney in Philadelphia, Sept. 23, 1926, lost to the fighting marine again a year later at Chicago trying to win it back. This second match with Tunney drew a record gate of $2,658,660. Both matches were 10-round decisions. At the outset of his career, Dempsey fought for purses as low as $2.50, going on to earn more than $5,000,000, and he was the first fighter to draw a million-dollar gate, a figure he exceeded five times. He continued to appear in exhibitions as a referee until 1940 when he retired from the ring and became a successful New York restaurateur. *See* also BOXING. (J. D. MCC.)

DEMPSTER, ARTHUR JEFFREY (1886–1950), Canadian-U.S. physicist, devoted his time almost exclusively to a single task—the discovery of stable isotopes of the chemical elements and the measurement of their relative abundances. He was born in Toronto, Ont., on Aug. 14, 1886, and attended the University of Toronto, obtaining his A.B. in 1909 and M.A. in 1910. He then studied in Germany, at the universities of Munich, Göttingen and Würzburg. Forced by World War I to leave Germany in 1914, he continued his work in physics at The University of Chicago, where he obtained his doctorate in 1916. His scientific career extended from 1911 (the date of his first paper) to almost the day of his death, March 11, 1950. He discovered a greater number of stable isotopes than anyone else except F. W. Aston, who opened this particular field of research. At the time of his death Dempster was professor of physics at The University of Chicago and director of the Argonne National laboratory's division of mass spectroscopy and crystallography. (S. K. A.)

DEMUTH, CHARLES (1883–1935), U.S. painter, a major influence in channeling modern European movements into American art, was born at Lancaster, Pa. His early training was under Thomas Anshutz and W. M. Chase at the Pennsylvania Academy of the Fine Arts, Philadelphia. Between 1907 and 1913 Demuth made several trips to Europe to study. In Paris he was attracted by the work of Marcel Duchamp and the Cubists, an influence which lasted throughout his career. After returning to the U.S. he illustrated works of several of his favourite authors, among them Henry James (*The Turn of the Screw, The Beast in the Jungle*), Émile Zola (*Nana, L'Assommoir*) and Edgar Allan Poe (*Masque of the Red Death*). Moving gradually away from illustrative art, he next executed a series of water colours of actors and actresses. These were characterized by the use of a graceful, fluid line and showed the influences of Aubrey Beardsley and Henri de Toulouse-Lautrec. Demuth's fame, however, lies more probably in the delicate still lifes of his late period. His careful use of

line and colour placed him in the first rank of water colourists of his period. He died on Oct. 23, 1935, in Lancaster, Pa.

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DENAIN, a mining and industrial town in the Nord *département* of France, is situated on the Nord coal field near the Belgian frontier, 12.8 km. (8 mi.) S.W. of Valenciennes. The development of mining and iron smelting caused its rapid growth from a mere village in the early 19th century to a town of 26,914 inhabitants in 1954. Besides large iron- and steelworks, it has important locomotive works and other engineering establishments. It is served by the Scheldt canal. Nearby is the site of the battle of 1712, when marshal de Villars defeated Prince Eugène.

(AR. E. S.)

DENBIGH, EARLS OF, an English title which has been held in the Feilding family since 1622. WILLIAM FEILDING (*c.* 1582–1643), 1st earl, was educated at Emmanuel college, Cambridge, and knighted in 1607. He was created baron of Newnham Paddockes and Viscount Feilding in 1620, and earl of Denbigh in 1622. He attended Prince Charles (afterward Charles I) in Spain (1623), served as admiral in the unsuccessful expedition to Cadiz in 1625 and commanded the disastrous attempt upon La Rochelle in 1628. In the Civil War he served under Prince Rupert. On April 3, 1643, during Rupert's attack on Birmingham, he was wounded, and died on April 8.

William's eldest son, BASIL (*c.* 1608–75), 2nd earl, was sent in 1634 by Charles I as ambassador to Venice, where he remained until the spring of 1638. During the Civil War Feilding supported the parliamentarians, led a regiment of horse at Edgehill, and having become earl of Denbigh on his father's death in April 1643, was made major general commanding the parliamentary forces in the midlands and lord lieutenant of Warwickshire. He resigned his command after the passing of the Self-Denying ordinance in April 1645. At Uxbridge (1645) and at Carisbrooke (1647) Denbigh was one of the commissioners appointed to treat with the king. He supported the army in its dispute with the parliament, but he would take no part in the trial of Charles I. Under the Commonwealth Denbigh was a member of the council of state (1649–51), but later he came to be regarded as a royalist and, as he concurred in the Restoration, was created Baron St. Liz in 1665. He died at Dunstable without issue on Nov. 28, 1675.

The 2nd earl's titles devolved on his nephew WILLIAM FEILDING (1640–85), son and heir of his brother George who had been created Baron Feilding of Lecaghe and Viscount Callan by the influence of the duke of Buckingham in 1622, and earl of Desmond in 1628. These titles continued to be held with the earldom of Denbigh, descending in direct line to WILLIAM RUDOLPH (1912–), 10th earl of Denbigh.

DENBIGH (DINBYCH), a municipal borough, the county town of Denbighshire, Wales, and the chief market town of the fertile Vale of Clwyd, lies 28 mi. W. of Chester. Pop. (1961) 8,044. Area 14.2 sq.mi. After the Norman Conquest Denbigh was a border town and the site of a Welsh fort. When Edward I conquered north Wales it became the centre of the lordship of Denbigh bestowed upon Henry de Lacy, 3rd earl of Lincoln (d. 1311), who built a massive castle which was completed in 1322 by Thomas, earl of Lancaster. De Lacy gave the town its first charter in 1284. The lordship was subsequently bestowed on other barons, the last being the earl of Leicester, the favourite of Elizabeth I; after his death it reverted to the crown.

Denbigh castle withstood a siege during the wars of Owen Glendower (Owain Glyndwr) who burned the town in 1402. During the Wars of the Roses it was taken and retaken by Yorkists and Lancastrians. In the Civil War it was held for the king by William Salisbury and Charles I spent a night there after his defeat at Rowton Heath in Sept. 1645. The castle was surrendered in Oct. 1646 to the parliamentarians. It was afterward razed. In 1920 the ruins were transferred to the ministry of works which also maintained the ruined friary of the White Carmelites, established in the 14th century. In the yard of the Hawk and Buckle inn there is a cockpit with a thatched roof dating from the 17th century. The earl of Leicester built the county hall and began the building of a very large church designed to replace the cathedral of St. Asaph. The Denbigh Grammar school was founded in 1727 and Howell's school, a boarding school for girls, in 1859.

Denbigh before the Industrial Revolution had many thriving industries; in the 1960s it was a busy agricultural centre with big fairs and markets and a few factories. Among the well-known men born in the town were Richard Clough (d. 1570) who suggested the building of the Royal Exchange, London; Sir Hugh Myddelton (1560–1621) who constructed the New River Head reservoir to bring the first water supply to London; Sir Henry Morton Stanley (1841–1904) the explorer; and Thomas Gee (1815–98) the Welsh Radical leader. (W. A. Ev.)

DENBIGHSHIRE (SIR DDINBYCH), a county of northern Wales, is bounded on the north by the Irish sea, on the west by Caernarvonshire, on the south by Merioneth and Montgomeryshire, and on the east by Shropshire, Cheshire and Flintshire. Area 668.9 sq.mi.

Physical Features.—The Conway (or Conwy) river forms most of the western boundary of the county. Much of the north-eastern boundary is marked by the Clwydian range, of which Moel Famma ("hill of mothers," 1,820 ft.) is the highest point, and most of the eastern boundary is formed by the Dee river. Broadly speaking, the boundaries coincide with the ancient ones of Gwynedd-is-Conwy and Powys Fadog. Apart from the vales of Conway and Clwyd (*q.v.*), the coastal plain and the Vale of Maelor in the east, Denbighshire is mountainous, with Mynydd Hiraethog forming the central mass of the plateau country. In the east and southeast a line of hills is formed by the Clwydian range, Cyrnybrian and the Berwyn range, of which the highest point is Moel Sych (2,713 ft.) at the meetingpoint of Denbighshire, Merioneth and Montgomeryshire. The Ceiriog, Rhayadr and Tanat rivers drain the southeast of the county, and the other main rivers are the Clwyd, Alwen and Dee, the last-named running through the deep and narrow incised meanders of the Vale of Llangollen, famous for its scenic beauty.

Geologically, the northwestern and southwestern regions of the county are divided by the dissected plateau of Silurian rocks north of Llangollen. The southeastern region includes the basin of the Ceiriog and its mountainous frame of the Berwyn ridge, of Ordovician rock with volcanic elements. This region also includes Ruabon and Wrexham and their Coal Measures on the borders of Cheshire. A narrow broken band of Old Red Sandstone, or what may be a conglomeratic basement bed of the Carboniferous Limestone series, crops up along the Vale of Clwyd and in Eglwyseg rocks. Resting upon this, the Carboniferous Limestone extends from Llanymynech, Shropshire, in the south, to the Cyrnybrian fault, and there forks into two divisions that terminate respectively in Great Orme's head, Caernarvonshire, and Talargoch, Flintshire, and are separated from each other by the denuded shales of the Clwydian range.

The Vale of Clwyd is sharply defined on its eastern margin by the great fault-line scarp which rises to the Clwydian range. Massive downfaulting to the west of this axis has led to the preservation of New Red Sandstone in the floor of the vale, where it overlies the limestone. In the eastern division it is itself overlaid by the Millstone Grit of Ruabon and Minera, and by a long reach of the Coal Measures which, near Wrexham, are 4½ mi. in breadth. Eastward of these a broad strip of the red marly bed succeeds, and between this and the Dee the ground is again occupied by New Red rocks. The red sandstone areas form the best agricultural land. The eastern flank of the county (less sharp than on the west) grades down to the coal field west of the Dee, and, from the limestone below, lead and silver and zinc ores have been obtained. Valuable fire clays and terra-cotta marls are also taken near Wrexham. The whole of the lower ground in the county is covered more or less thickly with glacial drift. On the western side of the Vale of Clwyd, at Cefn and Plâs Heaton, there are caves which have yielded the remains of rhinoceros, mammoth, hippopotamus and other mammals now extinct in Britain.

In the lower parts the climate is mild, but it is bleak in the highlands. The region of heaviest rainfall is the highlands with

more than 70 in. annually, but the rainfall tends to decrease eastward, and parts of the Vale of Clwyd have less than 27 in. Vegetation includes a considerable amount of rye-grass in the valley pastures, white clover and fescue in the higher pastures and much stunted heather in the highlands. Part of Denbighshire is included in the Snowdonia National park. The National trust owns the well-known gardens at Bodnant Hall, near Conway, as well as such beauty spots as Tir Ifan, southeast of Llanrwst.

History.—The period of earliest occupation by man is doubtful. The high ground is dotted with tumuli. Finds of gold and socketed axes dating from the Later Bronze Age indicate that the upper Dee valley and the Vale of Clwyd had become important lines of movement by that time. Native hill fortresses such as Dinorben, and Roman statues of later times, show the importance of the north Wales coastal route. One Roman road ran from Chester to Caernarvon (Segontium) through the north of Denbighshire, while another ran through the south of the county. To the Roman period belong the inscribed stones at Gwytherin and Pentre Voelas. Eliseg's pillar, near Llangollen, tells of the struggle at Chester between the Britons and Aethelfrith's invading Northumbrians (*c.* 613). In the southeast is a section of Offa's dike as well as part of the smaller and parallel Watt's dike. Among the ancient monuments of Denbighshire are the burial chamber at Capel Garmon and the beautiful, ruined Cistercian abbey Valle Crucis (founded *c.* 1200), near Llangollen.

After the conquest of north Wales by Edward I Denbigh castle was built by Henry de Lacy, 3rd earl of Lincoln, and Ruthin castle probably by Hugh of Avranches, earl of Chester. The rolls of the court of Ruthin are complete from 1294 and are now in the National Library of Wales, Aberystwyth. Owen Glendower failed to take Ruthin in 1400. In the southeast Chirk castle was completed by Roger de Mortimer in the early 14th century. The county was formed by an act of Henry VIII out of the lordships of Denbigh, Ruthin, Rhos and Rhyfoniog, which were roughly the Perfeddwlad (midland) between the Conway and the Clwyd, and the lordships of Bromfield, Yale and Chirkland, the old possessions of Gruffydd ap Madoc, *arglwydd* (lord) of Dinas Brân. Charles I took refuge in the county in 1645, and Denbigh castle was one of the last Welsh strongholds to surrender to the parliamentarians, who "slighted" (razed) both Denbigh and Ruthin castles. Near Ruabon is Wynnstay, formerly the seat of the old Watkin Williams-Wynn family of landowners. The fine church (1470) of Wrexham shows that this part of the county between the Welsh plateau and the English border had developed considerably during the middle ages. Royalist and Jacobite sympathies and continued adherence to the Roman Catholic Church on the part of some of the great families were features of the county, which developed greatly under the Nonconformist influences of the 18th century.

Oak wood lofts and screens are to be found in the churches at Llanrwst, Gresford and Derwen. Gresford has beautiful 15th-century stained glass, including the Te Deum east window, and in Llanrhaiadr church is a magnificent 16th-century Jesse window.

Population and Administration.—The population of the county in 1961 was 173,843. The chief towns are: Colwyn Bay (pop. 23,090), Denbigh (8,044), Ruthin (3,502) and Wrexham (35,427), all municipal boroughs; and the urban districts of Abergele (7,982), Llangollen (3,050) and Llanrwst (2,571). There are 5 rural districts and 72 parishes, of which Rhos Llanerchrugog, near Wrexham, has a population of more than 10,000. The county has two parliamentary divisions, Denbigh and Wrexham. Denbighshire is in the north Wales circuit, assizes being held at Ruthin, which is also the administrative centre of the county. Denbigh, the county town, and Wrexham have separate commissions of the peace, but no separate quarter-session courts. There are ten petty sessional divisions. The county is in the diocese of St. Asaph.

Agriculture and Industry.—Agriculture is one of the chief industries of the county, with milk production and the rearing of sheep as the predominant enterprises. The breeding of pigs and poultry is increasing. The chief markets are at Abergele, chiefly for fat sheep and lambs, Llanrwst, for fat sheep, lambs and store cattle (*i.e.*, cattle kept for fattening), and Wrexham, for store sheep and cattle, fat stock and dairy cattle. In the lowlands oats and mixed corn are grown and wheat to a lesser extent. Much heath and moorland was reclaimed after 1945. Forestry and its associated industries have also developed in recent years. Holt is a noted market garden centre.

Coal mining is an important industry in the southeast, the chief centres being Chirk, Ruabon, Wrexham, Gresford and Llay. High-quality steel is manufactured at Brymbo. Bricks are made, chiefly the famous red Ruabon bricks, fire-bricks and silica bricks for use in building blast furnaces. There are modern trading estates at Wrexham and Marchwiel, with such industries as light engineering and the manufacture of furniture and clothing.

The tourist industry is considerable, particularly along the coast and in the Dee valley. The International Musical Eisteddfod has been held annually at Llangollen since 1947. The Holyhead road to London, once a famous coaching route, traverses the Vale of Llangollen, and another main road runs along the north coast. A well-known road is the Horseshoe pass between Llangollen and Ruthin. The Holyhead railway line follows the coast in the north, and the Birkenhead-Shrewsbury line passes through Wrexham and Ruabon in the east. Of the canals built in the 18th and 19th centuries, only a six-mile feeder canal near Llangollen is still navigable, and there horse-drawn boats provide entertainment for thousands of holiday-makers.

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DENDERA: *see* DANDARAH.

DENDROCHRONOLOGY is the study of the chronological sequence of annual rings in trees and aged wood. The first observations on tree rings were probably made several millenniums ago, but the earliest known writings on the subject were those of Leonardo da Vinci late in the 15th century. During the next three centuries the study was expanded by European botanists, and several European universities were teaching courses on tree growth and climate early in the 19th century. The field spread to the new world with the immigration to the United States of German foresters. A. E. Douglass, an astronomer in Arizona, independently revived and developed the study early in the 20th century, and the field as it is practised today is primarily based on principles that he set forth. Douglass was engaged in the study of sunspot activity and its relation to climate, and the rings in northern Arizona trees were found to exhibit the effect of certain sunspot activities.

Tree-ring studies are possible because certain species produce growth rings during annual growing seasons. The width of the ring (the amount of growth) for each year is determined by certain internal (genetic, physiologic and metabolic) and external (edaphic, biotic and climatic) factors acting on the tree's metabolism. Under normal conditions the internal factors and most of the external ones remain constant, year after year. In widespread geographic areas where there is uniform variation in growth activity resulting in uniform variance in ring widths, the cause of this uniformity is some widespread climatic factor which affects all trees in a similar fashion. In the United States southwest, for example, tree growth is a reflection of the amount of rainfall. Trees growing in well-drained soils rely solely on precipitation for soil moisture, and in these locations, the quantity of soil moisture is a result of how quickly the rains fall and of the amount of water lost through runoff and evaporation. A soil-moisture history can thus be compiled by studying the relative ring widths in any given tree growing in such a location. The growth rings in trees whose roots tap a permanent supply of soil moisture are too complacent for such an analysis.

In the southwest, wood specimens from old Indian villages and archaeological sites have been dated back to about 60 B.C., thus extending the ring series beyond the reach of living trees and adding many years to the local tree-ring record. The long-lived sequoia and bristlecone pine trees of California have also been systematically studied. Sequoias have been dated back more

than 3,000 years and bristlecone pines over 4,000 years, but by the early 1960s it had not been possible to use this evidence for the dating of prehistoric objects in North America.

Studies in dendrochronology are applied in the fields of botany, climatology, ecology, geochronology, geology, forestry and silviculture. The studies are best known, however, in the field of geochronology (*q.v.*), where they are used to interpret the temporal placement of some prehistoric item or event through the study of wood contained in the archaeologic or geologic site. *See* also ARCHAEOLOGY: *The Materials of Archaeology.*

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DENGUE, also called breakbone fever or dandy fever, is an acute, infectious, mosquito-borne fever that temporarily is completely incapacitating but is almost never fatal. Besides fever, the disease, caused by a virus, is characterized by an extreme pain in and stiffness of the joints (hence the name "breakbone fever") that often induces a dandified gait in the victim (hence the Spanish derived name "dengue" and the English "dandy fever"). It may occur in any country where the mosquito vectors breed, although it is endemic only among inhabitants of warm climates. The disease was first accurately described by Benjamin Rush in 1780, during an epidemic outbreak in Philadelphia, Pa., and the causative organism was first demonstrated by P. M. Ashburn and C. F. Craig in 1907 in the Philippine Islands.

The vector incriminated throughout most endemic areas is the yellow-fever mosquito, *Aedes aegypti,* but in the western Pacific regions *A. albopictus* and several other *Aedes* species and *Armigeres obturbans* are implicated; in Hawaii *A. albopictus* was responsible for an epidemic in 1944. The mosquito becomes infected only if it bites an infected individual (man and perhaps certain species of monkey) during the first three days of the victim's illness and then requires 8 to 11 days to incubate the virus before it is able to transmit the disease to another individual. Thereafter the mosquito remains infected for life. The virus is injected into the skin of the victim in minute droplets of saliva as the mosquito prepares to feed.

On introduction into the victim's body the virus multiplies and, during the incubation period of four to ten days, penetrates all the tissues, but particularly attacks the lining of the smallest blood vessels and the softer tissues. The toxic by-products of the virus produce the symptoms. The acute stage is usually ushered in by a sudden onset with chills; excruciating pain in the joints, loins, epigastric region and behind the eyeballs; a reddened, puffy appearance of the face; a fever rising to 103°–104° F., and lasting from four to seven days; rapid pulse; and frequently extreme prostration. Thereafter there are characteristically a sudden drop in temperature, profuse sweating, loose stools and at times bleeding from the lips and nose. Although the patient is greatly weakened at this stage, he experiences profound relief. However, in approximately two-thirds of dengue patients the fever soon returns, the victim becomes exhausted and depressed and breaks out with a rash that rapidly progresses from the tips of the fingers and toes up the extremities to the trunk. In two or three days the rash recedes and is followed by a characteristic itching and a branlike sloughing of the skin. During the progress of the disease there is marked reduction in certain white cells (neutrophils) of the blood as a result of the death of the more mature cells of this type.

Convalescence is slow, and for many months there may be evidence of lassitude, nervousness and irritability, insomnia, a slow pulse and rheumatic pains. Recovery confers considerable immunity to the comparable strains of the virus. At times, however, dengue may be so mild as to produce no noteworthy symptoms.

Diagnosis is made on clinical findings; namely, sudden onset, moderately high fever, excruciating joint pains, intense pain behind the eyes, a second rise in temperature following the brief remission and particularly the type of rash and decided reduction in neutrophilic white blood cells. The disease must be differentiated from sandfly fever (*see* PAPPATACI FEVER), yellow fever (*q.v.*), typhus fever, Rocky mountain spotted fever, malaria, Weil's disease, relapsing fever, measles and scarlet fever.

There is no specific therapy; therefore attention is concentrated on relieving the symptoms. Temporary preventive measures must be directed to screening suspected as well as diagnosed cases during their first three days of illness and, by screens and repellents, to keeping mosquitoes from biting well persons.

Fundamental in the control of the disease is the use of DDT and other insecticidal sprays around human habitations and the destruction of breeding places of the mosquito vectors. In temperate climates mosquito breeding ceases with the first freeze and dengue is terminated until the next warm season; but in the moist tropics the disease is perpetual, and control must be both effective and prolonged to keep mosquito breeding below the disease transmission level.

See A. B. Sabin, "Recent Advances in Our Knowledge of Dengue and Sandfly Fever," *Am. J. Trop. Med.,* 4:198–207 (1954); J. S. Simmons, J. H. St. John and F. H. K. Reynolds, "Studies of Dengue," *Philippine J. Sci.,* 44:1–251 (1931). (E. C. F.)

DENGYO DAISHI: *see* SAICHO.

DENHAM, DIXON (1786–1828), English explorer in west Africa in the first half of the 19th century, was born in London, on Jan. 1, 1786. He joined the army and served in the Peninsula and Waterloo campaigns. In 1821 he volunteered to accompany Walter Oudney and Hugh Clapperton (*q.v.*) on a government expedition across the Sahara to Bornu. He joined them at Murzuch and they eventually reached Bornu in Feb. 1823. There Denham accompanied a Bornu slave-raiding expedition to the Mandara highlands. This was routed and he barely escaped with his life. In Dec. 1823 Clapperton and Oudney set out on a journey westward leaving Denham to explore the western, southern and southeastern shores of Lake Chad and the lower courses of the rivers Waubé, Logone and Chari. He was later rejoined by Clapperton, Oudney having died, and they returned across the Sahara to England in June 1825. Denham returned to west Africa, to Freetown, in Jan. 1827, as superintendent of liberated slaves on the west coast. In the following year he was appointed governor of Sierra Leone but died almost immediately of fever at Freetown on May 8, 1828.

See *Narrative of Travels and Discoveries in Northern and Central Africa in the Years 1822–24* (1826), the greater part of which is written by Denham. (R. M. P.)

DENHAM, SIR JOHN (1615–1669), English poet, forerunner of the Augustan writers. Born in Dublin in 1615 and educated at Oxford, he was admitted to the bar in 1639 but he was already active in literature. He had earlier translated Books I–VI of Vergil's *Aeneid,* parts of which were later printed, but he made his reputation with *The Sophy,* a blank-verse play acted in 1641, and *Cooper's Hill,* a poem published in 1642. Throughout the Civil War, although not a major figure, he was actively engaged in England and abroad in the king's cause. After the Restoration, partly for these services, and partly because he had been an amusing companion to Charles II, he was made a knight of the Bath and appointed surveyor general of the works (official architect), a post for which he had no qualification. He was elected to the Royal society, and served for some years as a member of parliament. He was possibly the first to praise Milton's *Paradise Lost* in public: he brought an unbound sheet of the first edition "wet from the press" into the house of commons saying that it was "part of the noblest poem that ever was wrote in any language, in any age." At his death in London on March 10, 1669, he was buried in the Poets' corner of Westminster abbey.

Denham's poetry is essentially didactic. His strength lies in his thought, in his neatly turned expressions of ethical and moral truisms; and his reputation rested chiefly on his style. Restoration and 18th-century poets and critics praised him as being responsible, together with Edmund Waller, for the development of the closed heroic couplet. Denham knew Waller personally, and his poetry shows Waller's influence. Dryden says, "Even after Chaucer there was a Spencer, a Harrington, a Fairfax, before Waller and Denham were in being; and our numbers were in their

nonage till these last appeared," while Pope speaks of "Denham's strength" and of "majestic Denham." Denham was not the first to write closed couplets, but he certainly had great influence in increasing their popularity, mainly because of *Cooper's Hill*, in which the couplets show a marked tendency toward Augustan conciseness. In this poem he originated a genre described by Dr. Johnson as "local poetry, of which the fundamental subject is some particular landscape, to be poetically described, with the additions of such embellishments as may be supplied by historical retrospection, or incidental meditation." *Cooper's Hill* is Denham's chief title to fame. His play and his occasional poetry are of no permanent value; his translations are of significance only because they served as models for Dryden and Pope. But in writing *Cooper's Hill* he established a new and long-popular type of descriptive poetry in which he surpassed all his imitators, except Pope, and established himself for more than 100 years as one of the most famous English poets. *The Poetical Works of Denham* were edited by T. H. Banks (1928). (T. H. Bs.)

DENHARDT, CLEMENS ANDREAS (1852–1929) and **GUSTAV** (1856–1917), German explorers and colonial pioneers who were brothers and collaborators. After two expeditions into the Tana regions (1876–77, 1878–79) Clemens was able to negotiate a friendly treaty with the sultan of Witu (Kenya). The territory was subsequently sold to the Deutsche Witugesellschaft but in 1890, according to the British-German convention concerning Zanzibar, it was given to Great Britain in exchange for Heligoland. Since the private rights of the two brothers had not been safeguarded, this brought them great financial losses. During the subsequent decades they were successfully engaged in the former German East Africa but in 1919 Clemens Denhardt once more lost his possessions through expropriation. (K. A. S.)

DENIFLE, HEINRICH SEUSE (baptized Joseph) (1844–1905), Austrian historian and Dominican priest, who made available for the first time a mass of medieval documents and based major reinterpretations upon them. He was born Jan. 16, 1844, at Imst, Tyrol, entered the Dominican order in 1861 and was ordained priest in 1866. From 1870 he taught theology and philosophy at Graz and began publication of his important work on the mystics with *Das geistliche Leben. Eine Blumenlese aus den deutschen Mystikern des XIV. Jahrhunderts* (1873). He was called to Rome in 1880 to undertake preparation of a new edition of the works of Aquinas. In 1883 he became subarchivist of the Vatican, a great opportunity which contributed to his production of revolutionary work on medieval universities in *Die Universitäten des Mittelalters bis 1400* (1885) and, with É. Châtelain, in *Chartularium Universitatis Parisiensis*, 4 vol. (1889–97), with two volumes of other documents. This latter work led him to undertake further French studies, culminating in *La Désolation des églises, monastères et hôpitaux en France pendant la guerre de cent ans*, 2 vol. (1897–99). At the same time, as cofounder with F. Ehrle, he was contributing to the invaluable *Archiv für Literatur und Kirchengeschichte des Mittelalters* (1885–). His last major work was *Luther und Lutherthum* (1904–09), a wholly unsympathetic but brilliant, well-documented and seminal reinterpretation which was fundamental to all subsequent Luther studies. Denifle died in Munich, June 10, 1905.

DENIKIN, ANTON IVANOVICH (1872–1947), Russian general and leader of "White" forces in the civil war, was born near Warsaw on Dec. 16 (new style; 4, old style), 1872. The son of a former serf, he entered the army, where his capacity for leadership earned him rapid promotion. He fought in the Russo-Japanese War and in 1914–16 distinguished himself as a divisional and corps commander on the German and Austro-Hungarian fronts. After the Revolution of March 1917 he became chief of staff to the new commander in chief, Gen. M. V. Alekseev. A professional soldier without political experience, Denikin accepted the revolution but strongly resented the resulting breakdown of army discipline, for which he held the provisional government chiefly responsible. In July he was dismissed on political grounds and appointed commander of the western front, in which capacity he lent enthusiastic support to Gen. L. G. Kornilov in his bid for power. Imprisoned for three months, he escaped, with Kornilov and other officers, and rejoined Alekseev on the Don, where an anti-Bolshevik volunteer army was being formed.

On Kornilov's death (March 1918) Denikin became supreme commander of the "White" forces in southern Russia. By the beginning of 1919 he had won mastery of the northern Caucasus, and in May, rejecting Gen. P. N. Wrangel's plan to strike northeastward, chose to advance on a broad front through the Ukraine, with Moscow as his goal. By October he had reached Orel, 250 mi. from the capital. But his communications were dangerously overextended; the population resented his military dictatorship, which tolerated looting and other excesses, and peasant risings broke out in his rear; his pronounced Great Russian nationalism, shared by his predominantly upper-class officers, hampered collaboration with minority and autonomist groups, particularly the Cossacks; and the Allies failed to provide effective military support. The tide rapidly turned against Denikin; his army melted away, and in March 1920 the demoralized remnants were evacuated from Novorossisk to the Crimea. Appointing Wrangel as his successor (April), he left Russia to spend the remainder of his life as an *émigré*, first in western Europe, and from 1945 in the United States. He died at Ann Arbor, Mich., on Aug. 8, 1947.

See his memoirs, *Ocherki russkoi smuty*, 5 vol. (1923–27), and *Put russkogo ofitsera* (1953). (J. L. H. K.)

DENIM, a durable fabric used principally for work clothing, the name of which is said to have originated in the French *serge de Nimes*. Yarn dyed, twill-woven and mill finished, denim is characteristically all cotton, although considerable quantities are of a cotton-nylon mixture. The material is mainly indigo or vat-dyed blue, but some is produced in other colours, as well as in stripes and various patterns. Traditionally used for ranch, farm, work and sea-going attire, denim became an important children's wear item and is used for casual wear for both sexes of all ages. (R. M. St.)

DENIS (Dionysius or Denys), **SAINT,** first bishop of Paris and patron saint of France. According to Gregory of Tours' *Historia Francorum*, he was one of seven bishops sent to Gaul to convert the people at the time of the emperor Decius. Little is known of his life except that he became bishop of Paris and later suffered martyrdom. In 626 his relics were translated to the recently founded Benedictine abbey at St. Denis, near Paris. In the 8th century a passage in Gregory of Tours' work was wrongly interpreted as stating that he had been sent to France by Clement of Rome about A.D. 90. In the 9th century, Hilduin, abbot of St. Denis, in his life of Denis further identified him with Dionysius the Areopagite (*q.v.*). According to the legend, after being decapitated at the age of over 100, Denis walked a considerable distance holding his head in his hands. Hence he is generally thus represented in art. He is one of the 14 auxiliary saints, or holy helpers. His feast day is Oct. 9 in the Western, Oct. 3 in the Eastern church.

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints*, vol. iv, pp. 67–68 (1956). (H. C. G.)

DENIS, MAURICE (1870–1943), French painter, lithographer, designer and writer on art subjects, one of the leading artists and theoreticians of the Symbolist movement, was born at Granville, on Nov. 25, 1870.

Denis studied at the Académie Julian (1888) under Jules Lefebvre and at the École des Beaux-Arts. Probably the greatest influence in his early development was the work of Gauguin, whose style was also much admired by Denis's fellow students Paul Serusier, Edouard Vuillard, Pierre Bonnard and Ker Xavier Roussel, whom Denis joined in the Symbolist movement and later in the Nabis movement. In 1890 Denis expressed the underlying principle of much modern painting in the following often quoted words: "It should be remembered that a picture—before being a warhorse, a nude or an anecdote of some sort—is essentially a flat surface covered with colours assembled in a certain order." Denis was also influenced by the colour theories of Seurat, and by the works of the great Italian fresco painters of the 14th and 15th centuries, such as Giotto, Fra Angelico and Piero della Francesco, whose paintings he admired during his visits in Italy between 1895 and 1904. Denis's monumental mural decorations are to be seen in

many French churches as well as on the ceiling of the Champs Élysées theatre in Paris. In 1919 he founded the Studios of Sacred Art, along with Georges Devallières. His work was one of the chief forces in the revival of religious art in France.

Denis illustrated numerous books, and created designs for stained-glass windows, wallpaper, tapestries, mosaics, bas-reliefs and statues, and, in addition, published several books and numerous articles on art. He died at Paris on Nov. 13, 1943.

DENIS, (JOHANN NEPOMUK COSMAS) MICHAEL (1729–1800), Austrian poet who used the pseudonym of Sined the Bard and is best remembered for his German translation of *Ossian* in hexameters (1768–69). He was born at Schärding on the Inn, Sept. 27, 1729. Brought up by Jesuits he entered their order. As a bardic poet he was a follower of Klopstock and he published his own poems, with his translation of *Ossian*, as *Ossians und Sineds Lieder* (6 vol., 1791–92). His anthology *Sammlung kürzerer Gedichte aus den neuern Dichtern Deutschlands* (3 vol., 1762–76) introduced North German literature to Austrian readers. Denis died in Vienna, Sept. 29, 1800.

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DENISON, a city of Texas, U.S.: *see* SHERMAN-DENISON.

DENIZLI (anc. LAODICEA AD LYCUM), chief town of an *il* (province) of the same name in southwestern Turkey. It is picturesquely situated at an altitude of 1,167 ft. at the foot of Baba Dag (Mt. Salbacus), on a tributary of the Çuruksu (Lycus), 115 mi. E.S.E. of Izmir. Pop. (1960) 48,925. Denizli is connected by a branch line with the Goncali station on the Izmir-Dinar railway. It took the place of Laodicea (*q.v.*) after that town had been deserted during the wars between the Byzantines and Seljuk Turks, probably betwen 1158 and 1174. It had become an important Muslim city in the 14th century, and was then called Ladik, being famous for its woven and embroidered products. The delightful gardens of Denizli earned it the name of the "Damascus of Anatolia."

The *il* of DENIZLI (pop. [1960] 425,449; area 4,576 sq.mi.) includes the eastern part of the fertile valley of the Büyükmenderes (Great Maeander) river and the mountainous areas surrounding it. The highest mountains of the *il* are Honaz Dagi (8,435 ft.) and Baba Dag (7,572 ft.). The climate is healthy with dry, warm summers, while the winters are relatively mild and rainy. The chief crops are cotton, cereals, grapes, figs and tobacco. Animal husbandry becomes increasingly important to the east. About 15 mi. N. of Denizli town is the famous Pamukkale (anc. Hierapolis), where limestone travertine deposited by hot springs forms wonderful cascades and basins. (N. TU.; S. ER.; E. TU.)

DENMAN, THOMAS DENMAN, 1ST BARON (1779–1854), English judge remembered for his knowledge and interpretation of the law of privilege, was born in London on Feb. 23, 1779. The son of the well-known obstetrician Thomas Denman, he was educated at Eton and St. John's college, Cambridge, where he graduated in 1800. In 1806 he was called to the bar at Lincoln's Inn. He first distinguished himself by his eloquent défense in 1816 of the Luddites; but his most brilliant appearance, in 1820, was as one of the counsel for Queen Caroline, for whom he made a great speech before the lords which gained him the enmity of the king and retarded his career. In 1818 he became Whig M.P. for Wareham, Dorset, and from 1820 represented Nottingham until his elevation to the bench in 1832.

In 1830 he was made attorney general under Lord Grey's administration and two years later lord chief justice. In 1834 he was raised to the peerage. As a judge he is most celebrated for his decision in the important privilege case of *Stockdale* v. *Hansard* (9 Ad. and El. i), but he was never ranked as a profound lawyer. In 1850 he resigned his chief justiceship. He died at Stoke Albany, Northamptonshire, on Sept. 22, 1854.

See Sir Joseph Arnould, *Memoir of Thomas, First Lord Denman* (1873); E. Manson, *Builders of Our Law* (1895; 2nd ed. 1904).

DENMARK (DANMARK), the smallest in area of the three Scandinavian kingdoms, comprises the northern part of the low peninsula of Jutland (Jylland) and two groups of islands. To the east, between the Skagerrak and the Baltic, lies the main archipelago of 482 islands with lonely Bornholm 88 mi. (142 km.) farther east. The second archipelago, that of the rocky Faeroe Islands (*q.v.*; Faeröerne), lies 700 mi. (1,127 km.) away in the Atlantic on the shortest route to Iceland (united with Denmark until 1941) and thence to Greenland (*q.v.*; 840,000 sq.mi. [2,175,603 sq.km.]), a Danish colony until 1953 and since then an integral part of Denmark. Of the total area (17,154 sq.mi. [44,429 sq.km.]) of the kingdom, Jutland covers 11,436 sq.mi. (29,619 sq.km.), the main archipelago 5,178 sq.mi. (13,411 sq.km.) and the Faeroe Islands 540 sq.mi. (1,399 sq.km.). Sjælland (Zealand), the largest island of Denmark proper, covers 2,709 sq.mi. (7,016 sq.km.) and is separated from south Sweden (Skåne) by the Sound (Øresund), only 2 mi. (3.2 km.) wide at its narrowest part. Fyn, the second largest island, is separated from Sjælland by the Store Bælt (Great Belt) and from Jutland by the Lille Bælt (Little Belt). Denmark's frontier with Germany extends across the Jutland peninsula from Flensborg fjord (Flensburger Förde) to a point between the islands of Rømø and Sylt.

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I. PHYSICAL GEOGRAPHY

1. Geology.—The Danish peninsula and archipelago are largely a product of the Quaternary Ice Age, solid rock being generally masked by thick deposits of glacial drift deposited by ice sheets that advanced south from Norway and Sweden and west from the Baltic. Beneath this mantle lies a basal platform of Cretaceous

rocks, mainly chalk, whose saucerlike rim can be traced in an arc extending from the beak of Jutland southeast through the islands of Læsø and Anholt to east Sjælland, Møn (Möen), Falster and Lolland. Senonian chalk is exposed at the base of the impressive cliffs (Stevns Klint) in southeast Sjælland and again at Møns Klint, while younger Danian limestone is extensively quarried at places such as Bolsdal and Fakse in southeast Sjælland. The remainder of the preglacial floor consists of Tertiary sands, marls and clays, with some lignite beds in Miocene deposits. In Bornholm the solid rock is markedly different, revealing close affinities with south Sweden. Exposures of Precambrian granites cover extensive areas in the northern half of the island, being overlaid to the south by Cambrian sandstones and shales with Triassic, Jurassic and Cretaceous deposits in the extreme southwest. Denmark was affected by three glacial periods of which the last (correlating with the Würm) was of paramount importance in determining the present surface features.

2. Relief and Drainage.—Although the whole of Denmark is relatively low-lying, a remarkable scenic boundary (A-B on map) can be traced from Nissum fjord on the west coast of Jutland eastward toward Viborg, thence swinging sharply south down the spine of the peninsula toward Åbenrå and the German city of Flensburg. Two major physiographical regions are distinguishable—the moraine lands and the outwash plains.

The Moraine Lands.—To the north and east of the boundary just described, which represents the maximum extent of Scandinavian and Baltic ice during the last glaciation, both the insular and peninsular areas are covered with a thick mantle of boulder clay giving rise to undulating country of fertile clay loams becoming markedly more sandy westward toward the ice front. This young moraine landscape attains its greatest elevation between Horsens and Silkeborg where lies Denmark's highest point, Yding Skovhøj (568 ft. [173 m.]). The sinuous eastward-flowing streams, with their broad, flat-floored valleys, enter the Kattegat in long, shallow inlets. Although the latter are called fjords, they cannot be compared in character or origin with those of Norway. Denmark's longest stream, the Gudenå, rises in east central Jutland and flows 98 mi. to its mouth in Randers fjord. Lakes are numerous in depressions on the hummocky moraine, often giving rise to peat bogs where infilling has occurred.

The Outwash Plains.—West of the old ice front the landscape changes dramatically. There, it comprises a series of low plateaus, or "hill-islands" about 50–60 ft. (15–18 m.), representing morainic remnants dating from the second glacial period. These are wrapped around by extensive, level, outwash plains composed of sands and gravels strewn by the meltwaters that poured west from the shrinking ice sheet. The small, misfit streams with their broad, shallow, steep-sided valleys reach the North sea through a narrow belt of coastal dunes; in places large lagoons have been formed, *e.g.*, Ringkøbing and Nissum fjords. Soils on the hill-islands are fairly fertile, though heavily leached, whereas the outwash sands and gravels generally bear hungry, acid soils.

Oscillations of land and sea level in the closing phases of the Pleistocene glaciation have also left their impress on the seaboard landscapes. Following the deposition of marine clays during the Late Glacial submergence associated with the Yoldia sea, land level rose in Boreal times and forests of birch, pine and hazel slowly colonized the land. Uplift continued until Sjælland was joined to south Sweden, and the Baltic became a fresh-water lake (Ancylus lake). This was followed by the Littorina submergence (which allowed the sea to flow into the Baltic) when milder Atlantic climatic conditions prevailed and mixed oak forest spread over the land areas during early Neolithic times. The limits of the Littorina submergence are still clearly visible in lines of inland cliffs and raised beaches. The beech, the national tree of Denmark, continued to increase throughout the Bronze Age and occupied extensive areas by the Early Iron Age. The reconstruction of these climatic and vegetational changes owes much to the pollen analysis of the plentiful peat deposits. (*See* also BALTIC SEA.)

Denmark's coast line is 4,622 mi. (7,438 km.) long and varies considerably in character. The smooth west coast of the peninsula, a product of tidal deposition as seen clearly in the long spit of Skagen, is remote from the main economic hub of Denmark centred on Copenhagen. Apart from a few small fishing harbours, Esbjerg is the sole important port on this exposed coast and its development dates only from 1860. Esbjerg has the advantage of protection by the island of Fanø, one of a long string of sandy islands extending south to the German border and beyond that to the Netherlands. On the landward side of the islands, coastal reclamation in areas of tidal and fluvial deposition is providing year by year more land for farming. Port facilities in the sheltered Kattegat and Baltic are much better, but in a very cold winter the busy Sound, as well as Store and Lille Bælts may be impeded by ice.

3. Climate.—Lying on the eastern borders of the North sea, Denmark has a moist climate transitional between the oceanic conditions of western Europe and the continental conditions of central and eastern Europe. Although cool maritime influences generally prevail, especially in west Jutland, cold anticyclonic conditions may spread westward in winter, causing ice to form on the Baltic, whereas in summer continental heat may be experienced. Toward the east temperatures decline in winter and increase in summer. The mean annual temperature is 8° C. (46° F.), the average for January and February being 0° (32°) and that for July, the hottest month, 16° (61°). Between October and April western coastal areas in Jutland have frost on about 75 days, but in Sjælland this increases to 110. Temperatures down to −25° C. (−13° F.) have been recorded in the east. The average annual precipitation of about 24 in. (610 mm.) is fairly evenly distributed throughout the year but is heaviest from July to December. Thunderstorms are common in summer, particularly in August, the wettest month. Precipitation is least in February. Mean annual rainfall decreases eastward, the heaviest amount falling in south central Jutland. Snow falls on between 20 and 40 days depending on situation. Winds vary in direction according to the prevailing pressure conditions; thus southwest and west winds are common in January, east winds in April, and west and northwest winds in July. The strong winds of the west coast of Jutland caused dunes to migrate inland until a stabilization policy was introduced in the late 19th century. Similarly, when cultivation began on reclaimed heath land, belts of trees were planted on the outwash plains to shelter fields from the blast.

4. Vegetation and Animal Life.—Pollen analysis of ancient peat deposits reveals that in Neolithic times mixed oak forest covered most of Denmark, both the moraine lands and the outwash plains, with beech increasing from Bronze Age times. Deforestation by herdsmen, cultivators, woodcutters and charcoal burners not only removed great tracts of woodland but on the outwash plains abandoned clearings were colonized by a poor secondary vegetation of heath. So extensive did the latter become that in 1800 heath occupied about 40% of Jutland, especially in the west and north, but vigorous reclamation had reduced this to less than 9% by the 1960s. Reafforestation, including the provision of shelter belts, has reintroduced trees, especially conifers, to most Danish parishes.

Wild animals and birds are those of central Europe generally, deer, foxes and hares still being numerous while rabbits are largely confined to the island of Fanø. Fresh-water fish and eels flourish in many rivers and lakes, with salmon in west Jutland and around Bornholm. Limfjorden is the centre of a prosperous oyster and mussel fishery. Sea fishing in the North sea, Skagerrak and Kattegat makes an important contribution to the national income and is the principal occupation of the Faeroe Islands. (HA. T.)

II. THE PEOPLE

The Danish people belong to the Nordic race but to a less pure strain than that to be found in the more northern parts of Scandinavia. The anthropological finds prove that the modern Danes are descended from the first invaders who came into the country from the south shortly after the last Ice Age. They are mostly tall and strongly built with blond hair, blue or gray eyes and a mesocephalic skull.

The language is Nordic, forming a subdivision of the Germanic group. It is closely related to but less melodious than Norwegian and Swedish. On account of the frequent stressing of syllables

Danish may sound rather guttural. As Denmark, apart from the peninsula of Jutland, consists of nearly 500 islands of varying size, numerous dialects are to be found, but the differences between them are gradually being lessened. (*See* DANISH LANGUAGE; SCANDINAVIAN LANGUAGES; *see* also DANISH LITERATURE.)

The constitution provides for religious freedom. Most of the people belong to the Lutheran Church (Folke Kirken), the established Church of Denmark, which is administered by the ministry of ecclesiastical affairs. The largest non-Lutheran community is the Roman Catholic Church. The religious festivals, Christmas, Easter and Whitsun, are kept according to old traditions, but there is a tendency to abolish old customs, even in the rural districts.

National costumes are still worn by women in the islands of Fanø and Rømø in the southwest of Jutland. The national flag is greatly revered; flagpoles are to be found in most private gardens and there are many official flag days during the year. A special custom is observed on Good Friday when the flag is flown at half-mast. The Danish people have a great sense of humour; the Copenhageners especially excel in ready wit while the humour of the Jutlanders is sterner. Danish wit was an active weapon against the *Herrenvolk* during the German occupation of Denmark in World War II. (E. M. E. B.)

III. HISTORY

The first trustworthy written evidence of a kingdom of Denmark belongs to the early Viking period. Roman knowledge of this remote country was fragmentary and unreliable, and the traditional accounts in *Widsith* and *Beowulf* and by later Scandinavian writers, notably Saxo Grammaticus (*q.v.*), are too mythological and legendary to serve as history. Archaeology and the study of place names, however, provide some information about the earliest settlements.

After the first nomadic hunters, before 10000 B.C., a Stone-Age culture developed which culminated in the megalithic culture *c.* 2000 B.C. There followed a break so violent as to suggest that the settled agriculturalists were displaced by newcomers, that is by the Separate-Grave people who eventually took possession of central Denmark. Apart from minor later immigrations the country seems to have received its permanent population at this time, though not to have been finally settled. The refined culture of the ruling class in the Bronze Age (*c.* 1500–400 B.C.) and the poor peasant culture of the earliest Iron Age were developed mainly in the old settlements, but in the centuries around the beginning of the Christian era it seems to have been completely reorganized. The old habitations round the small primitive field systems (dikes) were abandoned for the earliest of existing villages with the characteristic place name endings *inge*, *lose*, *sted* and *um*.

The open-field system with its long ridged strips was probably introduced at the same time or later. The period of the great migrations, the dimmest in Danish history, was one of war and unrest; probably at this time the whole country was conquered by Danish tribes from the east. There are glimpses of a tribal organization associated with local *things* (arbitrating assemblies), but no trace of comprehensive government. Place names indicate belief in the pagan gods; *e.g.*, Njord and Frey, Tyr and Odin.

1. Viking Period, 800–1050.—The northward extension of Charlemagne's empire brought Denmark into close connection with the rest of Europe. The Frankish conquests were halted by the Danish king Godfred or Gudfred (d. 810), and under his successor Hemming (d. 812) a solemn treaty on the Eider in 811 made this river the frontier, which it remained until 1864. Godfred may have ruled over all Denmark, but the centre of gravity was in the extreme south of the Jutland peninsula: there Hedeby, on the Schlei, became an important station on the new Frankish trade route to the Muslim states of the east via the Baltic sea and the Russian rivers. To protect this vital borderland a great rampart, the Dannevirke (Danewerk), was erected, but it failed to prevent temporary Swedish and German conquests. The Danes took an active part in the new trade together with the Frisians. At the same time Danish and other Scandinavian Vikings began the expeditions of plunder and conquest (*see* VIKING) which resulted in the Viking kingdoms in Friesland, England, France and Russia. After Hemming's death the kingdom was dissolved. Various dynasties contended for power and appealed to the Frankish rulers, who sought to promote Frankish infiltration into Scandinavia by missionaries—notably Ansgar (*q.v.*), "the apostle of the North"—though this was without lasting result.

In the 10th century a new royal line, centred at Jelling (north Jutland), succeeded at last in uniting the kingdom. The name of the kingdom occurs for the first time on Danish soil in runic inscriptions on the Jelling stones. The self-glorifying phrase "Denmark's salvation" (*Danmarks bod*) used of himself by King Gorm may refer to the reconquest of the Hedeby region; his son Harald Bluetooth (Harald Blaatand) boasted of completing the country's unification, converting the Danes to Christianity and conquering Norway.

After Harald's baptism (*c.* 960) his father's pagan tomb was transformed into a Christian place of worship with a church between two great mounds, and the newly appointed Jutland bishops, under the archbishop of Hamburg, organized the country's conversion. The expansion begun by Harald in Norway was continued by his son Sweyn I (*q.v.*; d. 1014), who conquered England in 1013. Under Sweyn's son Canute (*q.v.*) there grew up a great Anglo-Scandinavian kingdom that included parts of Sweden.

Numerous runic inscriptions show that, over the broad peasant population, there was a class of warlike chieftains (*thegner* and *drenge*), of great wealth and power; the circular encampments of Trelleborg, Aggersborg and Fyrkat (excavated from 1934), astonishing in size and mathematical construction, testify to a technically advanced and highly organized society. (*See* also SCANDINAVIAN CIVILIZATION.)

2. Kingdom of the Valdemars, 1050–1241.—Shortly after the death of Canute (1035) his great kingdom was dissolved. Denmark again became a purely Scandinavian power, for a time under Norwegian rule, until Canute's nephew Sweyn II (*q.v.*) founded a new Danish kingdom on western European lines and in close association with the Roman Church. He was succeeded by his five sons in turn (1074–1134), several of whom accepted a weak form of monarchy and worked in sympathy with the aristocracy; others, opposing the aristocracy but in close association with the church, sought to create a powerful and centralized monarchy. The church, which for a period had been under strong Anglo-Saxon influence, now passed once more under the leadership of Hamburg. In the end it became (*c.* 1104) a separate national church with an archbishopric at Lund in Skåne. Canon law made slow progress and never became absolute in Danish ecclesiastical law, but kings and nobles and villagers vied with each other in building Romanesque stone churches in nearly every parish, some of them new ones and some replacements of wooden buildings.

The reigns of Sweyn's sons were followed by disintegration and internal strife among their many heirs. For a time the country was split up into minor kingdoms, weak kings took their land in fief from the Holy Roman emperor, and the new Scandinavian church was reverting to the primacy of Hamburg. But unity and independence were restored, first in the church under Archbishop Eskil, a great founder of monasteries and persistent champion of Gregorian ideas of reform, and later (1157) in the nation, when Valdemar I (*q.v.*) had defeated his rivals. In close association with Absalon (*q.v.*; bishop of Roskilde, 1158), who was inspired by French monarchical ideas, King Valdemar built up a powerful monarchy. Archbishop Eskil, seeing a threat to the church's freedom, went into exile; but later, after an agreement with the king, he inaugurated in a double celebration at Ringsted in 1170 the theocratic and hereditary monarchy of the Valdemars, canonizing the king's father, the duke Canute Lavard, and crowning and anointing the king's young son Canute. In 1177, Eskil yielded the archbishopric to Absalon. Regardless of the oath of fealty to the emperor the country's military power was reorganized and in rivalry with the Germans the Danes began, after their conquest of Rügen (1169), to dominate the Slav countries of the Baltic.

After Valdemar's death (1182) Absalon rejected by force of arms the German demand for supremacy and consolidated the monarchy internally and externally. Under Valdemar II (1202–41) Baltic expansion gained impetus, and in 1214 the emperor ac-

knowledged Danish suzerainty over the German-Slav lands north of the Elbe and the Elde. Estonia was conquered in 1219. Thus culminated Danish dominion of the Baltic; soon after, the king having been taken prisoner by one of his German vassals, it collapsed. An attempt at reconquest of the German Baltic lands failed when the Danish army that had invaded Holstein was defeated at Bornhöved in 1227. Only Rügen and Estonia were left.

The successful establishment of a great Danish kingdom was due in part to German weakness, in part, however, to internal reasons. A rapid growth in population since the Viking period had led to intensive settlement within Denmark itself; new villages and towns had grown up and rising exports of agricultural goods and herring from Skåne gave increased prosperity. The Valdemars gained the allegiance of the clergy and of the class of the powerful landed lords (*herremaend*) that had arisen by a fusion of the king's retainers (*hird*) with the old nobility. From this were recruited the court officials who, together with the greatly expanded chancellery, were responsible for the central government, and the local officials (*ombudsmaend*), who also administered the royal demesnes. The landed nobility formed a new and better-equipped regular army, which increasingly took the place of the old peasant levies (*leding*). In return, the people's military obligations and services for maintaining the king were converted into fixed property taxes. Intellectual life flourished through a clergy educated at French and Italian schools. Denmark was drawing abreast of the civilized nations of Europe.

3. Dissolution and Consolidation, 1241–1375.—The policy of conquest had overstrained the country's resources, and when the population ceased to grow the resources were lacking to colonize what had been conquered. The breakdown of the expansionist policy was therefore inevitable. Moreover the powerful monarchy had sown the seed of internal disruption and national dismemberment. Valdemar II had distributed large areas of the royal patrimony as feudal appanages to his younger and illegitimate sons, and the extensive privileges which the autocratic monarchy had paid for the loyal support of the clerical and lay nobility had created a huge aristocracy that soon became a danger to the throne. Valdemar's eldest son, Eric IV Plovpenning (Ploughpenny), crowned as co-regent in 1232 and king from 1241, was soon in dispute with the church and with his brothers about royal prerogatives. His brother, Duke Abel of Schleswig, proclaimed himself king and had Eric murdered (1250). He was then elected king, but when he fell fighting against rebel Frisians (1252) his sons were passed over and his brother was elected as Christopher I. Thus not only was the hereditary principle broken, but the older Abel line, which continued to hold the duchy of Schleswig (Slesvig), became a permanent source of unrest and, by its close association with Holstein, began the germanization of Schleswig. In Denmark itself a number of prelates, notably the archbishops Jacob Erlandsen and Jens Grand, persisted in the church's struggle against the crown. In this nationally destructive contest the king held the upper hand. He had been forced, however, to accede to the constitutional demands of the aristocracy. In the 1250s an aristocratic national assembly (Lat. *parlamentum*, Dan. *hof*) was formed, which imposed legal limits to the arbitrary rule of the monarchy. After a long constitutional struggle in which the king turned for support to a narrow privy council and to some extent to German princes and mercenaries, Eric V Glipping (*q.v.*; 1259–86) was forced to yield. The first charter (*haandfaestning*) of 1282 legalized the assembly's authority and limited the king's powers; during the next few years the nobles carried out a policy of radical reforms and reorganization. When Eric V was murdered in mysterious circumstances, the royalists seized the opportunity to regain control and had the leaders of the reform party convicted of the murder and exiled.

Eric VI Menved (*q.v.*; 1286–1319) tried to restore the power of the throne and revive expansion into German territories. Government finances broke down, and the kingdom began to disintegrate, especially when large territories were mortgaged to raise capital.

At subsequent royal elections the discontented nobles tried to control the monarchy by strict charters; but the result was more mortgages and increasing disintegration. From the death of Eric VI's brother Christopher II (1332) to 1340 the country was without a king. Holsteiner counts ruled over and impoverished Jutland and the islands as mortgagees, while Skåne subjected itself to the Swedish king. From 1241 the tendency had been for officials and nobles to separate themselves from government control while many free peasants abandoned their property rights to seek protection from the strong, which seemed to them more effective than the weak legal safeguards afforded by the monarchy.

Through the mediation of German princes and Hanseatic towns Valdemar IV (*q.v.*; 1340–75) reached a settlement with the Holsteiner mortgagees and obtained recognition as king. He gradually reunited the country, by redemption or by force of arms, and reconquered Skåne in 1360. Laying great stress on national unity and fellowship, he built up a strong central authority. He established a national army in which burghers and peasants gained a place beside the nobles. However, his military power rested chiefly on a chain of castles; under strict supervision, their wardens (*lensmaend*) became the leaders of local administration. The crown's finances were firmly restored: the old land taxes were given a fixed money value, and new taxes and labour services were levied; meanwhile the nucleus formed by the royal demesnes was continually increased, as a royal court of law (*retterting*) awarded to the crown all lands lost during the period of dissolution. A national assembly at Kalundborg in 1360 closed with a "national peace," a two-sided, legally inspired contract fixing the king's and the people's rights and duties. The reorganization of the kingdom made great demands on all classes, especially since it was carried out at a time of agrarian crises with falling prices, derelict farms and abandoned villages. Discontent smoldered, particularly among the formerly independent nobles, who rebelled repeatedly. A rash assault on Visby in 1361 led to a dangerous coalition of the great Hanseatic league, Sweden, the Holsteiners and the Jutland nobles. Pressed on all sides, the king left the country; the privy council then assumed control and, in 1370, concluded the peace of Stralsund, which granted the Hanseatic towns great commercial privileges but left the kingdom intact. Reluctantly Valdemar acquiesced in the treaty as a condition of his return to the throne.

4. Scandinavian Union, 1375–1523.—The male line of the dynasty having died out with Valdemar IV, the privy council took control and elected as king Olaf (1375–87), the young son of Valdemar's daughter Margaret by her marriage with King Haakon VI of Norway and heir also to the succession of Sweden (where Albert of Mecklenburg, Haakon VI's cousin, was at that time reigning). The power of the throne was limited by charter; but the real ruler was Margaret who, when first her husband and then her son died, was acknowledged in 1387 as sovereign by Denmark and Norway. With wisdom and moderation she gained control over the privy council (which had taken over the authority of the *parlamentum*) and ruled with the aid of private court officials. She kept a close watch over the conduct of her stewards and zealously carried out the legal restitution of the lost demesnes.

Called in by discontented Swedish nobles, Margaret expelled the Mecklenburgers from Sweden in 1389 and thus became the actual ruler of all Scandinavia (*see* MARGARET, queen of Denmark, Norway and Sweden). Everywhere she enforced allegiance to her elder sister's grandson, Eric, duke of Pomerania, who was crowned king of all three countries in a solemn joint act at Kalmar in 1397. At this assembly, attempts were made to set up a more permanent connection between the several countries, but as there was disagreement over the question whether the government of the union should be aristocratic and constitutional or strictly monarchical the meeting seems to have ended without result. The famous charter of the union of Kalmar was probably never adopted; the aristocratic constitution at least never became effective. The monarchy remained powerful and was strengthened after Margaret's death in 1412. Being childless, Eric of Pomerania (Eric VII of Denmark) arranged for a Pomeranian cousin to be designated his successor and gained acceptance of the principle that the royal castles after his death should pass to his successor directly, not via the privy council. In foreign policy Eric evidently planned to create a great Baltic state of the Scandinavian kingdoms and Pomerania, but despite the best intentions he lacked the ability to accomplish even

limited tasks within Denmark. He wanted to recover for the crown the duchy of Schleswig, which after the expiry of the male line of the Abel dynasty had in 1386 been enfeoffed to the counts of Holstein; and he sought to weaken the commercial power of the Hanseatic league by such means as encouraging a Danish urban middle class—a policy that found expression in his edict of 1422, which reserved trades and crafts for Danish citizens. This caused the Hanseatic league to ally itself with the Holsteiners and, although the Danish navy defeated the league repeatedly in the Sound (where from *c.* 1429 Denmark exacted tolls), Denmark was inferior on land. The burdens of war converted Swedish discontent with royal rule into open revolt, and the Danish privy council enforced a tolerable peace with the Hanseatic league and the Holsteiners in 1435 in order to apply every energy to perpetuating the union. But at a meeting at Kalmar in 1436 the Danish councilors deserted the king's union policy and supported the constitutional program of the Swedish nobles, disavowing the Pomeranian succession; the result was an open breach. Eric withdrew to Gotland, and the nobles established a federative union in 1438. In 1439 Eric was also deposed in Denmark in favour of his sister's son, Christopher of Bavaria.

During Christopher III's brief reign (1439–48) the privy council predominated and the three Scandinavian countries remained united. After his death the union was dissolved. The Swedes elected the former regent, Karl Knutsson, king as Charles VIII; Denmark and later Norway took a descendant of the royal house, Count Christian of Oldenburg, founder of the Oldenburg dynasty (1448–1863) who became king as Christian I (d. 1481). Thereafter it was only for brief periods that the Oldenburgs reigned even nominally over Sweden. Christian I was more successful in his policy toward Schleswig: when the ducal line died out (1459) he managed—despite his confirmation in 1448 of the provision in the *Constitutio Waldemariana* of 1326 that Schleswig and Denmark must not be united under the same ruler—to become both duke of Schleswig and count of Holstein. He had himself elected, in 1460, by the combined Schleswig-Holstein knighthood, but only on severe economic terms and on condition that the two lands remain "for ever undivided."

5. The 15th-Century State.—In the 15th century the dualism that was to characterize Danish politics for two centuries was already clearly discernible. The *rigsraad*, comprising the country's 7 bishops and about 20 noble landowners whom the king chose from the leading families, possessed in theory the highest constitutional powers. It elected the king, who from 1481 had to sign a pre-election charter drawn up by its members, embodying the constitution of the country and asserting that the king should conduct no important state affairs without its sanction. Yet, except by open revolt, the *rigsraad* possessed in reality only limited means of compelling the king, once elected, to observe the rules laid down in this charter; and further, the king and his chancery naturally retained control of the day-to-day administration of the country. Only in matters of local government was the king virtually obliged to make use of the nobles, who, insisting on their right to be appointed lords-lieutenant, were in charge of the local administration in the 200 *herreder* (hundreds) of the provinces which were governed from the king's castles.

The people now became divided more sharply into estates. Denmark's principal industry, then as at all times, was agriculture; the cultivated soil, apart from about 1,000 manorial estates, consisted of about 80,000 farms, clustered together in groups of 5–20 as villages. Each of these villages was administered by the peasant farmers in common, whether these owned their farms themselves or were tenants paying a yearly rent (*landgilde*). In the year 1500 there were about 12,000 Danish peasants who owned farms, about 18,000 *faestebonder* or leasehold tenants of crown lands, and about 30,000 leasehold tenants of the church estates or of the estates belonging to the nobles. These last were numerous, because such properties were free from the old land taxes due to the state. In one or two respects, however, this tax exemption had other results. Thus the leasehold tenant on a manorial estate was liable to certain terms of forced labour and feudal duties, and when, as a result of the agrarian crisis in the 14th century, many leasehold farms became vacant, a law was introduced by the lords of the manor, especially in Sjælland, that the next heir to any leasehold tenant must take over his farm. This was in fact a form of serfdom which meant that a farmer's sons who had become artisans or tradesmen in a town could be forced to abandon their occupations in order to continue the cultivation of their father's farm.

The Danish Church at this period, with its 7 bishoprics and more than 70 monasteries, was immensely rich. It derived a huge income from its estates and leasehold farms, which were exempt from the old land taxes and on which extraordinary taxes could be levied only with its consent. It drew still greater revenues from the tithes on the entire grain production of the country, one-third of such tithes going to the bishops, one-third to the parish churches and one-third to the parish priests. The pope, since the Council of Basel, had assumed the right to make all ecclesiastical appointments in Denmark, though he allowed certain nominations by the king. The Danish nobles, however, tried to reserve ecclesiastical appointments for their younger sons, who were too poor to buy estates, and in 1523 King Frederick issued a decree that to become a bishop a man must be a Danish noble; for an important prelacy he must be either a noble or else a doctor of theology. This was one cause of the decline of religion in Denmark during the 15th century: people turned away from a church most of whose leaders did little but enjoy the material rewards of their high offices. Still, with the setting up of a university and school of theology in Copenhagen in 1479, a more serious study of the principles of Christianity began. Paul Helgesen, who became *lektor* in 1519, vigorously attacked the malpractices in the church, especially in the matter of the sale of indulgences; but Martin Luther's break with Rome in 1521 changed Helgesen into one of the last great champions of the Catholic Church in Denmark.

The 15th century marks a turning point in the history of the Danish nobility. Until then any Dane could become a noble by presenting himself, in time of war, well-equipped for military service at his own expense. In return for this he was exempted from all taxes on his entire estate. But from the 15th century the nobility became an estate apart: to belong to it a man had to show that his forefathers had enjoyed tax exemption for at least three generations.

The nobles thus stopped new families from entering their ranks. The king sought to assume the right to issue titles of nobility, but despite this the Danish nobility in the 15th century developed the characteristics of a caste. From 264 families known during the years 1400–50, the number sank from 230 families in 1500 to 140 (including at most 3,000 persons) in 1650. Of the noble families in the 15th century the Gyldenstjerne and the Rosenkrans (whose names are commemorated in Shakespeare's *Hamlet*) were among the most important.

The Danish landowning nobility of the 15th century acquired estates in great numbers, were capable agriculturists and witnessed Denmark's increased exports of farm produce. The country had a long-standing market for its horses; now stall-fed bullocks were added and the landowners had to find sales not only for their own produce but also for that levied by them as rent from their leasehold tenants. In this way the estate owners, lay and clerical, also became merchants, many of them having their own ships.

(A. E. Cn.)

6. The First Oldenburgs and the Estates.—The three first Oldenburgs, Christian I (reigned 1448–81), John (Hans; 1481–1513) and Christian II (1513–23), tried to foster the economies of the Danish towns while curbing the direct trade of German Hanseatic merchants with the peasants. By the 1422 ordinance of Eric of Pomerania, reissued and extended in 1475, the peasants had to sell their produce in the towns and make their purchases there, while the Hanse merchants were confined to trading with burghers. Hanseatic merchants and other foreign traders therefore settled permanently in Danish towns. The Danish nobility and prelates now had their medieval trading rights restricted to agricultural produce and household goods. The king favoured the towns partly to counterbalance the power of the nobility. The bishops in the *rigsraad*, with few exceptions, were clerics of noble

parentage, and the council acted in unison even though its lay members were nominated by the king. Christian I and John tried to balance the *rigsraad's* power by calling in an assembly of estates. John also employed commoners in the central administration and as bailiffs on the royal manors. This irked the leading nobles, who had derived much of their income as administrators of royal demesnes held in farm. The king's income from these had become negligible: to pay for the royal household he had to rely on the royal manors and the income from customs such as the Sound tolls. Occasionally the *rigsraad* or an assembly of estates grudgingly voted taxes—usually to support the king's wars with the Hanseatic league or with Sweden. Christian II, the son of John, was early known to share his father's views. As regent in Norway he had shown his taste for democracy, so that the majority in the *rigsraad*, distrusting him, tried to safeguard themselves by a stringent charter which Christian was forced to issue before his accession in 1513. In it he conceded all the traditional privileges of the nobility and recognized the constitutional power of the *rigsraad*. However, he soon broke these terms, especially after 1517. Although not completely disregarding the *rigsraad*, he used commoners as his advisers, giving them the rank of councilors. The two most prominent were Hans Mikkelsen, the burgomaster of Malmö, and Sigbrit Villoms, the wife of a Dutch burgher. Her daughter Dyveke had become Christian's mistress during his stay in Norway, and the king brought Sigbrit and Dyveke to Denmark in 1513. Dyveke's death in 1517 left her mother's influence over the king unimpaired, and during the later years of Christian's reign she virtually controlled Danish finances. Her power provoked much hatred and ill-feeling. The influence of both Sigbrit and Mikkelsen shows in the reformed legal codes, *Landloven* and *Byloven*. These two codes presupposed increasing central control and inspection and therefore remained at best a program of reform adding to the widespread discontent, as also did the desperate means (including debasement of the coinage) used to meet the heavy costs of the Hanseatic wars and revolts in Sweden (reconquered in 1520 and finally independent in 1523). Members of the Jutish nobility, who had suffered from Christian's drastic changes in local administration and feared worse, turned to Christian's paternal uncle, Frederick, duke of Schleswig and Holstein, and offered to support his claim to the throne. When he accepted they renounced their allegiance to Christian. In April 1523 Christian left Denmark with his queen (sister to the emperor Charles V), Sigbrit and Hans Mikkelsen. From his exile in the Netherlands he made several attempts to reconquer Denmark and Norway, but these ended in disaster in 1531 when an attempted invasion of Norway failed. In the spring of 1532 Christian II signed a truce and sailed to Copenhagen on a Danish ship. Though he was not a prisoner the Danes, fearing new troubles if he returned into exile, confined him first at Sønderborg castle and later at Kalundborg castle. (*See* also CHRISTIAN II.)

7. Frederick I, 1523–33.—The charter which Frederick I issued before his accession was no less rigorous than that agreed to by Christian II. The privileges of the nobility were enlarged and their freedom to trade specifically mentioned. Frederick I adhered to the charter but under protest. He refused to settle in Denmark, claiming that his Danish revenues were inadequate, and stayed mostly at the castle of Gottorp. From 1525, when he visited Denmark, it became evident that Frederick adhered to Lutheranism, as did prominent members of the *rigsraad*. With the king's sanction the Franciscans were expelled from their houses, while Lutheran preachers received freedom to preach in several towns.

8. Civil War and the Lutheran Reformation.—After the death of Frederick I in April 1533 the Catholic and conservative majority of the *rigsraad* once more triumphed. They postponed the election of a new king, fearing that the obvious candidate Prince Christian (later King Christian III; *q.v.*), if elected, would immediately introduce Lutheranism. Unsuccessfully they tried to sponsor his younger brother Hans. In the civil war that followed (1534–36), the burgomasters of Malmö and Copenhagen accepted an offer of help from the democratic burgomaster of Lübeck. The Lübeckers, on the pretext of restoring Christian II, hoped to regain their mercantile supremacy and control of the Sound. The landing of Lübeck troops in Sjælland in the early summer of 1534 roused the Jutish nobility. Now even the Catholic bishops rallied to support Prince Christian. Count Christopher of Oldenburg was leader of the forces of Lübeck, while Christian's general was the Holstein noble Johan Rantzau, who was also a Lutheran. Rantzau subdued a revolt of the Jutish peasants and then won the rest of Denmark for Christian. The civil war ended with the surrender of Copenhagen in the summer of 1536. Shortly thereafter, the Catholic bishops were put into custody and their property confiscated; the monasteries were dissolved and vast estates came to the crown. In Oct. 1536 the estates sanctioned a Danish Lutheran Church. The year 1537 saw the appointment of new bishops, several of them former Lutheran preachers and all of burgher descent. They could not, however, claim political influence, as bishops no longer sat in the *rigsraad*. The church organization was finally established in 1539. The purged *rigsraad* which emerged after 1536 was soon able to assert itself. The charter which Christian III issued differed only slightly from former charters on the subject of the privileges of the nobility and the constitutional power of the *rigsraad*. The king's attempt to make the throne hereditary did not quite succeed. The *rigsraad* named Prince Frederick as the successor of his father and the king's charter provided that a Danish prince should always be elected, but this was omitted in Frederick II's charter in 1559. The *rigsraad* thus suffered no permanent loss of elective power.

9. Reorganization, Stability and Prosperity.—During the first years of Christian III's reign the Holstein nobility exercised a powerful influence. Denmark was impoverished; the situation improved only when the chancellor Johan Friis (*q.v.*) arranged a settlement and division of the war debts and the nobility offered substantial loans. From 1539 Christian took up residence in Denmark. In 1544 Schleswig and Holstein were equally divided between Christian and two of his younger brothers. By several statutes and with the assent of the *rigsraad* much of the reform program sketched in Christian II's two laws was given new life. Johan Friis likewise modernized the central and local administration, in which the younger members of the nobility became increasingly important. The most able began in the chancery or obtained responsible posts in the local administration, usually ending their careers with royal nomination to the *rigsraad*. The exchequer, too, came to be partly staffed by chancery clerks. Not until 1660 did commoners again hold responsible government posts. As Christian's coronation charter required sanction by the *rigsraad* for any new ennoblement it maintained the castelike nature of the nobility. The few exceptions had no political significance. Some of the king's German favourites or councilors serving in the *Tyske Kancelli* (German Chancery) and the diplomatic service were admitted to the full privileges of the Danish nobility, but they usually belonged to the nobility of their home country.

During the second half of the 16th century the nobles had considerable wealth. The price revolution in the century showed a steeper rise in food prices, which favoured Denmark, whose chief exports were grain and livestock. The nobility reaped most of the benefit. Living was easy and luxuries became everyday habits. The astronomer Tycho Brahe (*q.v.*) illustrates the high standing of the nobility. The royal justiciar Arild Huitfeldt wrote the comprehensive chronicle *Danmarks Riges Krönicke*. Enterprising burghers developed a remunerative export and import business. The nobility gave up trade with German merchants and entrusted their affairs to Danes, who also succeeded in becoming providers to the court. It seems that the peasants during the 16th century did not fare too badly either. Nearly all of them were copyholders but by statute it was forbidden to raise their rent. During the later decades of the century few taxes were imposed. Cattle raising must have given the farmer a reasonable surplus.

10. The First Swedish Wars.—Christian III tried to avoid war but in 1542 was forced into conflict with the emperor Charles V who supported his nieces in their claims on the Danish throne. A lasting peace was, however, achieved by the treaty of Speyer (1544). Under Christian III of Denmark and Gustavus I Vasa of Sweden the two Scandinavian kingdoms remained at peace.

With the accession, however, of the young warrior kings, Frederick II of Denmark (1559) and Eric XIV of Sweden (1560), war became inevitable. The Seven Years' War of the North (1563–70) sprang mainly from their rivalries, though the Baltic provinces were also at issue. The Danish crown still had many outlying possessions both in the Baltic (Gotland) and in the North sea and the Atlantic (Norway, the Faeroe Islands, Iceland). Moreover, Skåne was still a Danish province. Denmark thus controlled the entrance to the Baltic and so could claim *dominium maris Baltici* (dominion of the Baltic sea). The Danes soon raised similar claims for the waters surrounding their other possessions, but with less success. The war with Sweden produced only financial exhaustion, though a new Sound toll (*lastetold*), originally imposed during the war, gave the king an additional source of income. After 1570 Frederick concentrated on maintaining peace and building castles; above all, Kronborg castle at Elsinore. Peace lasted during the minority (1588–96) of Frederick's son and successor Christian IV (*q.v.*). Not until 1611, when Christian threatened to declare war as duke of Holstein, was the *rigsraad* compelled to sanction plans for war against Sweden. In the Kalmar War which followed (1611–13) the Swedish army consisted of trained peasant soldiers, whereas the Danes had mostly to rely on mercenaries. Nevertheless since Gustavus II Adolphus was engaged elsewhere, the Danes were able to seize and hold Elfsborg (Älvsborg) against the payment of ransom.

11. Christian IV's Achievements.—After this fruitless war Christian IV concentrated on the economic development of his kingdoms, especially the towns. Copenhagen prospered; he adorned it with buildings and erected an exchange. However, his attempt to organize a textile industry failed, and his trading companies did not survive his reign. His outlay on the fleet was more effective. The royal shipyards were enlarged and a protective harbour built at Copenhagen. Christian founded new towns both for economic and defense purposes. Glückstadt in Holstein was planned as a rival to Hamburg, and a chain of fortresses was begun on the Swedish frontier, though Christian had no desire to resume war with Sweden. He built two royal palaces: the magnificent Frederiksborg at Hillerod and the small castle of Rosenborg at Copenhagen.

12. Decline and Wars.—From 1620 it became obvious that Christian aspired to meddle in international politics. He had his younger sons chosen as coadjutors in secularized bishoprics in northwestern Germany. Soon he was involved, and not unwillingly, in the Thirty Years' War (*q.v.*). The Protestant cause in northern Germany was endangered. While Gustavus II Adolphus of Sweden had rejected the English subsidies for his intervention as insufficient, Christian accepted and began operations in 1625. His adversaries were experienced and famous generals. His defeat was complete. During the following years Jutland was invaded and plundered. Christian's humiliation was the greater as a fairly favourable peace treaty was partly due to the intervention and support of Gustavus. Christian had to abandon the German bishoprics and to renounce further intervention in the German war. Gustavus Adolphus continued the war, nor did his premature death in 1632 stop Swedish operations in Germany. Christian, however, thought he could now act as mediator. He tried to strengthen the army and increased his income by raising the Sound tolls, but his policies made him generally distrusted. In 1643 the Swedes invaded Jutland; the Danes were again defeated. By the treaty of Christianopel (1645) Denmark ceded Jämtland and Härjedalen (Norway), Halland (Denmark) and the islands of Gotland and Ösel to Sweden. The *rigsraad* held Christian responsible, but he relied on his sons-in-law for support. When he died in 1648 the *rigsraad* forced on his son and successor Frederick III a charter binding him to co-operate in all matters of state and to seek approval when nominating new members. But as prices for agricultural produce slackened, Denmark suffered an economic decline, while the government, now somewhat outmoded, found its task increasingly difficult. Many nobles had become indebted to the merchants, who were however not entitled to acquire landed property in payment. In 1657 when Charles X of Sweden was at war with Poland, Frederick felt he might regain the lost provinces. But Denmark was ill-prepared and Charles X roundly defeated the Danes by a lightning attack from the south of Jutland. The severe winter had frozen the Danish Bælts, permitting Charles to march his troops across against Sjælland. In Jan. 1658 he prepared a siege of Copenhagen. Ensuing negotiations led to the peace of Roskilde in Feb. 1658. Denmark ceded the Skåne provinces, the island of Bornholm, and Trondheim and Bohus in Norway.

Soon Charles wished that he had completely conquered Denmark. He resumed war, but now Frederick (aided by the Dutch who were opposed to Swedish control of both sides of the Sound) and the population of Copenhagen were determined not to yield. In Feb. 1659 a Swedish attack on Copenhagen's fortifications was repelled. Trondheim was reconquered and the inhabitants of Bornholm shook off Swedish rule. Early in 1660 Charles suddenly died, and the Swedes had to end the war. The treaty of Copenhagen (May 1660) confirmed that of Roskilde in several points, but Trondheim and the island of Bornholm were regained.

13. Constitutional Revolution of 1660.—The estates met in Copenhagen in Sept. 1660. Heavy debts contracted during the wars required immediate measures, and an excise duty was proposed. The nobility was for the most part unwilling to forgo its exemption from taxes. But the clergy, headed by bishop Hans Svane, and the townsmen, led by the burgomaster of Copenhagen Hans Nansen, jointly forced the *rigsraad* and nobility to relinquish their fiscal privilege and to negotiate with the king for a change in the constitution. Svane and Nansen, acting for their estates, offered to confer hereditary succession on Frederick III and his descendants. The *rigsraad* ultimately yielded under pressure on Oct. 13, when all three estates made the same offer to the king. Frederick was absolved from his coronation charter and on Oct. 18 was acclaimed as hereditary sovereign. In Jan. 1661 the government sent out an instrument or pragmatic sanction, to be signed by all the more prominent citizens, landowners, bishops, professors, magistrates, etc.; by this the king conferred on himself not merely the succession but also absolute power.

The constitution which Frederick had promised was signed on Nov. 14, 1665. The King's law or *Kongeloven* made the Danish sovereign absolute; it charged him with keeping the kingdom undivided and maintaining the Christian religion in accordance with the Confession of Augsburg and settled the succession on Frederick's heirs. An absolute monarchy was essential to deprive the nobility of its political power. Henceforth distinctions of rank were minimized: all citizens, the peasants excepted, were to be on a level under the absolute rule of the king.

14. Absolutism and Reorganization.—The central administration, not divided into departments as in other European states, had now to be completely overhauled. The chancery continued to be the most important department of state dealing with home affairs, but burghers were now able to serve as much as aristocrats. Alongside the admiralty, a new war office was created. The exchequer was reorganized. For a short while the noble Hannibal Sehested (*q.v.*) was lord high treasurer (*rigesskatmester*), but the aristocracy soon lost its lead; the burghers came to the fore, as did representatives of the Holstein aristocracy and Germans of varied descent. All these departments of state, as well as the department for foreign affairs and the Schleswig-Holstein duchies and the supreme court, were organized as administrative boards (*kollegieordningen*). Proposals from the several boards were debated in the king's presence by the privy council, whose members, selected chiefly from the heads of the boards, were nominated by the king. In the local administration civil servants or former members of the royal household were now appointed as *amtmaend*, acting as the king's representatives in the provinces, but they no longer administered the rapidly declining royal estates. The greater part was sold to the creditors of the state. Landed property thus passed into burgher hands. Often the new owners found their land a burden, as grain prices were falling and livestock became less profitable. Under the outdated agricultural system the peasants were worse off than ever, not to mention the increasing pressure of taxation. The towns fared better, especially Copenhagen. With government support new trading com-

panies were launched, while the Asiatic company, founded under Christian IV, was revived. The carrying trade prospered during the European wars.

The most brilliant figure of the new bureaucracy was Peder Schumacher, later Count Griffenfeld. (*See* Griffenfeld, Peder Schumacher, Count.) A member of a rich and respected Copenhagen family, he became librarian to Frederick III. The king died in 1670, and in the first years of Christian V's reign Schumacher's rise was rapid. In 1674 he became *rigskansler*, having been created a count and a knight of the Elephant. However, his independent line on foreign policy, his distaste for Christian's ambitions to reconquer Skåne, and the enmity of rivals led to his fall in March 1676. The so-called Skåne War (1675–79) failed to win back the lost provinces. For the following 20 years peace reigned. In 1683 a joint code of laws for the whole kingdom was issued, *Christian V's Danske Lov*. This and subsequent legislation showed that in spite of poverty Denmark was developing on the lines of the more advanced European states. (As. F.)

15. Frederick IV's Wars and Holstein-Gottorp.—Twenty years after the failure of Christian V's Skåne War, his successor Frederick IV (1699–1730) decided to resume the struggle against Sweden. In 1700 and from 1709 to 1720, Denmark participated in the Great Northern War, which entailed terrible sacrifices. Though Skåne was not recovered, Frederick's victories over Sweden's allies, the dukes of Holstein-Gottorp, enabled him to annex the ducal part of Schleswig to the royal part.

The resentment of the house of Holstein-Gottorp was to threaten Frederick's successors for the next 50 years, especially after the adoption of Peter of Holstein-Gottorp by the Russian empress Elizabeth (1741) and the election of Adolphus Frederick as heir to the Swedish throne (1743). On Peter's accession to the Russian throne as Peter III (1762), war seemed inevitable and Denmark had to arm, but the tension was diminished after his assassination, when his consort took his place as Catherine II. Denmark's foreign policy, controlled since 1751 by J. H. E. Bernstorff (*q.v.*), now took on the new aim of inducing the empress to exchange the Gottorp portion of Holstein for Oldenburg (which Griffenfeld had assured to Denmark by a treaty of 1671). This aim was achieved in 1773; the Danish king once again held both dukedoms, Schleswig as a Danish and Holstein as a German fief.

16. The 18th-Century State.—Taxation lay heavy on the people. Danish agriculture long remained stagnant. Grain, the chief export to Norway, fell in price during 1720–40, though it began to recover by 1750. Trade in bullocks to the Netherlands declined when the Dutch imposed a heavy duty in 1718; the North German market took some of these exports instead. Cattle plague inflicted great losses after 1745. To pay for the war with Sweden, the crown, after 1660, had to sell much of its property. Gifts from the king to ministers and favourites, and continual sales steadily raised the landowner's share of the soil. In order to collect taxes from the peasants the crown had to make the landowners responsible for levies due from their leasehold tenants. In return the owners were granted exemption for their principal estates; thus privilege was restored, though on a new basis of law. This applied also to the new nobility of counts and barons who acquired all the rights formerly enjoyed by the old Danish nobility, including the right to leave their estates in entail to the eldest son, though as a fief which on extinction of the direct line should revert to the crown. The harder the times the more the crown had to accede to the landowners' demands for the right to compel occupation of their leasehold estates and obtain free labour from their tenants. One of the first acts of Christian VI (1730–46) had been the abolition of the national militia, but in 1733 it was reintroduced, in combination with the so-called *stavnsbaand*, which provided that all Danish farmers' sons from their 14th to their 36th year should be bound as villeins to the estates on which they were born. In 1746 it was further decreed that even soldiers who had served their time were bound to return to the same estate and to take up tenant farms. As grain prices began to rise about 1750, landowners, bent on greater production, extorted more work from their tenants, either by force or by contracts often open to abuse.

The mid-18th century, however, brought economic advance when, mainly through French enterprise, colonial goods from the West Indies (especially sugar, coffee and tobacco) began to find a European market. Denmark acquired three West Indian islands, of which the most important were St. Croix and St. Thomas. The eastern Asiatic trade also began to flourish under the leadership of England. Danish trade expanded and the new Asiatic and West Indian companies both prospered. A Danish bank of issue, founded in 1736, supported these ventures. When the great colonial war broke out between France and England the neutral trade of Denmark soared. A. G. Moltke (*q.v.*), the favourite of Frederick V (1746–66) and a great landowner, was the first to realize that this might also expand Danish agriculture, but the landowners were too conservative to consider the economic freedom of the peasants. However their rule was overthrown in 1770 by J. F. Struensee (*q.v.*), an accomplished physician and a man of great gifts, who secured power through his liaison with Caroline Matilda, sister of King George III of Great Britain, who had been unhappily married to the degenerate and morbid Christian VII (1766–1808). Struensee carried through a number of reforms, including some reduction of villeinage, but conservatism again revived under Ove Höegh-Guldberg, who declared that the "yoke of the peasants could not be removed without Denmark's shaking and quivering to its foundation."

Agricultural reforms were imminent, however, and when in 1784 the crown prince Frederick had acquired power by a *coup d'état*, he found a brilliant spokesman in a landowner of old Danish stock, Christian Ditlev Frederik Reventlow (*q.v.*), who had studied agriculture in England. Reventlow became the life and soul of a commission which freed the Danish peasant. The *stavnsbaand* was ended on June 20, 1788; villeinage was either clearly defined or commuted, compensation in money being given; the old agricultural associations were abolished, and the peasant was allotted his own plot of land. Many at once left the villages for the country. This thorough and successful land reform ultimately aimed at freehold ownership. Danish agriculture and trade now took great strides. Commerce was facilitated by the toll law of 1797 which extended the principle of free trade. Wealthy businesses grew up in Copenhagen, and the bank of issue granted ever-increasing credit. After 1757 the bank was exempted from having to meet its notes with silver; after it was taken over by the state in 1773, the note issue had to cover both the needs of business and the state's financial demands.

17. Napoleonic Wars.—In the late 18th century England had become a grain-importing country. The prices of grain and agricultural products rose steadily during the French Revolution and the Napoleonic Wars. In this favourable period, which continued until 1807, nearly half the Danish peasants became freeholders.

Danish trade also prospered while the foreign minister, Andreas Peter Bernstorff, like his uncle J. H. E. Bernstorff before him, succeeded in keeping Denmark out of war. After his death in 1797 there came a clash with England. In Dec. 1800 Denmark joined the second armed league of neutrality of the Baltic powers, set up to protect the rights of neutral shipping by convoy in time of war. In 1801 an English fleet was dispatched to Copenhagen under Sir Hyde Parker, with Nelson his second-in-command, to compel Denmark's withdrawal. The Danish government refused to be coerced, but in the battle of Copenhagen in April, the Danish fleet was largely destroyed and Denmark had to agree to the English terms. (For an account of the battle *see* Copenhagen.)

In 1807 the British asked the neutral Danes to give up their navy lest Napoleon use it against England. The Danes yielded, but not before a British squadron of ships of the line with troop transports had laid large portions of Copenhagen in ruins. In anger over this, Frederick VI (1808–39) thenceforth backed Napoleon. In the seven burdensome war years that followed, relations between Denmark and Norway were completely broken off and Danish trade was brought to a standstill. With Napoleon's defeat Denmark had to conclude a peace at Kiel in 1814, losing Norway to Sweden and Heligoland to England, but acquiring Lauenburg. Since neither taxes nor loans could be raised to meet the immense war costs, the state bank issued notes without limit;

in 1813 it went bankrupt and a new national bank was founded, which became private in 1818. The failure of the bank, the destruction of Danish trade and the fall of grain prices, especially between 1818 and 1824, caused a period of poverty and stagnation during which the land reforms came to a standstill.

18. The Liberal Constitution, 1849.—This naturally provoked criticism of Frederick's absolute government. Under the influence of the July revolution of 1830 in France, Frederick in 1834 set up four consultative provincial assemblies. These marked the beginning of parliamentary life and encouraged public discussion of political questions. A Liberal party came into existence, basing itself on the principles of constitutional and representative government. Not even Christian VIII (1839–48), who as king of Norway in 1814 had co-operated in framing Norway's free constitution, seemed disposed to perform the same service for Denmark. Immediately after his death on Jan. 20, 1848, came the February revolution in France and the short-lived victory of liberalism. In Copenhagen there was a public procession on March 21 to the new king demanding a liberal constitution. Frederick VII (1848–63) thereupon announced he would renounce absolute rule and had already planned a representative government. This was appointed next day with A. W. Moltke (*q.v.*) as prime minister; among the ministers were leading National Liberals like D. G. Monrad and Orla Lehmann; A. F. Tscherning, leader of the Bondevenner, or Friends of the Peasants, was more radical. On Oct. 23 a national assembly met; on the basis of a draft submitted by Monrad, it prepared the Danish constitution of June 5, 1849. The legislature became a *rigsdag*, with specified powers, consisting of a *landsting* and a *folketing*; the members of the former were to be elected for eight years by indirect vote and the latter for three years by direct vote.

19. The Schleswig-Holstein Question.—The question of the new constitution was, however, overshadowed by the widening differences between Germans and Danes. The Napoleonic Wars had awakened German national feeling, and the political bonds which had existed between Schleswig and Holstein ever since the election of Christian I as their joint ruler in 1460 suggested that these two regions should form a single country within a united Germany. A countermovement developed among the Danish population in North Schleswig and from 1838 in Denmark itself, where, from 1842, the Liberals were insisting that Schleswig had belonged to Denmark for centuries and that the frontier between Germany and Denmark must in the future as in the past be the Eider. (*See* SCHLESWIG-HOLSTEIN QUESTION.) This difference between Eiderdanism, as it came to be called, and Schleswig-Holsteinism led in March 1848 to an open Schleswig-Holstein revolution, helped by the armed intervention of Prussia. The outcome of this was a three years' war (1848–50) which ended in a victory for Denmark. Great Britain, France, Russia and Norway-Sweden in 1850 recognized the integrity of the Danish monarchy and, in the London convention of 1852, together with Austria and Prussia acknowledged Prince Christian of Glücksburg as heir to the whole monarchy after the death of the childless Frederick VII. In the agreement with Prussia, however, the Danish government by a protocol of 1852 undertook not to tie Schleswig more closely to Denmark than to Holstein. That this condition was impracticable soon emerged.

In the Danish *rigsdag* three parties had been formed: the Conservatives, comprising most of the landowners and all opponents of the free constitution; the National Liberal Burgher party, which had carried through the June constitution; and the left, including the Peasants and the Friends of the Peasants, whose chief aim was continued land reform. The Conservatives were in favour of restricting the June constitution as much as possible, being ready to fulfill the guarantee to Prussia by creating a conservative joint constitution for the whole kingdom, with a joint *rigsraad* in which the Holstein landowners should also be represented. Such a constitution came into existence in 1855, but the Holsteiners promptly refused to meet in a joint *rigsraad*. After 1857 the National Liberals returned to power with Carl Christian Hall (*q.v.*) as prime minister. He abolished the joint constitution for Holstein and on Nov. 18, 1863, prevailed on the new king, Christian IX (1863–1906), to sign a new joint constitution for Denmark and Schleswig. Prussia and Austria were now able to intervene as the upholders of the 1852 protocol. In 1864, Danish military resistance was crushed in two brief campaigns, and by the treaty of Vienna in October Christian IX surrendered his claims in Schleswig, Holstein, Lauenburg and Danish North Schleswig to the emperor of Austria and the king of Prussia. In 1866 after the Austro-Prussian War these territories became part of Prussia. The treaty of Prague (1866) provided that North Schleswig should be reunited with Denmark should the majority of the population by a free vote so desire; but in 1878 Prussia and Austria agreed to cancel the article.

20. The 1866 Constitution.—The National Liberal Eider-Danish policy had brought about Denmark's defeat. The Conservatives took office and carried through the new constitution of July 28, 1866, which was considerably more conservative than that of June 1849: the general suffrage was retained for the *folketing*, but in the composition of the *landsting* the landowners and the most highly taxed people were given an overwhelming influence. This resulted in the two chambers entering into a state of permanent opposition to each other. In 1870 the left severed their alliance with the Conservatives, who soon combined with the National Liberals to form a right. This right leaned on the *landsting* and maintained the king's privilege of selecting his ministers without regard to the majority in the *folketing*.

In 1872 the left secured a majority in the *folketing* and insisted that the king must choose his ministers from the majority party. The struggle persisted from 1875, when J. B. S. Estrup (*q.v.*), the leader of the right, became prime minister. The contest was bitter, for throughout all this period the left had a growing majority in the *folketing*. The election of 1884 gave them more than 80 seats, of which 2 were held by the first Social Democrats ever elected to the chamber. The right demanded large appropriations for defense, in particular for the fortifications around Copenhagen; the left, especially Viggo Hörup, who after the 1870s stood for a foreign policy of neutrality and disarmament, refused to admit this. Under the leadership of Christen Berg the *folketing* went so far as to reject the budget in 1877 and again in 1885. But Estrup did not shrink from letting the king declare a "provisional budget," and by this means the right were able to maintain themselves in power. In 1894 a group of Moderates came to an agreement with the Conservatives about defense policy, and Estrup now resigned as prime minister. Only when the election of 1901 had reduced the government's strength in the second chamber to 8 members of the right and 16 of the so-called Moderates, as against 76 of the left and 14 Social Democrats, did King Christian IX request J. H. Deuntzer to form the first left ministry, of which Jens C. Christensen, Hörup and Christopher Hage became members.

21. Economic Progress.—Since prices went on rising, land reform could be resumed, as the Friends of the Peasants and the left desired. The National Liberal government supported these moves with Monrad's law of 1861 changing the leasehold tenancies into freehold land. Thus 87% of the farms were freehold by 1873 and 95% by 1905. The increasing exports of grain from America and Russia between 1873 and 1895 undermined Danish agriculture, but the farmers now developed the export of butter and bacon and through a system of co-operative dairies and slaughterhouses established a strong position in the English market. Later there came co-operative export associations.

The port of Esbjerg, established in 1868, became an important centre for the English export trade. C. F. Tietgen founded the United Steamship Co. (whose Esbjerg-Harwich line took over the export to England) and the great Northern Telegraph Co., which acquired its greatest importance through its relations with China and Japan. New banks were founded, including the Landmandsbank (Agriculturists' bank) in 1871 and the Handelsbank (Trade bank) in 1873. The towns grew; during the 1870s Frederick III's old ramparts round Copenhagen were pulled down and new quarters arose on their site. A wage-earning class arose and was soon identified with the Social Democrats. A labour conflict in 1899 led to the establishment of an arbitration court for settling labour

disputes (the June constitution had already acknowledged the full right of association). In 1891 there was introduced an old-age pension law, in 1892 a health insurance law, in 1899 an important law for the establishment of small farms with state help.

22. Ministries of the Left.—As a ministerial party, the left had great difficulties to overcome. It had to try to introduce universal suffrage in the election of parish councils (*sogneraad*), of county councils (*amtsraad*) and even of the lower chamber itself, for which a new fundamental law was required; it had to proceed with social legislation; it had to change taxes such as the tithe into taxes on the incomes and property of the citizens; it had to introduce regular budgets. The Deuntzer ministry carried through a tax reform in 1903; two years later Jens C. Christensen became prime minister. He was anxious to demonstrate that the left could rule, even with a hostile upper chamber, but he believed that to do this the left should break with the Social Democrats and declare itself willing to carry through measures of defense adequate to the country's needs, even if defense expenditure could not be reduced. A small section of the left which would not admit these two measures set up as an independent party, the Radical party, under the leadership of Carl Theodor Zahle. In the following year the military problem became the dominant issue; the prime minister tried to solve it in conjunction with the Moderates, whose leaders were Klaus Berntsen and Niels Neergaard. But in 1908 the ministry was severely shaken when the minister of justice, A. Alberti, was forced to resign and subsequently confessed himself guilty of fraud. The Christensen cabinet had to resign in Oct. 1908. Three short-lived cabinets followed (Neergaard, Count Holstein-Ledreborg, Zahle), and finally, in June 1910, Klaus Berntsen formed a cabinet of the left, including the Moderates, which lasted until 1913. King Frederick VIII, who had succeeded in 1906, died in 1912.

In 1910 the left had begun to agitate for a democratic amendment to the constitution. The right, strong in the *landsting*, opposed this, and no solution had been reached when the elections were held in May 1913. The Radicals and Socialists now held 63 seats out of the 114 in the *folketing* and united to force the reform under a new Zahle cabinet containing Erik Scavenius (foreign affairs), Edvard Brandes (finance), Ove Rode (interior) and Peter Munch (defense). The right answered by obstruction in the *landsting*, which the government then dissolved. The new *landsting* contained 38 supporters and 28 opponents of the constitutional amendment.

23. World War I.—During the crisis of July 1914 the Danish government remained cautious. When war broke out on Aug. 1 it forthwith proclaimed its neutrality and mobilized an emergency force.

On the night of Aug. 4–5 Germany began mining southern Danish waters and next morning the German minister asked if Denmark would lay mines in the Store Bælt. Fearing that the Germans would otherwise lay the mines themselves and build fortifications on the coast to protect them, the Danes gave an affirmative answer, King Christian X (1912–47) having informed his cousin the king of England, who agreed. All Danish waters were mined.

During this crisis the Zahle government proposed a coalition of all four parties, but discussions between them failed. The *rigsdag* passed several emergency laws, primarily economic. Germany could stop Danish exports to England, and England strangle imports of supplies needed for Danish agriculture and industries. Arrangements acceptable to all interests were concluded, and in November the Scandinavian countries declared that they intended to follow a uniform trade policy. In December a meeting of the three Scandinavian kings, prime ministers and foreign ministers took place at Malmö.

As the war progressed the restrictions on imports, imposed by England, became more severe. The German U-boat warfare was expanded from Jan. 31, 1917, and Danish shipping suffered increasing losses. When the United States entered the war difficulties increased, because of U.S. restrictions on trade with Germany. Gradually the consequences of war were felt on the domestic scene. Agreements with the belligerents made restrictions on business necessary and were received with resentment. To combat inflation, prices on domestic products were fixed; but legislation requiring the farmers to deliver certain amounts of grain met with opposition. From April 1, 1917, rationing was gradually imposed on several goods. Salaries did not rise and shortages in raw materials created unemployment. Rising governmental expenditure made higher taxes and loans necessary.

When the first anxiety over the war had died down the question of a new constitution was taken up again. The right was now interested in an agreement, and on June 5, 1915, the king signed the new constitution. This provided a two-chamber parliament with equal suffrage for men and women. The privileged suffrage for the landlords and the wealthier classes electing the upper chamber came to an end. The voting age for the upper chamber (the *landsting*) was 35 and for the lower chamber (the *folketing*) the age was to be lowered successively from 30 to 25. The *landsting* had 72 members, 18 of whom were elected by the outgoing chamber, the remainder by indirect elections. The *folketing* had 140 members; of these 93 were elected in individual districts and 24 in Copenhagen according to proportional representation. The additional 23 seats were distributed according to each party's percentage of the total vote. Any amendment to the constitution had to pass the two chambers of parliament, according to specific rules, and to be approved by 45% of the eligible voters in a referendum.

With the adoption of the new constitution the right accepted parliamentary government, and important legislation was passed during the following years without much opposition. This included a reform of the administration of justice (April 1916), which separated the administrative and judicial systems and introduced oral proceedings and publicity and trial by jury in criminal and political cases. The privileged suffrage for county councils (*amtsraad*) was finally abolished in 1916. The land reform of 1919 resulted in the division of many large estates and church lands into small holdings. A law of 1916 required all employers to insure their employees against accidents. A law regulating limited companies was passed in 1917 and the first regulatory bank law was passed in 1919.

When in Aug. 1916 the government concluded a treaty ceding the Danish West Indies (the Virgin Islands) to the United States for $25,000,000 a political conflict arose. The Conservative and Liberal parties were originally opposed to the sale of the islands, but a coalition government was formed and a plebiscite was held on Dec. 14, which agreed to the ratification of the treaty.

The first election of the *rigsdag* in accordance with the new constitution was held in April 1918. Already in January the coalition had been dissolved, but the Zahle government was upheld by the Radical Liberal and Social Democratic parties. The election issues were the government's economic policies, as many groups were tired of the restrictions and rationings imposed during the war. The government parties won a narrow victory in the *folketing*, but the opposition parties were in a majority in the *landsting*.

24. The Schleswig Question, 1918–24.—After the armistice on Nov. 11, 1918, the emergency army was quickly demobilized, the wartime military regulations abolished and the land defenses of Copenhagen destroyed. Germany's defeat now made possible the return of a part at least of Schleswig. The Danish population's representative in the German parliament, the Schleswiger H. P. Hanssen, and the Zahle government wanted only those parts where the majority of the population was indisputably Danish to return to Denmark and suggested a plebiscite in the northern zone of Schleswig; but a growing body of Danish opinion wanted the city of Flensburg too, or the whole province of Schleswig.

Hanssen had already raised the question of self-determination for the Danes in Schleswig in the German *Reichstag* in Oct. 1918. The Danish government on Nov. 28 turned to the victorious Allied powers and suggested a plebiscite in two zones: the first zone should vote as an entity, while in the second, which should include Flensburg, votes should be counted community by community. The Versailles treaty contained these provisions. Voting took place on Feb. 10, 1920, in zone 1, where approximately 75,000

votes were cast for Denmark and 25,000 for Germany, and on March 14 in zone 2, where there were 52,000 for Germany and 13,000 for Denmark, only three small communities voting for the latter. The frontier was thus drawn as close to the nationality line as possible. In June the necessary amendment of the constitution was passed, and North Schleswig was incorporated into Denmark.

Disagreement over the Schleswig question and other political controversies had resulted in the "Easter crisis" of 1920. Although the Zahle government had a slight majority in the *folketing*, the king felt that the people were on the whole against the government's Schleswig policy and dismissed the ministry on March 29. The Social Democrats considered this move unconstitutional and threatened a general strike, but in a few days a ministry of nonpoliticians was formed with the task of framing an electoral law and holding elections. The election took place on April 26, 1920, when the Radical Liberals lost nearly 50% of their seats. The Liberal Neergaard then formed a new ministry.

The immediate postwar period was one of economic and social crisis. Trade was declining, unemployment growing, prices rising and the krone depreciating. This led to inflation, unrest among the workers and numerous strikes; and in April 1920 the employers threatened a general lockout.

The Neergaard government (1920–24) slowly reconciled the conflicting interests. Its program was to abolish what remained of the economic control introduced during the war. This it gradually did, and the latter part of 1920 saw an economic boom. But the fall of world prices in 1921 produced a severe crisis. Counting on new markets in eastern Europe, many firms had overstocked, and when their expectations proved wrong they found themselves in difficulties. Home industries that had grown up during the war were now hit by foreign competition, and in 1921–22 unemployment rose to 19.3%. The industries called for protection, but the government stuck to the free-trade policy. Many bankruptcies ensued and several banks closed. In March 1922 the Copenhagen Landmandsbank was saved only by government intervention. Losses amounted to 500,000,000 Kr. Several of the leading bankers were convicted of fraud.

From 1923 the business cycle turned, exports rose and unemployment fell; but the value of the krone continued to fall. In the elections for the *folketing* held in April 1924 the Neergaard government was defeated and the Social Democrats became the largest party in the lower house. Important legislation during the Neergaard period had included a new defense law in 1922, reducing expenditure on defense to 44,000,000 Kr.; an extension of land possibilities for smallholders; and several laws concerning the church, such as one that admitted laymen to the pulpit and one that permitted free choice of civil or ecclesiastical marriage.

25. Social Democratic Government, 1924–26.—After the election in 1924 the Neergaard government resigned and Thorvald Stauning formed the first Social Democratic government in Denmark. Together with the Radical Liberals the Social Democrats had a majority of 2 in the *folketing*, while the opposition had a majority of 10 in the *landsting*. This forced the government to restrict legislation to the fields where an agreement with the opposition was possible.

On the advice of a committee the government in December introduced a law bringing the value of the krone gradually up to par; and in 1926 the gold standard was reintroduced. This deflationary policy led to a new crisis, marked by a heavy fall in agricultural prices, industrial difficulties and unemployment. There were labour disputes from March to June in 1925 and wages rose slightly. Bad economic conditions continued through 1926, unemployment figures reaching 29.8%. A poor harvest and German tariff on agricultural products increased the difficulties. In October the government introduced extensive legislation to combat the crisis, but the Radical Liberals voted against it. The ensuing election in December resulted in a narrow defeat for the government. A new party, the Retsforbund, won only 2 seats.

26. The Madsen Mygdal Government, 1926–29.—The Liberal leader T. Madsen Mygdal, an estate owner, became prime minister. In February Madsen Mygdal introduced a budget cutting governmental expenditure by 60,000,000 Kr. through reduction in civil service salaries, social legislation and military appropriations; but this did not solve the problems arising from unemployment and agricultural distress. In 1928–29 economic prospects seemed brighter, but a bank crisis in Sept. 1928 indicated further worries ahead. The government's continued deflationary policy, together with a law restricting the activities of trade unions, raised bitter opposition among labour groups. Then a conflict with the Conservative party on military appropriations forced the Madsen Mygdal government to dissolve the *folketing*. In the election of April 1929 the Social Democrats regained their position as the largest single party in the lower house.

27. The Stauning-Munch Government, 1929–40.—The new government was a coalition of the Social Democrats and the Radical Liberals, with Stauning as prime minister and the Radical Liberal leader Munch as minister of foreign affairs; its program included disarmament, reform of the social legislation and the abolition of the *landsting*.

Denmark, being highly dependent on foreign trade (especially with England and Germany), soon felt the effects of the great depression which now broke on the world. At the end of 1930 there was a steep decline in agricultural prices. The crisis spread to industry and to the building trades, and unemployment rose. In 1932 one-third of registered labour was unemployed, and in the winter of 1932–33 economic collapse seemed imminent. A return to prewar economy was thus impossible, and many forms of state planning were introduced. But strained economy and social unrest gave extreme parties a chance. During the early 1930s dissatisfied farmers formed a party and the Communists won seats in the *rigsdag*. A small group had adhered to Fascism in the 1920s and a Nazi party was also formed in the 1930s. Neither Fascists nor Nazis gained any substantial following, however, and their activities were curtailed by the law of April 1933, which forbade the civilian use of uniforms in public (except for Boy Scouts).

When Great Britain left the gold standard in Sept. 1931 Denmark followed suit. In Jan. 1932 the government assumed central control over trade in foreign currency and imposed import restrictions which enabled it to stabilize the krone. After the Ottawa agreements an Anglo-Danish trade agreement was concluded in April 1933, increasing imports from England. Bilateral trade agreements with Germany and other countries followed. The economic crisis required much domestic legislation and brought about co-operation between the coalition parties and the opposition. In Oct. 1931 the first "crisis agreement" was concluded with the Conservative party, providing relief for the unemployed and help to farmers, financed by increased taxation. In 1932 a new agreement was concluded, with all four parties co-operating.

In Nov. 1932 the *folketing* was dissolved. In the new elections the government parties won, but for the first time the Communists were represented in parliament. In Jan. 1933 a compromise was concluded (*Kanslergadeforliget*) by which the agreements on wages were prolonged, the value of the krone reduced and the farmers guaranteed better prices on the most important products. Earlier social legislation was co-ordinated and expanded into the *Socialreform*, which made Denmark one of the most progressive "welfare states" of western Europe. A new criminal code was passed and several public-works projects begun; *e.g.*, the building of bridges connecting the islands.

In the autumn of 1935 the government again dissolved the *folketing*, and the Social Democratic party won a great victory. At the elections for the *landsting* next year the government coalition also won a majority. After long negotiations the government parties and a majority of the Conservatives, led by G. L. J. Christmas Møller, agreed on a constitutional reform design to combine in a new *rigsdag* the advantages of the two-chamber and single-chamber systems. In May 1939 the measure was passed by the *rigsdag* but failed to secure sufficient votes in a plebiscite. After this defeat the government declared that the constitutional question would rest. A few months later World War II began.

28. Denmark and Iceland, 1918.—From the beginning of the 20th century public opinion in Iceland had turned more and more toward independence, and in 1918 the constitutional link between Iceland and Denmark was amended. According to the new Danish-

Icelandic treaty of union the two countries were independent sovereign states, united through the king. The treaty contained provisions for common citizenship and stipulated that the Danish foreign service should represent Iceland in foreign countries; that Danish naval ships should take care of the inspection of fisheries in Icelandic waters; that a Danish-Icelandic council, meeting alternately in the two countries, should give advice on questions of common interest; and finally that amendments or a declaration of complete Icelandic independence could take place in 1943. (*See* ICELAND: *History.*)

29. Foreign Relations, 1918–40.—Already before the end of World War I a Danish committee had worked on a charter for an international organization. In March 1919 a delegation participated in forming the covenant of the League of Nations, and in Jan. 1920 Denmark accepted the invitation to join the new organization. The parliamentary resolution authorizing this stated that the charter did not bind the small nations to participate in military sanctions or restrict their freedom to reduce armaments. Denmark took part wholeheartedly in the activities of the league in the following years and had a nonpermanent seat in the council from 1933 to 1936. It concluded arbitration treaties with several countries in the 1920s and signed the Kellogg pact in 1928.

In 1931 a conflict with Norway arose over Greenland. When the Norwegian-Danish union was dissolved in 1814 this island had remained with Denmark. The Danish trading system had been extended to the western coast during the 19th century, and the United States had acknowledged Danish sovereignty over the whole island in connection with the sale of the Danish West Indies. In 1921, Denmark's sovereignty over all Greenland was acknowledged, but the Norwegian government maintained that East Greenland, apart from one Danish settlement, was no man's land. In 1931 the country between the 71st and the 75th parallel and in 1932 the district between the 60th and the 63rd were occupied by Norwegian expeditions and proclaimed to be Norwegian sovereignty. Denmark appealed to the Permanent Court of International Justice, which decided on April 5, 1933, in favour of Danish sovereignty over the whole of Greenland. Excitement over this conflict soon subsided in both Norway and Denmark, and Scandinavian co-operation in foreign affairs increased in the late 1930s; meetings of the Scandinavian foreign ministers had been taking place since World War I. A common attitude was discernible in the League of Nations, and as the European and international atmosphere grew tense in the 1930s understanding between the Scandinavian states, now joined by Iceland and Finland, became closer. Denmark joined Finland, Norway, Sweden, Belgium and the Netherlands in the "Oslo group" created in 1930 for co-operation in tariff questions, and these states tried also to form a political partnership. But as the influence of the League of Nations declined the Oslo group at a meeting in Copenhagen in July 1938 declared that members of the league were no longer bound to participate in applying sanctions.

As the power of Adolf Hitler's Germany grew, so did Danish apprehensions; it was feared that Germany would raise the question of North Schleswig. Early in the 1930s the German minority in this province had become restless, and its representative in the *folketing* raised the question of reunion with Germany. The government in many ways tried to satisfy the German-speaking citizens. When in May 1939 Germany proposed a nonaggression treaty, Scandinavian co-operation broke down: Denmark accepted the German offer, Sweden and Norway rejected it. The treaty, valid for ten years, was signed on May 31 in Berlin. The two countries pledged themselves not to go to war against each other or give help to belligerents against the other; normal trade should be allowed during a conflict between one of the powers and a third country.

30. German Occupation, 1940–45.—In 1933 and 1937 new defense laws had been passed, but when war broke out in Sept. 1939 Denmark was badly prepared to withstand an attack. The government at once proclaimed Danish neutrality and, as in 1914, parliament passed laws adapting the economy to the new situation. Precautions were taken to prevent violations of Danish waters by U-boats, and in Jan. 1940 the Stauning-Munch government declared that Denmark would fight if attacked.

Although Germany at the end of Aug. 1939 had declared that Danish neutrality would be respected, in Jan. 1940 Hitler gave orders to make plans for the occupation of Norway, with Denmark included as the vital passage. Herluf Zahle, the Danish minister in Berlin, reported rumours of German concentrations in Baltic harbours on April 4, and the departure of transport ships from Stettin on April 7. England and France on April 7 and 8 mined Norwegian waters and at the same time German troops were reported on the move between Rendsburg and Flensburg. The German minister Cecil von Renthe-Fink warned Munch against any measures that might provoke Berlin to retaliation. After consultations with the leaders of the parties the government therefore decided not to mobilize the emergency army, but an order of readiness was issued to the navy. On the same day a German fleet went through the Store Bælt. Two of the ships went north of Sjælland, then turned south and sailed through the Sound.

The attack began as planned, at 4 o'clock on April 9. At that time Renthe-Fink presented Munch with a memorandum (the 13 points) stating that Great Britain planned to occupy Denmark, that Germany therefore must protect Danish territory but would respect Denmark's integrity and political independence. German troops crossed the border with some fighting and landed at several points on the islands. They also entered Denmark's only naval harbour, Copenhagen. Ice had prevented the necessary patrolling and confusion in one of the forts at the harbour entrance allowed two German ships to enter without a shot being fired. Troops landed, occupied the citadel and moved toward the Amalienborg palace, where fighting with the royal guards began. The king and several of the ministers were discussing the ultimatum while German bombers were circling over the city. As help from Great Britain or France could not be expected, it was decided to accept occupation under protest. The people felt dismayed and humiliated, but obeyed the king's proclamation to maintain order and avoid conflict with the German troops. Normal life was gradually resumed. The Danish people, generally pro-British and for historical reasons antagonistic toward Germany, at first adopted an attitude of "wait and see" in view of the correct behaviour of the Germans. But the ostensible willingness to co-operate turned into passive resistance when the Germans broke their promise not to interfere in Danish affairs.

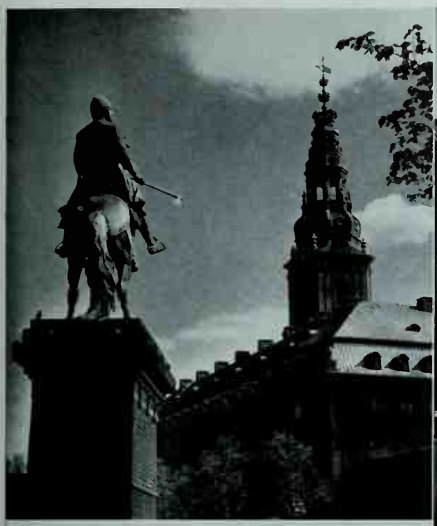
A coalition government was formed on April 10, with Stauning as prime minister, and the democratic parties in parliament formed a co-operation committee which established the unavoidable collaboration with the Germans. The necessary economic provisions were passed by parliament. Imports from the west were stopped, and despite agricultural production stocks of food ran low. The requirements of the Germans led to severe shortages and strict rationing became necessary. Inflation was kept under control.

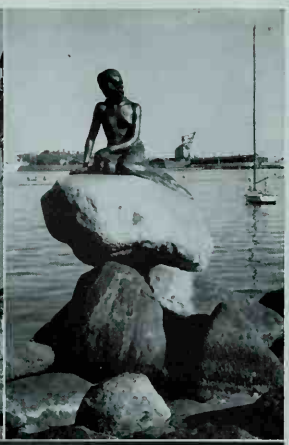
On April 9 the connection between Denmark and Iceland was broken, and on April 10 the Icelandic ministry took over the functions of the king. The Faeroe Islands were occupied by British troops on April 12, and the Danish minister in Washington, D.C., Henrik Kauffmann, laid the foundation for the U.S. occupation and protection of Greenland.

The government was reconstructed in July: Erik Scavenius, accused by many of a pro-German attitude as foreign minister during World War I, took over the portfolio of foreign affairs, and the industrialist Gunnar Larsen was appointed minister of transport. On July 8 Scavenius issued a declaration promising co-operation with the Germans. Negotiations on a customs and currency union began, but the German proposals invariably involved Danish subservience to the German economy, and in August the government succeeded in postponing the negotiations indefinitely.

Passive resistance soon increased. The king's 70th birthday in September was made the occasion for loyal demonstrations. The minister of trade, Christmas Møller, leader of the Conservative party, was one of the first politicians to express Danish antagonism toward the conqueror. During the negotiations on the customs and currency union the first underground newspaper was printed.

In the autumn a Nazi-infiltrated farmers' group and a group of industrialists and rightists attempted unsuccessfully to force a





PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE RIGHT, BOTTOM RIGHT) DANISH INFORMATION OFFICE, (TOP CENTRE, BOTTOM LEFT) HENRY MARCO—PIX FROM PUBLIX

VIEWS OF COPENHAGEN, CAPITAL OF DENMARK

Top left: Christiansborg castle, the Danish house of parliament and supreme court, as seen from the statue of Bishop Absalon, honoured as the founder of Copenhagen in the 12th century

Top centre: The Frederikskirke or Marble church

Top right: The "Little Mermaid" statue in Copenhagen harbour. The statue, by Edvard Eriksen, was inspired by the fairy tale by Hans Christian Andersen

Centre right: Night view of the Vesterbrogade, a busy street in the heart of Copenhagen

Bottom left: Small fishing boats tied up along the waterfront

Bottom right: Houses and apartments along the Oresund (the Sound) between Denmark and Sweden

DENMARK

PHOTOGRAPHS, (TOP) BOURY FROM THREE LIONS, (OTHERS) DANISH INFORMATION OFFICE

THE DANISH COUNTRYSIDE AND GREENLAND

Top: Scene at Dyrehaven, a large park and deer preserve at Klampenborg, near Copenhagen. In the background may be seen "Eremitagen," a small hunting château formerly used by the Danish royal family

Centre left: A massive dolmen on the Mols peninsula, East Jutland

Centre right: Settlement at Godthåb in southwest Greenland. The island became an integral part of Denmark in 1953

Bottom left: Fishing boats on the beach near Lokken, on the North sea coast of Jutland

Bottom right: Farm lands on Fyn Island

change of government. In November the Nazi party, under the leadership of F. Clausen, tried a coup that ended in utter failure. Around the New Year, 1941, the Germans tried in vain to have Stauning dismissed. However, they succeeded in forcing two leading Social Democrats to resign from their party posts and used the ensuing conflict to press the government into delivering a number of destroyers to the German marine.

From the beginning of 1941 the Germans increased their efforts to absorb Denmark into "the new Europe." A crisis arose in April, when Henrik Kauffmann, who from the beginning of the occupation had detached himself from the government, concluded the Greenland treaty with the United States: the government repudiated this step and dismissed him from office. In May, Iceland declared that the union of 1918 would not be renewed when it came up for review in 1943.

The Communists had taken a benevolent attitude toward the occupation, but after the German attack on the U.S.S.R. they were arrested and interned, the Communist party being made illegal. In July, with Scavenius' official approval, Danish volunteers joined "Frikorps Danmark" to participate in the war on the eastern front. Along with other tensions in the ministry, this led to a crisis in July, when Scavenius threatened to resign. In the autumn the Germans forced the government to sign the anti-Comintern pact, which provoked the first serious anti-German demonstrations in Copenhagen. In April 1942 Christmas Møller and others, interested in active resistance against the Germans, founded the underground paper *Frit Danmark*. Christmas Møller fled to England in May and was elected chairman of the Danish council in London. His broadcasts strengthened the will to resistance, and the first saboteurs, trained in England, were parachuted into Denmark and established contact with the resistance movement.

In September, when Frikorps Danmark returned home on leave, clashes between citizens and soldiers broke out because the population generally considered them traitors. The Germans, angered at the flight of Christmas Møller, accused the Conservatives of duplicity. Patriots spoke and lectured. Attempts to curb them by prison sentences only produced more and bolder harangues. As sabotage consequently increased the Germans' anger grew.

Hitler, offended by the king's curt reply to a birthday telegram, now had his excuse for an ultimatum (the so-called Telegram crisis, Nov. 1942). The German minister was recalled, the Danish minister in Berlin was handed his passport and the Germans demanded the resignation of the Social Democratic prime minister Vilhelm Buhl (who had taken office on Stauning's death in May 1942) and the formation of a ministry that would actively collaborate with them. Scavenius, though he despised German and Danish Nazis, nevertheless was convinced of Germany's strength: he accepted the prime-ministership, but was received with resentment both among the people and in parliament.

The new German representative, Werner Best, reputed as an intelligent Nazi, wanted to restore quiet in Denmark to exhibit the country as a "model protectorate." The Germans, in March 1943, therefore permitted an election for the *folketing*. The democratic parties fought the campaign on a closed front, there was an enormous poll and the result was a resounding defeat for Danish Naziism. But Best could interpret the result as a victory for the government and his appeasement policy. During the summer of 1943 sabotage increased regardless of warnings from the king and from the prime minister. After the fall of Italy, general unrest prevailed. In August violent riots broke out in several cities, followed by waves of sabotage. On Aug. 28 Best delivered an ultimatum demanding proclamation of martial law and death sentences for acts of sabotage. This was rejected the same day. Next morning the German army assumed control and their commander in chief, Gen. Hermann von Hanneken, declared martial law. Simultaneously, fearing that it would help the Allies in the event of invasion, the Germans attacked the Danish army at several places. A great part of the navy was scuttled to prevent its falling into German hands. The king was provisionally interned. Peaceful co-operation had ended. In September the Liberty council (*Frihedsraadet*) was formed by representatives of all groups participating in active resistance. Until the liberation it was Denmark's unofficial government. In October the Germans began arresting Jews; some were sent to a German concentration camp, but most escaped to Sweden. The first patriots were shot for sabotage. From then onward resistance increased rapidly: armed groups were trained and contact was established between the Liberty council and the political parties. Civil servants stayed at their posts in order to maintain as far as possible an orderly administration.

The Germans, assisted by Danish traitors, formed terror groups (*Schalburgkorps*), arranged countersabotage and murdered patriots, the so-called "clearing murders." In June 1944 the population of Copenhagen revolted and called a general strike (*folkestrejken*). For several days the situation was tense but finally the Germans accepted a compromise, by which the strike was called off and the German troops moved away from the city.

In September the Danish police, rightly suspected of helping the resistance, were arrested and sent to concentration camps. From then on lawlessness and terror reigned. Several leaders of the resistance, who had been interned by the Gestapo in the Shell building in Copenhagen, escaped when the building was destroyed by the Royal Air Force (March 21, 1945); and the Gestapo's archives disappeared in the flames. The Gestapo headquarters in Århus and Odense were also bombed.

From Feb. 1945, with the defeat of Germany in sight, thousands of German civilian refugees began to arrive in Denmark. On May 4, 1945, German forces in northern Germany, the Netherlands and Denmark capitulated, and the next day British troops moved over the Danish frontier. While the main part of Denmark was liberated by British units, Soviet troops moved into Bornholm, where on May 7 several places were bombed as the Germans refused to surrender.

31. Post-World War II Developments.—A government under Buhl, which included members from the political parties and from the resistance movement, was appointed on May 5. During the summer parliament repealed all legislation enacted under German pressure and passed laws for the prosecution of collaborators and war criminals. After an election held on Oct. 30, the Buhl ministry resigned and the Liberals formed a minority government under Knud Kristensen, with the diplomat Gustav Rasmussen as foreign minister.

During 1945–46 there were frequent strikes, partly over wages and partly over the conduct of the prosecution of collaborators and war criminals. Another question that gradually brought the government into conflict with the majority in parliament was that of South Schleswig. After the liberation the government had declared that it would not seek immediate revision of the frontier and that it favoured self-determination for the Danish population of South Schleswig. But as pro-Danish sympathies manifested themselves there, groups in Denmark came to press for the recovery of South Schleswig, and the prime minister's speeches indicated his agreement with this policy. On Oct. 28, 1947, the *folketing* was dissolved. In the ensuing election both the Social Democrats and the Liberals gained seats, the Communists lost heavily but the Retsforbund increased its representation. Knud Kristensen resigned, and the Social Democratic leader Hans Hedtoft formed a new minority government. King Christian X died and was succeeded by his son Frederick IX in April 1947.

After 1945 the government's major problems were economic. New investment was necessary to bring production back to prewar levels, and occupation costs had to be liquidated. The 200,000 German refugees who stayed in the country until 1949 increased the difficulties. The Marshall plan therefore afforded decisive help. From mid-1948 economic prospects improved; production reached prewar levels and rationing was abolished for most goods. The postwar period brought vigorous economic activity. Increases in incomes in conjunction with a weak foreign exchange position several times created difficulties calling for drastic government action.

Immediately after the war a delegation went to San Francisco to participate in the United Nations conference. During 1945 and 1946 the South Schleswig question loomed large in foreign relations, but from the beginning of 1948 defense and potential alliances began to overshadow all other issues. The Communist

coup in Czechoslovakia changed public opinion, and during the second half of 1948 Denmark, Norway and Sweden began negotiations for a defensive alliance. In Jan. 1949, however, these negotiations broke down. The Hedtoft government suggested a Swedish-Danish defense arrangement, but this was rejected by the Swedes. Thereupon Denmark in April 1949 accepted the invitation to join the North Atlantic Treaty organization (NATO). This complete break with the traditional policy of neutrality was accepted by the majority of the people but was opposed by the Communists and, because of their belief in neutrality, by the Radical Liberals.

An election in Sept. 1950 did not decisively alter the strength of the parties in the *folketing*, but shortly afterward the Hedtoft government was replaced by a coalition of Liberals and Conservatives under Erik Eriksen. Economic troubles continued and rearmament contributed to the growing deficit. The government introduced several measures to combat inflation and to limit imports, and early in 1952 there was some indication that the situation was beginning to improve.

The question of constitutional reform was taken up again and agreement was reached among the five main parties. The new constitution which was adopted in May 1953 and signed by the king on June 5 introduced a single chamber system, the *landsting* being abolished. The *folketing* had 179 seats, of which two were for the Faeroe Islands and two for Greenland. The voting age became 23; new rules governing plebiscites were introduced and parliamentary rule, practised in Danish politics since 1901, was now embodied in the constitution. Female succession to the throne was provided for, so that Frederick IX's elder daughter, Princess Margrethe, now became heir apparent.

The first election under the new constitution took place in Sept. 1953 and was won by the Social Democrats. Erik Eriksen retired, and Hans Hedtoft again formed a government; H. C. Hansen became foreign minister and, after Hedtoft's death in Jan. 1955, prime minister. As a rule the government had the support of the Radical Liberals in contending with the country's economic difficulties. An increasing exchange deficit made it necessary to increase taxation and restrict state expenditure on building. In 1956 Hansen was obliged to intervene in an industrial dispute and to impose arbitration. The Communists, Liberals and Conservatives attacked the government, and in the election of May 1957 the Social Democrats lost some ground. Nevertheless the crisis resulted in Hansen's forming a coalition government together with the Radicals and the Retsforbund; together the three parties had a majority in the *folketing*. During the following years the exchange position improved, agricultural and industrial production increased and unemployment practically disappeared. Prices for agricultural products were however relatively low and the opposition demanded tax reliefs, while the government's taxation policy was intended to limit the increase of consumption. Social legislation was extended, a new education act was passed and a defense policy carried through by agreement among all the Danish parties of the *rigsdag* except the Communists. Hansen died in Feb. 1960. Viggo Kampmann, finance minister since 1953, now became prime minister. In the election of Nov. 1960 the Social Democrats gained 6 seats now holding a total of 76 seats. Viggo Kampmann's new cabinet consisted of Social Democrats and Radicals; it included a minister for Greenland.

Denmark had joined the Council of Europe but rejected, together with the other Scandinavian states and Great Britain, the continental European policy in this body. Although Scandinavian defense plans had broken down, Denmark still tried to develop Nordic co-operation. Negotiations for a customs union came to nothing, but in 1953 the Scandinavian council (Nordisk Raad), a consultative body of parliamentary and ministerial representatives of Denmark, Norway, Sweden and Iceland, was inaugurated.

The Scandinavian council had held 10 sessions up to May 1962 and achieved results in common Scandinavian legislation on juridical, social, political and cultural matters. Economic co-operation did not lead to a Nordic common market, but in 1960 Denmark, with Norway and Sweden, joined the European Free Trade association (E.F.T.A.). However, the export interests of Danish agriculture, in particular, caused Denmark to maintain a preference for a broad, European solution of trade problems.

Kampmann resigned on Sept. 3, 1962, for reasons of health, and was succeeded by Jens Otto Krag, the foreign minister. Denmark applied for admission into the European Economic community in 1961, but dropped the matter when British negotiation for full membership broke down in Jan. 1963.

After years of negotiations, an agreement was reached with the Federal Republic of Germany concerning the joint defense of the Baltic Approaches, under NATO supreme command. The *folketing* approved it on Dec. 7, 1961.

A bill reducing the voting age from 23 to 21 was ratified by a national referendum on May 30, 1961. Election for a new 175-seat *folketing* (on Sept. 22, 1964) increased Conservative representation at the expense of the Radicals. Krag formed a Social Democratic minority government. (E. Ap.; S. Hn.; F. Sk.; X.)

IV. POPULATION

The total population in 1960 was 4,585,256 (*cf.* 3,844,312 in 1940) with an average density of 275.9 per sq.mi. (106.6 per sq.km.). During World War II the annual increase averaged 1.11%; from 1955 to 1960 it was 0.61%, roughly the prewar average. The rapid population growth during World War II was caused by an increase in the rate of births from 18.3 per 1,000 inhabitants in 1940 to 23.5 in 1945, the death rate in the same years being 10.4 and 10.5. In 1960 the birth rate was 16.6 and the death rate 9.5.

The density of the population in the islands was nearly twice that in the peninsula. Copenhagen (*q.v.*), the capital, had 721,381 inhabitants in 1960 (700,465 in 1940); the capital area, including Frederiksberg and Gentofte (*qq.v.*), however, totaled 923,974 (890,130 in 1940). With the suburbs included, "Greater Copenhagen" numbers more than one quarter of the total population. The next largest town Århus (Aarhus; *q.v.*), had 119,568 inhabitants in 1960 (99,881 in 1940), Odense (*q.v.*) 111,145 (87,521), Ålborg 85,800 (55,652) and Esbjerg 55,171 (33,155). The urban population in 1960 amounted to 2,166,421.

TABLE I.—*Counties, Areas and Population*

Amter (Counties)	Area (sq.mi.)*	Population 1955 census	Density (per sq.mi.)	Population 1960 census	Density (per sq.mi.)
Åbrenå-Sønderborg	475	98,280	206.9	106,036	223.2
Ålborg	1,125	242,885	207.0	239,041	212.5
Århus	311	210,409	676.6	221,895	713.5
Bornholm	227	48,632	214.2	48,373	213.1
Copenhagen (København)	460	598,228	1,300.5	690,761	1,501.7
Copenhagen Commune	31	753,361	23,542.5	721,381	23,270.4
Frederiksborg	519	162,889	313.9	181,663	350.0
Haderslev	518	71,715	138.4	72,153	139.3
Hjørring	1,106	173,233	156.6	177,778	160.7
Holbæk	676	127,127	188.1	127,747	189.0
Maribo	694	133,870	192.9	131,699	189.8
Odense	701	254,218	362.7	264,745	377.7
Præstø	654	122,919	187.9	121,976	186.5
Randers	952	170,802	179.4	170,231	178.8
Ribe	1,185	178,501	150.6	185,048	156.2
Ringkøbing	1,795	198,389	110.3	205,772	114.6
Skanderborg	664	136,495	205.6	137,865	207.6
Sorø	571	128,639	225.3	129,580	226.9
Svendborg	643	150,365	233.8	149,163	232.0
Thisted	685	86,703	126.6	84,955	124.0
Tønder	537	42,842	79.8	42,457	79.1
Vejle	907	207,881	229.2	213,705	235.6
Viborg	1,178	160,018	135.8	161,232	136.9
Total†	16,614	4,448,401	267.7	4,585,256	275.9

*1 sq.mi.=2.59 sq.km. †Excludes Faeroe Islands.

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—Denmark is a constitutional monarchy. Legislative authority, based on the 1953 constitution, rests jointly with the crown and the parliament, which consists of one chamber, the *folketing*, with 179 members (including two from the Faeroe Islands and two from Greenland), elected for four years. The franchise is held by all persons over 21 years of age. The *folketing* is in session throughout the year. No minister can continue in office if the *folketing* passes a vote of no confidence in him; and if a vote of no confidence is directed against the prime minister the government must either resign or demand a new election.

The executive power is vested in the monarch who exercises it

through the *Statsraad* (state council) which is made up of 18 ministers, headed by the prime minister. The country is divided into 88 urban and about 1,250 rural municipalities, each having a municipal council, elected every four years. The ministry of the interior has the superintendence of the cities and towns, and the governors of 22 counties (*amter*) have the superintendence of the rural municipalities. (See *History* above for constitutional development.)

2. Taxation.—Land taxes, taxes on buildings and a special tax on increase of land value contribute to the revenues of both the state and the municipalities. Income taxes and taxes on companies also contribute, whereas customs and excise duties are paid only to the state. The taxation of individuals is combined with a system of deductions and a progressive rate of taxation, and excise duties are to some degree placed on luxury articles so that the total taxation tends to level differences between individual incomes.

3. Living Conditions.—The standard of living has kept pace with 20th-century development. Unemployment, a big social problem in the 1920s and the 1930s, diminished steadily, and by the mid-1960s Denmark had full employment. Most workers are members of trade unions, the bulk of which are affiliated to the Landsorganisationen i Danmark, De Samvirkende Fagforbund (Federation of Danish Trade Unions). Employers are represented by the Dansk Arbejdsgiverforening (Danish Employer's Confederation). Wage agreements are concluded every two years and real wages have been raised. The working hours were reduced to 48 a week in 1919, to 45 in 1958, and to 44 in 1965; a three weeks' vacation is given to every worker who is employed throughout the year. Housing conditions have been improved by state loans and guarantees, and the trend toward one-family houses has been strong since World War II.

4. Welfare Services.—Denmark has an old-age pension system for all persons over 67 and also a disability pension system. These pensions are financed wholly through taxation whereas health insurance, open to everyone regardless of age or condition of health, is subsidized by the state to the extent of 25% of total compensation. State or municipal hospitals are open to everyone at 10% to 15% of the real costs, and as this charge is usually paid by the health insurance, hospitalization is practically free of charge. Unemployment insurance is voluntary but widespread; worker and employer pay the insurance but get state repayment if unemployment rises or becomes protracted. Children's allowances are paid until the age of 18. Widows get a pension from the age of 55. Every child is medically examined, free of charge, at regular intervals from birth and throughout the school years.

5. Justice.—The administration of justice is exercised by more than 100 lower courts, 2 appeal courts (one in Jutland and one for the islands) and a supreme court in Copenhagen. At the appeal courts cases may be tried by juries, and at the lower courts the judge may be assisted by two jurymen. The police are organized on a national basis under the control of the chief of the state police; there are more than 70 police districts, each headed by a chief constable.

6. Education.—Illiteracy is practically unknown. Education is compulsory in elementary schools for children between 7 and 14 years. Secondary schools give instruction to those between 14 and 19 years. Both elementary and secondary education is free. In the mid-1960s more than 2,800 schools were maintained locally; in addition there were about 350 private, 40 government institutions and more than 30 teacher-training colleges. In secondary schools there is a choice between practical, classical, modern language and scientific courses, terminated by a state examination after three or five years. Youth schools are free to those who do not attend the secondary schools. There are more than 60 popular high schools for adults (*folkeshøjsoler*), all private but assisted by the state. For specialized study there are a number of agricultural colleges, domestic science colleges and dairy schools; also more than 200 commercial schools and about 150 technical schools as well as institutions for dentistry, pharmacy, music and art. Copenhagen university was founded in 1479 and has about 15,000 students. Århus university, founded in 1928, and the Technical university in Copenhagen have about 5,000 and 3,000, respectively. More than 1,000 students attend the Veterinary and Agricultural university in Copenhagen. There are 1,400 public libraries.

7. Defense.—National defense policy is based on collective security attendant on membership in the North Atlantic Treaty Organization (*q.v.*). After 1964 recruits served 14 months in all three services. The principle of national conscription has been maintained since 1849, but the armed forces enlist a growing number of volunteers. Liability to call-up extends over 16 years. Total strength of the armed forces in the mid-1960s was about 52,000 men, of whom 34,000 were in the army and organized as 2⅔ motorized brigade groups (each with 3 infantry battalions and 1 tank battalion). There was also a volunteer home guard of 56,000 men and women. Two "Honest John" battalions were armed with nonnuclear warheads. The air force (10,000 men) comprised 7 fighter, 1 reconnaissance and 1 transport squadrons. The navy (8,000 men) comprised 93 ships, including 18 frigates or escort ships, and 3 submarines.

8. Political Parties.—The Socialdemokratiske parti (Social Democratic party), mainly representing the workers, is the biggest of the political parties (76 seats at the 1964 election). The Radikale Venstre parti (Social Liberal party; 10 seats), mainly representing smallholders, handicraftsmen and salaried employees, has on several occasions formed coalition governments with the Social Democrats. The Venstre parti (Moderate Liberal or Agrarian party), mainly representing the farmers, is the second biggest (38 seats); it formed an Agrarian-Conservative coalition government in 1950–53 and has since then co-operated with the Konservative folke-parti (Conservative party; 36 seats) which especially represents the more prosperous section of the urban population. The Communist party (6 seats in the 1957 election but none in 1964) was split in 1958 when a smaller group formed the Socialistisk Folke-parti (Socialist People's party; 10 seats at the 1964 election). The Schleswig party, representing the German minority in North Schleswig, had one seat until 1964. De Uafhængige (the Independents), representing ultraconservatism, held 5 seats.

VI. THE ECONOMY

Denmark has always been famous for high quality agricultural produce and one of the most significant facts of its economy is the high ratio of productivity of the land: 90% is productive and 75% actually farmed. Long stretches of the coast are protected against erosion by breakwaters, especially along the North sea; elsewhere low-lying stretches have been protected by dikes, while considerable areas have been reclaimed by damming. Despite the lack of raw materials industrialization has been growing rapidly, especially since World War II, and industry now occupies more people than agriculture.

1. Agriculture.—Denmark possesses an unusually large number of freehold farms—95% as against 5% rented, which is the result of an attempt by the government to subdivide large farms and to establish agricultural workers on independent holdings. Co-operatives help to make small-farm operation profitable, and animal husbandry, a prominent feature of their activity, also lends itself to small individual enterprise.

The Small Holdings acts of 1899, 1919 and 1949 and the agricultural expansion of the country resulted in the subdivision of large estates, the parceling out of glebe land and the abolition of leasehold. Tiny parcels were added to other small holdings or enlarged by land from bigger farms. Thousands of small holdings have been established since 1899 and small- and medium-sized farms (between 25 and 150 acres [10 and 60 hectares]) now compose the majority of the nearly 200,000 holdings. Purchasers under the acts of 1919 of glebe land, fiefs or estates pay no purchase sum but only an annual rent to the government. In effect these holders become owners.

Production and Marketing.—From 1875 Danish agricultural production increased rapidly, though there was a temporary decline during World Wars I and II and the agricultural depression in the early 1930s. Between the 1880s and the 1960s the crop yield was

ADAPTED FROM AAGE H. KAMPP

THE CROP REGIONS OF DENMARK

tripled, mainly through the purposeful application of science in the breeding of plants, a more enlightened use of manure and fertilizers and mechanization, apart from expansion of the cultivated area. Crops include grain, hay, potatoes, fodder beet, sugar beet, seeds, and green fodder. Barley and oats account for 85% of the grain crop, fodder beet for 85% of the root crops.

The increase of crop yield together with the importation of feeding stuffs made the Danish specialization in animal husbandry possible. The rise in the livestock production, which began in the 1880s, must also be attributed to the application of science in breeding, to improved methods in feeding and care and to versatility in farm management and marketing. World Wars I and II seriously injured the industrialized agricultural economy. The stocks of horses (65,000 in 1964) and cattle (3,278,000) of course fluctuate less widely than those of pigs (8,021,000) and poultry (25,598,000), which can be adjusted very quickly to changing conditions.

In the mid-1960s the aggregate production of animal husbandry in metric tons was as follows (in parentheses the annual average for 1935–39): milk 5,100,000 (5,270,000); butter 150,000 (180,000); cheese 122,000 (33,000); beef and veal 295,000 (176,000); bacon, pork fillets, etc. 695,000 (329,000); eggs 108,000 (120,000).

Co-operatives.—Associational promotion began with the founding in 1769 of Det Kongelige Danske Landusholdningsselskab (Royal Agricultural Society of Denmark), and both it and numerous special societies stimulate breeding and other improvements. The De Samvirkende Danske Landboforeninger (Federation of Danish Farmers' associations) established in 1919 a joint organization with the De Samvirkende Danske Andelsselskaber (Federation of Danish Co-operative societies) known as the Agricultural council (Landbrugsraadet). This council and De Samvirkende Danske Husmandsforeninger (National Federation of Smallholders' societies) represent agriculture in dealings with the government and with industry and in foreign trade. Numerous co-operative societies flourish, and in the important dairy and bacon business they dominate the scene. In the mid-1960s there were more than 1,200 dairies, most of which were co-operative societies, and about 60 co-operative bacon factories. About 30% of the egg production is co-operatively organized. The extraordinary success of the Danish farmers in managing their co-operative societies, following the establishment of the first dairy co-operative society in 1882, resulted largely from the spread of adult education especially through the folk high schools.

Financial Returns.—After the long period of depression, at the close of the 19th century prices improved and the relatively few accounts available for the years 1910–13 show an average yield of interest on capital invested in well-managed farms of about 4%–5%. During the first years of World War I the prices of grain and seed, and later of eggs, bacon and dairy products, rose so that the average yield of interest increased to 8.3% in 1918–19. In the following ten years the average yield of interest was from 1.1% to 6.4%. The international agricultural depression brought an average loss of 0.4% on agricultural produce in 1931–32; when the depression was overcome, the average yield of interest rose to 3.8% in 1939–40. Rising prices during World War II increased the interest to 6.6% in 1943–44; but much of this increase was also caused by reduction of livestock. When the reduction was stopped after the war and prices were lowered, the average yield of interest dropped to 2.3% in 1945–46. As the result of very good harvests, increased prices and a considerable rise in livestock, the interest rose to 6.5% in 1948–49. It was 4.6% in 1958–59 and more than 7% in the early 1960s.

2. Forestry, Mining and Fisheries.—Forests and plantations cover about 10% of the country. About half of this area is covered with conifers, the rest being under broadleaf trees, mainly beech, and mixed growth (see *Vegetation and Animal Life* above).

Though coal is found in Bornholm, neither coal nor metals can be profitably mined anywhere. Lignite was mined in Jutland and peat was cut in many places during World War II. Bog iron ores in Jutland are used for purifying purposes in gasworks. The newer chalk is utilized in lime burning and in the important cement in-

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UNLOADING CANS OF MILK AT ONE OF DENMARK'S MANY CO-OPERATIVE DAIRIES

dustry. Bornholm supplies granite for building and paving, and kaolin for the china and paper manufactures. Salt is mined in western Jutland as a basis for chemical industries. About 0.4% of the Danish people are directly engaged in fishing and many others are dependent on it, such as workers in herring-oil factories, merchants, netmakers, boatbuilders and makers of marine engineering equipment (most of the motors and gear are manufactured in Denmark). The catches consist largely of fish for industry with flatfish, cod, herring, mackerel and eel following in order of importance. The fishermen have marketing and purchasing cooperatives, though not on the same scale as the farmers' societies.

3. Power and Industries.—Power plants are owned by cooperatives or municipal authorities and mainly use coal, lignite or oil as fuel. In Jutland there is a small hydroelectric plant. Some power is imported from Swedish hydroelectric plants.

Before 1870 Danish industry was unimportant. In the 1870s the Industrial Revolution reached Denmark and by 1900 the former cottage industries at the farms, such as spinning, weaving, brewing, baking and sewing, had been supplanted by factories which produced primarily for home consumption. Between the two world wars, and especially after World War II, industrial production increased rapidly and by the 1960s accounted for a bigger share of the national income than agriculture. The iron and metal industries provide more than half the total value of the expanding industrial exports and their chief products are diesel motors, steamships and motor vessels, dairy and agricultural machines, refrigerators, cement machines, electrical equipment and automobiles. The chemical industry (vegetable and animal oils, fish meal, oil cakes, pharmaceutical products, etc.) comes next in importance in value of exports while other exports include portland cement, beer, china, furniture, sugar and textiles.

The metal industries employ the most workmen, followed by food processing, earthworks and building, textile, footwear and clothing industries, woodworking and chemicals. About 30% of the total number of industrial workers are women.

4. Trade and Finance.—The per capita rate of Denmark's foreign commerce is exceptionally high, about 6,000 Kr. per inhabitant. In the first three decades of the 20th century this commerce depended especially on the United Kingdom to which Denmark sent about 60% of its exports. The depression caused a decline in the 1930s and World War II put an end to the British trade. After the war this trade was resumed, comprising by the early 1960s about 25% of total Danish exports and 20% of imports. Other principal trade partners were the Federal Republic of Germany, Sweden and the U.S. Since 1960 Denmark's trade with the European Free Trade association (*see* ECONOMIC UNION), has been increasing, although its trade with the six countries of the European Economic Community (the Common Market), has remained considerable. Principal imports include fuels, textiles and clothing, machinery, vehicles and base metals. By the mid-1960s about half of the exports were agricultural (live animals, meat and meat products, dairy produce) but the export of industrial commodities (machinery, electrical equipment, vehicles, ships, etc.) was increasing. There was also a large transit trade.

The Danmarks Nationalbank is the only bank of issue and is controlled by a board of 25 governors, who are chosen by the government, the *folketing*, the ministry of trade and the board itself. In the mid-1960s there were three large private banks and about 150 smaller ones, the three large ones doing about half the total business. Savings banks numbered about 500. The stock exchange is in Copenhagen. Insurance companies, several dating from the 1700s, do a large business abroad and at home.

The monetary unit is the krone. (One U.S. dollar is equivalent to 6.91 Kr.) In the early 1960s current revenue and current expenditure each exceeded 11,000,000,000 Kr. and the national debt amounted to more than 7,000,000,000 Kr.

5. Transport and Communications.—Motor transport is highly developed. The total length of the principal roads is 5,289 mi. (8,512 km.) of which 1,447 mi. (2,328 km.) are main highways; byroads total 29,322 mi. (47,190 km.). The state runs 1,518 mi. (2,443 km.) of railways, and 979 mi. (1,576 km.) are run by private lines in which the state and the larger towns hold nearly all the shares. There are highly organized train-ferry and car-ferry schemes for communication between Sjælland and Fyn and between Sjælland and Jutland. A bridge (800 m. [875 yd.]) connects Fyn and Jutland, and another bridge (3,200 m. [3,499 yd.]) connects Sjælland and Falster. The main land route is the railway and the highway from Copenhagen to Esbjerg, from where there is regular connection with England by sea to Harwich. On this main route Fredericia in Jutland is a junction from where railways and highways go south to Hamburg, West Germany, via Padborg and north to Frederikshavn which has a ferry service to Norway (Oslo and Larvik) and Sweden (Göteborg). Another main railway and a main highway go from Copenhagen north to Elsinore (ferry to Sweden), and south to Lolland-Falster. From Gedser ferries serve Warnemünde (German Democratic Republic). The Bee Line ferry, from Rødby Havn (Lolland) to Puttgarden (Fehmarn, Schleswig-Holstein), was inaugurated in 1963.

Denmark has numerous ports, small harbours and quays. It has a large merchant fleet in proportion to its population and was a leader in the modern transition to motor ships; its biggest diesel works are in Copenhagen. Danish vessels carry about two-fifths of the national sea-borne trade and do a large foreign business.

Copenhagen with Kåstrup airport serves inland routes to Jutland and Bornholm and is a centre of international traffic. S.A.S. (Scandinavian Airlines system, a joint Danish, Norwegian, Swedish enterprise) serves European and intercontinental lines.

The state runs the postal, telegraph, cable, radio and television services, whereas the telephone is owned by the state and the municipalities jointly.

See also references under "Denmark" in the Index. (H. LN.)

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(HA. T.; E. AP.; S. HN.; F. SK.; H. LN.)

DENNERY (D'ENNERY), **ADOLPHE PHILIPPE** (1811–1899), French dramatist and novelist, was born in Paris on June 17, 1811. He obtained his first success in collaboration with Charles Desnoyer in *Émile, ou le fils d'un pair de France* (1831), a drama which was the first of a series of about 200 pieces written alone or in collaboration with other dramatists; among them were *Gaspard Hauser* (1838) with Anicet Bourgeois and *Les Bohémiens de Paris* (1843) with Eugène Grangé. *Les Deux Orphelines* (1874), perhaps his best work, was written with Eugene Cormon. With Louis Gallet and Edouard Blan he composed the book of Massenet's *Cid* (1885); and, with Cormon, the books of two of Auber's operas. Dennery adopted some of his plays to the form of novels. He died in Paris in 1899.

DENNIS, JOHN (1657–1734), English critic and dramatist whose insistence upon the importance of passion in poetry led to his long quarrel with Pope, was born in London in 1657. Educated at Harrow and Cambridge, he traveled on the continent before settling in London where he mixed with leading literary figures. At first he wrote Pindaric odes and plays, but, although a prolific dramatist, he was never very successful. He produced, among other plays, *A Plot and No Plot* (1697), a satire on the Jacobites; *Rinaldo and Armida* (1699) from Tasso's *Gerusalemme Liberata; Iphigenia* (1700); and *Liberty Asserted* (1704), which attacked the French and was something of a success.

The most important of Dennis' critical works are *The Advancement and Reformation of Modern Poetry* (1701), *The Grounds of Criticism in Poetry* (1704), *The Usefulness of the Stage* (1698) and *An Essay on the Genius and Writings of Shakespear* (1712). His basic contention is that literature, and especially drama, is comparable to religion in that its effect is to move men's minds by means of the emotions. What he looks for primarily in a work of art is passion and elevation rather than decorum and polish. "Poetry," he says, "is Poetry because it is more Passionate and Sensual than Prose . . . where-ever a Discourse is not Pathetick, there it is Prosaick." His idol among the moderns is therefore Milton. Fundamentally this bias probably explains Dennis' antipathy toward Pope and accounts for the hostility between them. Pope included an adverse allusion to Dennis in his *Essay on Criticism:*

> But Appius reddens at each word you speak,
> And stares, tremendous, with a threat'ning eye,
> Like some fierce Tyrant in old tapestry . . .

Dennis replied with *Reflections Critical and Satyrical, Upon a Late Rhapsody, Call'd, An Essay Upon Criticism* (1711) which mixed criticism of the poem with a vicious personal attack upon Pope as "a hunch-back'd toad" whose deformed body mirrored a deformed mind. Despite a temporary reconciliation the quarrel continued sporadically until Dennis' death, Jan. 6, 1734, in London.

Dennis defended the drama against Jeremy Collier's *A Short View of the Immorality and Profaneness of the English Stage* (1698). He argued that plays were of value in discouraging disaffection by spreading pleasure and in providing exercise for the passions. His central practical doctrine is the necessity of observing strict poetic justice, because through poetic justice the writer instructs his audience by anticipating the divine rewards and penalties normally postponed until a future life. In this way the stage becomes "useful to the Advancement of Religion."

Dennis believed passionately in the arguments that he propounded, and his prose is often hectoring, always forceful, with the conviction of a man who believes that "Poetry has been thought . . . by God himself . . . to be the fittest Method for the enforcing Religion upon the Minds of Men," and who feels it his business to set this idea clearly before the writers and readers of his day.

See *The Critical Works of John Dennis,* ed. by E. N. Hooker, 2 vol. (1939–43). (JN. C.)

DENNISON, AARON LUFKIN (1812–1895), U.S. watch manufacturer who was among the first to adapt the technique of interchangeable parts to the production of pocket watches and is generally credited with being the "father of American watchmaking." Dennison was born March 6, 1812, in Freeport, Me., and at the age of 18 was apprenticed to a watchmaker in Brunswick, where he learned the prevailing manual methods of watchmaking. Later he went to Boston, where he set up his own business and then studied mass-production techniques employed at the Springfield arsenal. Surmounting the technical difficulties of machine production of small parts, Dennison in 1850 set up a factory and began to supply the market with the first inexpensive factory-made watches. This shop was the forerunner of the Waltham Watch company. Another by-product of Dennison's inventiveness was the Dennison Manufacturing company, which grew out of Dennison's successful efforts to use machinery in manufacture of paper boxes and, later, paper products. He died Jan. 9, 1895.

See E. P. Hayes and Charlotte Heath, *History of the Dennison Manufacturing Company* (1929); Charles W. Moore, *Timing a Century, History of the Waltham Watch Company* (1945). (G. S. GB.)

DENOMINATIONAL SCHOOLS: *see* PAROCHIAL EDUCATION, U.S.

DENON, DOMINIQUE VIVANT, BARON (1747–1825), French artist, archaeologist and museum official whose connoisseurship was instrumental in the development of the Louvre collection, was born at Chalon-sur-Saône on Jan. 4, 1747. He studied law in Paris, and in his 23rd year wrote a well-received comedy. Denon then took up drawing with Noël Hallé and did some painting. Louis XV commissioned him to arrange a cabinet of carved gems inherited from Madame de Pompadour. Between 1772 and 1787 Denon was entrusted with several diplomatic missions which brought him to St. Petersburg, Naples and Switzerland. In 1775 he visited Voltaire in Ferney and drew his portrait. Much to the discontent of the writer, Denon had the drawing engraved. During his stay in Naples, he engraved the majority of his reproductions after old masters, collected works of art and etched small portraits of members of society. In 1787 he became a member of the Académie de Peinture as *artiste de genre.*

During the Revolution he returned to Paris, where he was protected by his friend, the painter David. At Bonaparte's invitation he joined the expedition to Egypt, and there made numerous sketches of the monuments of ancient art, sometimes under the very fire of the enemy. The results were published in his *Voyage dans la basse et la haute Égypte* (1802). From 1804 to 1815 he was director-general of museums. He accompanied Napoleon in his expeditions to Austria, Spain and Poland, advising the conqueror in his choice of spoils of art from the various countries pillaged. After Denon had become acquainted with the work of Aloys Senefelder, the inventor of lithography, he was one of the first artists to introduce lithography into France. His first lithograph is dated Sept. 15, 1809. Denon died in Paris on April 27, 1825. He left unfinished a history of ancient and modern art, with admirable engravings, which was published posthumously, with an explanatory text by Amaury Duval, under the title *Monuments des arts du dessin chez les peuples tant anciens que modernes* (4 vol., 1829). (HS. H.)

DENOTATION. A *name* is said to *denote* that thing or those things of which it is a name, or to which, in other words, we intend to *refer* when we use the name. The threatened circularity of this definition (the three italicized words are not easily defined except by means of one another) suggests that we are here dealing with a basic concept, for which an axiomatic treatment may be more appropriate than definition. And though, for a fixed formalized language a definition of *denotation* of names in that language is possible, there is no definition available for *denotation* in general except by semantical terms closely related to it (*see* SEMANTICS IN LOGIC). *See* NAME (IN LOGIC), where the denotation of names in natural language is discussed more fully. For the distinction of denotation and connotation, *see* CONNOTATION. (AO. C.)

DENSITY, or mass per unit volume, is an important and easily measurable property of matter in all its states. The inert elements were discovered by tracing the difference in the densities of samples of nitrogen prepared from ammonium nitrite and extracted from the air. Later experiments on the density of gases have yielded information on the nature and magnitude of the forces exerted between molecules; and the densities of decomposing gases or vapours have been used to extend knowledge of the forces which hold atoms together within the molecule. Measurements of the density of liquids serve as a convenient adjunct to

their analysis, and are frequently used in the control of industrial operations. The degree of proof of spirituous liquors and the gravity of beer are determined densimetrically. The density of a solid is intimately related to its structure and to the distance apart of the neighbouring ions, atoms or molecules which constitute it. The difference between soot and diamond is due, as W. H. and W. L. Bragg have shown, to the arrangement of the identical carbon atoms from which both are built, and is reflected in the difference in their densities.

FIG. 1.—A SIMPLE PYCNOMETER

In scientific work, density is expressed in grams per cubic centimetre (c.c.) or in grams per millilitre (ml.). The difference between the two units, though small, is not insignificant: 1 ml. = 1.000028 c.c. Each density datum should be accompanied by a specification of the temperature and pressure to which it refers. When the pressure is not specified, that of one atmosphere is implied. Specific gravity is the ratio of the density of a substance to that of water at the same temperature.

Matter in the solid state is denser than in the liquid state under identical conditions; water and gallium are exceptions. Pure liquids

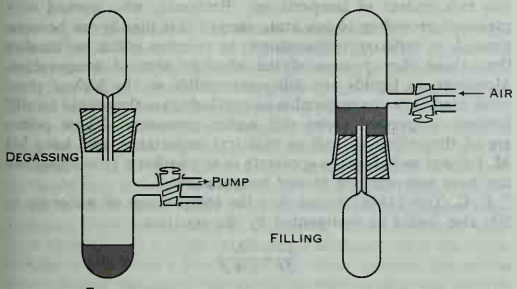

FIG. 2.—DEGASSING AND FILLING A PYCNOMETER

are denser, except at the critical point, than the vapours with which they are in equilibrium. An increase in pressure at a constant temperature and a decrease in temperature at a constant pressure generally lead to an increase in density. The densest matter is found in the interiors of the stars, and the most attenuated in interstellar space.

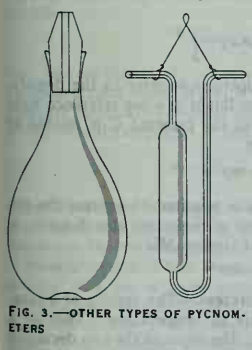

FIG. 3.—OTHER TYPES OF PYCNOMETERS

The Pycnometric Determination of Density.—Of the pycnometers in use for measuring the densities of liquids, one of the simplest consists of a glass tube of about 10 c.c. capacity, to which has been sealed a length of about 4 cm. of 0.5-mm. bore capillary (fig. 1). After cleansing successively with chromic acid, nitric acid, hot water, absolute alcohol and dry acetone, the vessel, supported by wire, is weighed empty (apparent weight w_1), full of water (apparent weight w_2) and finally full of the liquid which is being examined (apparent weight w_3). A simple device for degassing the liquid and for completely filling the pycnometer is shown in fig. 2. Each weighing refers to a sample which has attained a known constant temperature. Then if W_1, W_2 and W_3 be the corrected weights *in vacuo* of the pycnometer alone and of the pycnometer filled respectively with water and the liquid at a temperature t, the specific gravity of the liquid is, by definition,

$$s_4^t = \frac{W_3 - W_1}{W_2 - W_1}$$

and the density is

$$\rho_4^t = \frac{W_3 - W_1}{W_2 - W_1} \cdot D_4^t$$

where D_4^t is the density of water at $t°$ C., relative to its value of unity at 3.98° C.

The real weights are related as follows to the apparent weights:

$$W_1 = w_1\left(1 + \frac{\rho_a}{\rho_g} - \frac{\rho_a}{\rho_b}\right)$$

$$W_2 = w_2\left(1 + \frac{\rho_a}{\rho_g + \rho_w} - \frac{\rho_a}{\rho_b}\right)$$

$$W_3 = w_3\left(1 + \frac{\rho_g}{\rho_g + \rho_l} - \frac{\rho_a}{\rho_b}\right)$$

The subscripts to the density term, ρ, refer to air (a), brass weights (b), water (w), liquid (l) and glass (g). Approximately, $\rho_a = 0.012$, $\rho_b = 8.5$ and $\rho_g = 2.3$ gm./c.c. Finally

$$\rho_{g+w} = w_2 \Big/ \left(\frac{w_1}{\rho_g} + w_2 - w_1\right)$$

and

$$\rho_{g+l} = w_3 \Big/ \left(\frac{w_1}{\rho_g} + w_2 - w_1\right)$$

More familiar types of pycnometers, of which there are many modifications, are shown in fig. 3 and 4. With any of these, densities can be readily measured with an accuracy of 0.0001 gm./c.c.

The Electromagnetic Float Method.—The buoyancy method of determining density is convenient with toxic liquids and with systems which for other reasons must be sealed off. The float consists of a soda-glass vessel, F (fig. 5), containing in its narrow end some soft iron turnings or a small coil of steel. A perforated plunger, P, may be used to keep the float submerged. To counteract its buoyancy, a magnetic field is produced by sending through an electromagnet, M, placed beneath the thermostat, a current of just sufficient strength, i, to pull down the float. The magnetic force acting on the float is ki^2, where k is a constant. The gravitational force acting on it in the same direction is $V\rho_o g$, where V is the volume of the float, ρ_o is its density and g is the gravitational constant. The upthrust, according to Archimedes' law, is $V\rho g$, where ρ is the density of the liquid. When the current has reached the critical value, i, which is just sufficient to release the float and start it on its downward journey we have the equality

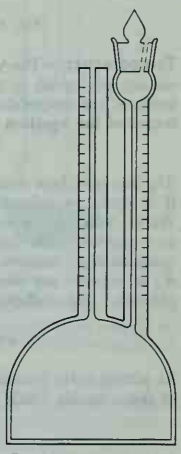

FIG. 4.—WHITING'S PYCNOMETER

$$V\rho g = V\rho_o g + ki^2$$

or

$$\rho = \rho_o + (k/Vg)i^2$$

For a given float, V is constant; hence

$$\rho = \rho_o + Ki^2$$

The density, ρ_o, of the float, and the apparatus constant K are best measured by working with a series of liquids of known densities, such as aqueous solutions of sucrose or mixtures of di-(n-butyl)-phthalate and β-bromonaphthalene.

Binary liquid mixtures of benzene and methylene di-iodide at ordinary temperatures provide a nearly fourfold range in density. When the known liquid densities are plotted as a function of the square of the critical current, the intercept corresponding to zero current gives ρ_o, and the gradient is K. The sensitivity of the method is limited only by the precision with which the current strength can be measured.

The Variation of the Density of Liquids With Respect to

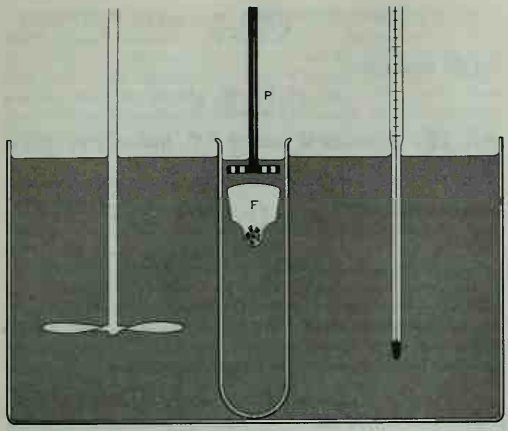

FIG. 5.—ELECTROMAGNETIC FLOAT

Temperature.—The variation with respect to temperature of the density of liquids at atmospheric pressure can be expressed in terms of the temperature, T, and of three empirical constants by means of the equation

$$\rho=\rho_o-K_1T-K_2T^2$$

The first term here denotes the density which the liquid would have if it could be subcooled to the absolute zero of temperature. Water, which has a maximum density when T is 277.14° K., is an exception. The constant K_1 is positive for all liquids, and the constant K_2 is positive for most. Among those liquids for which K_2 is negative are mercury, hydrogen fluoride and carbon tetrachloride. The coefficient of cubical expansion is defined as follows:

$$\alpha=\frac{1}{V}\left(\frac{dV}{dT}\right)_P=-\frac{1}{\rho}\left(\frac{d\rho}{dT}\right)_P$$

At atmospheric pressure, therefore, the coefficient of expansion of those liquids which obey this equation is

$$\alpha=\frac{K_1+2K_2T}{\rho_o-K_1T-K_2T^2}$$

Subcooled liquids, therefore, retain at the absolute zero of temperature a real coefficient of expansion, which is $\alpha_o=K_1/\rho_o$. This property is to be contrasted with that of solids. It is reasonably certain that α_o for solid metals is zero, as it is also for molecular solids like carbon dioxide, the intermolecular separation of which varies as the square of the absolute temperature.

Empirical equations like the one discussed here are useful in predicting many properties of liquids. For example, the variation, with respect to pressure, of the heat capacity at constant pressure is given thermodynamically as follows:

$$\left(\frac{dC_P}{dP}\right)_T=-T\left(\frac{d^2V}{dT^2}\right)_P$$

Hence

$$\left(\frac{dC_P}{dP}\right)_T=-\frac{2MT}{\rho_2}\left[K_2+(K_1+2K_2T)^2/\rho\right]$$

We would therefore expect the heat capacity of liquids at atmospheric pressure to decrease as the pressure is increased, and this is in fact what P. W. Bridgman found (1931).

The Variation of the Density of Liquids With Respect to Pressure.—The density of liquids, as of all pure substances, increases as the pressure is increased. The relative increase in density caused by unit increase in pressure is termed the compressibility, or the coefficient of isothermal compression. This is defined in terms of the volume, V, or the density, ρ, as follows:

$$\beta=-\frac{1}{V}\left(\frac{dV}{dP}\right)_T=\frac{1}{\rho}\left(\frac{d\rho}{dP}\right)_T$$

The compressibility can be measured by observing the decrease in volume caused by sudden compression, or the increase in volume caused by sudden expansion, or by taking account of the fact that the velocity of sound is proportional to the square root of the compressibility. These methods yield an adiabatic compressibility, β^*, to which the isothermal compressibility is related by the thermodynamic equation

$$\beta=\beta^*+\alpha^2VT/C_P$$

where C_P is the molar heat capacity and V the molar volume. Accurate values of the compressibilities of all the elements and of a variety of compounds in the gaseous, liquid and solid states have been obtained by G. H. J. A. Tammann and P. W. Bridgman. The isothermal compressibility is not constant but decreases with increasing pressure; *i.e.*, substances become less compressible the more they are compressed.

Whether liquids become incompressible under enormous pressures cannot be experimentally decided. Tammann believed that liquids under very high pressures reached a limiting volume, which was independent of temperature. Bridgman, who worked with pressures exceeding 10,000 atm., showed that liquids can be compressed, at ordinary temperatures, to volumes which are smaller than those they possess at the absolute zero of temperature. Moreover, as liquids are still compressible at the highest pressures used, it seems reasonable to conclude that they could be still further compressed under still higher pressures. These points are of theoretical as well as practical importance, and have led M. Polanyi and others to speculate as to whether a pure substance can have zero entropy at real temperatures.

P. G. Tait (1888) found that the compression of water up to 500 atm. could be represented by the equation

$$\frac{dV}{dP}=\frac{A'}{B+P}$$

where A' and B are constants. The former has the dimensions of a volume and is negative in sign. If we replace it by $A=-A'/V^o$, where V^o is the volume at some reference pressure, P^o, we obtain the following isotherm

$$\frac{V}{V^o}=\frac{\rho^o}{\rho}=\left[1-A\ln_e\left(\frac{B+P}{B+P^o}\right)\right]$$

Another isotherm takes the form

$$\frac{\rho}{\rho^o}=\left[1+C\beta^o(P-P^o)\right]^{1/C}$$

where the symbols bearing the superscripts refer to the density, compressibility and pressure of the liquid in some reference state (say at atmospheric pressure), and the constant C is related as follows to certain integers, n and m,

$$C=\tfrac{1}{3}(n+m+6)$$

These integers (n and m) are those required to express the potential energy, ϕ, of an isolated pair of molecules at a distance, a, apart, according to the equation of Gustav Mie:

$$\phi=Aa^{-n}-Ba^{-m}$$

The Law of Rectilinear Diameters.—The density of a saturated vapour increases with a rise in temperature. That of a liquid, as we have seen, decreases. The mean of the two decreases linearly with respect to the absolute temperature (L. P. Cailletet and E. Mathias, 1887), so that

$$\frac{d}{dT}\left[\tfrac{1}{2}(\rho_L+\rho_V)\right]=-C$$

where C is a positive constant, and the subscripts L and V refer

to the liquid and saturated vapour respectively. On integrating between the absolute zero, when ρ_V vanishes, and the critical temperature, T_c, when it is equal to ρ_c, we may rewrite the equation in the form

$$\rho_L+\rho_V=\rho_o-(\rho_o-2\rho_c)\ (T/T_c)$$

By plotting the sum of the densities of the liquid and its saturated vapour as a function of the reduced temperature T/T_c, it is thus possible to determine the limiting density ρ_o and the critical density ρ_c. Their ratio is nearly 4 for all liquids except helium, for which it is approximately 2.

The Density of Liquid Solutions.—Let us first consider one mole of a solution to be formed at constant temperature and pressure from two components which mix without a change in volume. Then if V_i denotes the molar volume of the pure components, we have

$$V_i=x_1V_1^\circ+x_2V_2^\circ$$

where x is the molar fraction. Since the total mass of the solution is $x_1M_1+x_2M_2$ and the densities of the pure components are M_1/V_1° and M_2/V_2°, it follows that the density of the solution is

$$\rho_i=\rho_1^\circ+(\rho_2^\circ-\rho_1^\circ)\theta_2$$

where θ_2 is the volume fraction of the second component. The same result can be written in the form

$$\rho_i=\rho_1^\circ+(1-\frac{\rho_1^\circ}{\rho_2^\circ})c_2$$

where c_2 is the weight of the second component in 1 c.c. of solution. The coefficient of c_2 in this equation has been termed the density increment by G. S. Adair. The density of solutions of this kind thus varies linearly with respect to the concentration, expressed in grams per cubic centimetre of solution.

Most binary solutions are formed with a change in volume. Thus, for example, if we were to add successive amounts of methyl iodide at 25° C. to chloroform, so as to make one mole of mixture, we would find at first a contraction; with a mole fraction of 0.3 of methyl iodide there would be no volume change; at higher compositions, there would result an expansion. Even in simpler solutions showing only a single maximum or minimum when the molar volume is plotted as a function of the molar fraction, the results are extremely difficult to understand or even to represent analytically.

Densimetric Determination of Isotopic Composition.—Because the forces exerted by isotopic atoms are identical, their contribution to volume is also identical in all the states of matter. Hence, if ρ_1 be the density of an element or compound, and ρ_2 that of its isotope, the density of a binary solution containing a volume fraction θ_2 of the isotope is given rigorously by the linear equation

$$\rho=\rho_1+(\rho_2-\rho_1)\theta_2$$

But, because the atomic volumes, or the molar volumes, of the two components are equal, M_1/ρ_1 is equal to M_2/ρ_2, and volume fractions are identical with molar fractions. Hence the molar fraction of the second component is seen to be

$$x_2=\left(\frac{\rho-\rho_1}{\rho_1}\right)\left(\frac{M_1}{M_2-M_1}\right)$$

Most of the many investigators who have worked with heavy water have used this equation to determine the molar fraction of deuterium (heavy hydrogen) in solution.

Measurement of the Density of Gases and Vapours.—The density of a gas is more sensitive to changes in pressure and temperature than are the densities of liquids or solids. With ideal gases, the density, ρ, at a constant temperature is directly proportional to the pressure, P, and the density at constant pressure is inversely proportional to the absolute temperature, T, for we have

$$\rho=(M/RT)P$$

where M is the molar weight ($O_2=32$) and R is the universal gas constant (8.3144×10^7 ergs/mole-degree$=0.082052$ litre-atmosphere/mole-degree). This law applies also to real gases in regions of high dilution, and the limiting values of ρ/P consequently give reliable molar weights.

The principle of the methods used for measuring the density of a gas or vapour is the same as that used with liquids: a vessel of known volume is weighed empty, full of gas or vapour, and full of a liquid of known density (*e.g.*, water or mercury). In Viktor Meyer's apparatus for measuring the density of vapours (fig. 6), the liquid in A is heated until air ceases to issue from the tube B. The calibrated tube C, filled with water, is placed over B, and a weighted sample of liquid is introduced into D in a small glass phial with a glass stopper. The temperature of the jacket A is usually kept well above the boiling point of the liquid, so that, as soon as the phial is let into D, the stopper is blown off, and the liquid vaporizes. The air displaced by the vapour is collected and measured in C, at a known temperature and pressure. Its volume is equal to that of the vapour at the same temperature, and its pressure can be found in terms of the barometric reading, the height of the water left in C, the saturation pressure of water and the solubility of the vapour in it.

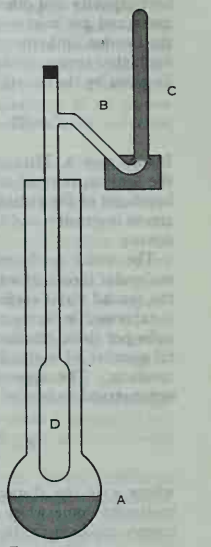

FIG. 6.—MEYER'S APPARATUS

In precise work, the pressure of the gas is measured directly, and its volume is found by weighing mercury which the sample of gas has displaced. The principle of the apparatus used by A. Michels, B. Blaisse and C. Michels (1937) for determining the densities of gases at high pressures is shown in fig. 7. Initially, the vessel A and the bell jar B are filled, and the vessel D partially filled, with mercury. A known weight of gas is introduced into B, and the mercury which it displaces is caught and weighed in the vessel D. The weight of mercury gained by D gives an accurate measure of the volume of the gas, and its pressure is measured at F. The weight of the gas is known from the volume which has been admitted, at low pressures, into B.

Isotherms of Gases.—Any relationship between the pressure and volume of a system at a constant temperature is termed an isotherm. Results obtained at the Reichsanstalt, Berlin, are given in the form

$$PV=A+BP+CP^2+DP^4+\ldots$$

where P is the pressure of the gas, and B, C, ... are constants at a constant temperature. Results of the Dutch chemists working at Leyden are given in terms of the density of the gas:

$$PV=A+B\rho+C\rho^2+\ldots$$

The constant B is known as the second virial coefficient, C as the third, and so on. Each is a function of the temperature. The product PV, being an extensive property of the system, depends in magnitude on the amount of substance in it. The Leyden convention is to take as unit quantity of gas that amount which will make

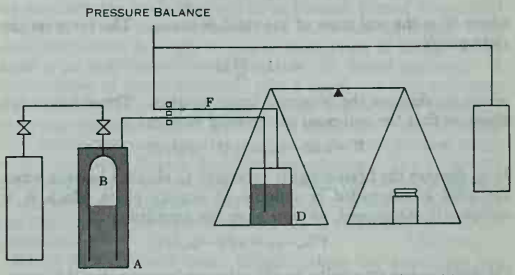

FIG. 7.—APPARATUS OF MICHELS, BLAISSE AND MICHELS

A exactly unity at 0° C. and at atmospheric pressure. If under these conditions the gas obeyed the ideal laws, the amount concerned would be $PV/RT = 1/0.082054 \times 273.16 = 0.044615$ gram-mole in one litre.

Real gases are not quite ideal under the conditions stipulated, and the amount of gas to which V refers differs slightly from gas to gas. Thus, for example, the Amagat unit of density for carbon monoxide is 0.044643 moles per litre, and for ethane is 0.045064. PV values are often given correctly to 1 part in 10^5, and densities to 1 part in 10^6. From sets of such isotherms obtained by Michels and his collaborators in the van der Waals laboratory, he derived accurate values of the changes in entropy, heat capacity and other thermodynamic properties of several pure gases and gas mixtures under varying conditions. Starting from the Leyden isotherm in the form $P = RT\rho + B\rho^2 + C\rho^3$ and neglecting higher terms, the heat capacity at constant volume is found to be given by the equation

$$C_v = C_v^\circ - (\rho - 1)T\frac{d^2B}{dT^2} - (1/2)(\rho^2 - 1)T\frac{d^2C}{dT^2}$$

In this way A. Michels and J. Strijland (1952) have shown that the heat capacity of carbon dioxide, at temperatures in the neighbourhood of the critical temperature, at first increases with an increase in density, and then rises to a sharp maximum at the critical density.

The virial coefficients can be interpreted in terms of intermolecular forces, as was shown by Lord Rayleigh. If, for example, the second virial coefficient alone is considered, and the isotherm is expressed in terms of the molecular concentration, n^*, in molecules per cubic centimetre, $PV/NkT = 1 + Bn^*$, where N is the total number of molecules in the volume V, and k is Boltzmann's constant. The approximate theoretical interpretation of B for symmetrical molecules is

$$B = \frac{2\pi\sigma^3}{3}\left[1 - \frac{3\left(\frac{n^n}{m^m}\right)\frac{1}{n-m}}{(n-3)(m-3)} \cdot \frac{D_e}{kT}\right]$$

where σ is the distance to which the centres of two isolated molecules come when their interaction energy is zero, D_e is the energy required to dissociate an isolated pair of molecules from its most stable state, and n and m are integers. By plotting the experimental values of B as a function of $1/T$, both constants can be evaluated. They enable us to calculate the interaction energy, ϕ, of an isolated pair of molecules at any separation, a, using the equation of Gustav Mie:

$$\phi = \frac{D_e}{n-m}\left(\frac{n^n}{m^m}\right)^{1/(n-m)}\left[\left(\frac{\sigma}{a}\right)^n - \left(\frac{\sigma}{a}\right)^m\right]$$

The integer m is less than n and is generally known, being 6 for nonpolar molecules, according to the dispersion theory of F. London (1931).

The Density of Solids.—Many different methods are again available, based on the same principles. One consists of weighing the solid, of volume, V, and density ρ_s, first in air of density ρ_a and then in a liquid of density ρl. In the first case, the force acting downward on the left pan of the balance is

$$V(\rho_s - \rho_a)g = W(1 - \tfrac{\rho_a}{\rho_s})g$$

where W is the real mass of the solid *in vacuo*. The force on the right pan is

$$w_1(1 - \tfrac{\rho_a}{\rho_b})g$$

where w_1 denotes the observed brass weights. These forces are equal, so that the real mass of the solid *in vacuo* is

$$W = w_1[1 - (\rho_a/\rho_b)]/[1 - (\rho_a/\rho_s)]$$

If w_2 denotes the brass weights necessary to obtain a balance when the solid is suspended in a liquid of density ρ_l, in which it is completely submerged, we now have the equality

$$V(\rho_s - \rho_l) = w_2[1 - (\rho_a/\rho_b)]$$

On dividing one expression by the other and rearranging the terms, remembering that $\rho_s = W/V$, we obtain the following expression for the density of the solid:

$$\rho_s = \frac{W_1\rho_l - W_2\rho_a}{W_1 - W_2}$$

A slight correction is necessary to allow for the interfacial tension exerted between the liquid and the fine wire used for suspending the solid in it. It will be seen that, if W_2 were zero, ρ_s would equal ρ_l. This leads us to another method of finding the density of a solid. It is to place it successively in a series of liquids of varying densities, in some of which it rises and in some of which it sinks, until a liquid is found of such a density that the solid neither rises nor sinks in it. This method has been successfully used in an accurate determination of the density of hemoglobin in aqueous solution.

Nicholson's hydrometer (fig. 8, after J. Reilly and W. N. Rae, *Physico-Chemical Methods*, 4th ed. [1943]) provides an interesting, though not accurate, method of measuring the density of a solid without using a balance. Weights are first added to the top pan until a mark on the hydrometer stem is in the liquid surface. Different weights are required to bring the hydrometer to the same position when the solid is placed, secondly, in the top pan and, finally, in the bottom pan. From these three weights, the density of the solid is readily estimated.

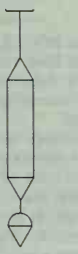

FIG. 8.—NICHOLSON'S HYDROMETER

In principle, the determination of internuclear distances in crystals by the methods of X-ray reflection and electron diffraction offers a highly accurate means of determining their densities, but a difficulty has arisen which until recently was unexpected. If molecules in a crystal are symmetrically arranged, and the distance between the centres of neighbouring molecules is a, the volume of a specimen of crystal containing N molecules must be $V = \kappa N a^3$, where κ is a structural constant, of order of magnitude unity. In a body-centred cubic arrangement, for example, κ is $4/3\sqrt{3}$, and in a face-centred cubic lattice, κ is $1/\sqrt{2}$. The molar volume is $V_m = \kappa N_o a^3$, where N_o is Avogadro's number which is known from a variety of experimental sources to be 6.024×10^{23}. Since V_m is also M/ρ, we see that the density of the crystal should be $\rho = M/\kappa N_o a^3$.

Densities of solids computed in this way, however, prove to be in many instances somewhat greater than the observed densities, and the difference is not thought to be due to imperfections in the crystal lattice. Some of the molecules apparently leave their proper sites, and occupy abnormal interstitial positions, or there may happen to be at ordinary temperatures a few holes in the crystal. There is evidence that the diamond lattice attains perfection, and that the quartz and calcite lattices are not greatly lacking in it.

Crystalline alkali chlorides prepared from melts are less perfect than those which crystallize from solution. Defects in chemically pure crystals at temperatures far below the melting points are relatively few, so that, under these conditions, the intermolecular-distance method of determining the density of solids is reliable.

See also references under "Density" in the Index volume.

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DENTAL AUXILIARIES are persons qualified by training and experience to perform dental work under the direction and supervision of the dentist. Some of these auxiliary persons work directly for the dentist in his own office; others work in a separate office or laboratory, in which case they perform services to the dentist on the basis of work authorizations or prescriptions. There are three principal dental auxiliary groups: the dental hygienist, the dental laboratory technician and the dental assistant. The great majority of dental auxiliary persons are women, who

serve either as hygienists or as assistants; a high percentage of laboratory technicians are male. Very few hygienists or assistants make a lifetime career of these vocations, and they remain in active practice on an average of only five or six years. The laboratory technician stays in the laboratory industry longer than this as a rule, but in the United States, though not in Great Britain, there is a very high turnover of persons entering and leaving this craft each year. Since all dental schools instruct students in the effective use of dental auxiliary personnel, demand by dentists for the services of hygienists, laboratory technicians and assistants is expected to increase substantially over the next 10 to 15 years.

Dental Hygienist.—The hygienist, working under the direction of a licensed dentist, cleans and polishes the patient's teeth and gives advice on the care of teeth. If she works for a dentist in private practice, she may also take and develop X-ray pictures of the teeth, mix filling compounds and otherwise assist the dentist in his work with the patient. In the United States hygienists are also employed by public-school systems to visit schools, examine the teeth of the children periodically and refer to the dentist cases in which more extensive dental health treatment is indicated. Some hygienists are employed in hospitals and public health clinics; in the hospitals they may be called upon to work with bed and ambulatory patients who require limited prophylactic treatment. In some dental offices, dental hygienists are permitted to apply fluorides to the teeth of the patient.

The profession of dental hygiene got its start largely through the efforts of Alfred Fones, and the first school was established in 1913 by Fones in his home. Of the dental auxiliaries in the U.S., the hygienist is the only one who must obtain a licence to practise and also is the only one permitted to work in the mouth of the patient. Her responsibilities are specified in the dental practice acts, as are the responsibilities of the dentist. The Council on Dental Education of the American Dental association (A.D.A.) accredits dental hygiene schools, of which there are more than 30; approximately two-thirds are associated with the dental programs of universities, the others with colleges or universities that do not have dental schools. The dental hygienist student may elect to take either a four-year college course leading to a bachelor's degree or a two-year college-level course for which she receives a certificate or diploma in dental hygiene. The four-year degree program includes two years of regular college training and a two-year specialized course in dental hygiene; the two-year program includes only the specialized dental hygiene course. Whether the dental hygiene student takes the two- or the four-year training program, she must obtain a licence from a licensing board in the state in which she wishes to practise. Upon passing the licensing examination, the hygienist becomes a registered dental hygienist (R.D.H.) and is then permitted to practise under a licensed dentist within the jurisdiction of the licensing agency.

Dental Laboratory Technician.—The second major auxiliary group of the dental profession is composed of laboratory technicians. Most technicians in the United States are employed by or own commercial laboratories. Of the remainder (approximately one-seventh of the total), most work for dentists in the dental office, although a few are employed by schools as teachers and by dental manufacturers and dental supply houses. A dental laboratory technician, through a prescription or work authorization form received from a licensed dentist, fabricates various appliances that the dentist uses in making restorations for the patient. The dental practice acts of the various states and territories and the District of Columbia do not permit the laboratory technician to serve the public directly. Instead, on receipt of the work order or prescription from the dentist, he fabricates full and partial dentures, crowns and bridges and other prosthetic devices needed by the dentist for the patient. The laboratory technician is not permitted to fit into the patient's mouth the appliances that he fabricates, nor is he permitted to take the impressions of the patient's tooth and jaw structures from which the dentures and other devices are fabricated.

Most technicians in the United States have been trained by the laboratories or the dentists in various types of on-the-job training programs; however, a few formal two-year training programs, developed by the American Dental association in co-operation with the National Association of Dental Laboratories and accredited after 1948 by the Council on Dental Education of the American Dental association, are in operation, and it is expected that larger numbers of laboratory technicians will be trained in the formal training programs. Requirements were established and approved by the American Dental association in the latter part of 1957. The training program extends over a period of two years and is divided into two parts of one year each. The first year, for which a high-school diploma or its equivalent is a requirement, may be offered by public-school systems as vocational or technical postgraduate training programs, or by junior colleges, technical institutes or dental schools. The second year is designed as an experience program and in most cases is conducted in commercial dental laboratories that have been approved for such purposes by the Council on Dental Education of the A.D.A. The second year is intended to give the student practical experience in all phases of dental laboratory technology and permits him to earn and learn simultaneously.

In 1958 the National Association of Dental Laboratories established the National Board for Certification, an agency empowered to grant certificates to certain laboratory technicians who can demonstrate exceptional knowledge and skill in the technology of the craft. These technicians, to be eligible for certification by the National Board for Certification, after Jan. 1, 1963, must have successfully completed the two-year formal educational program and give evidence of having an additional three years of experience in the craft, either in general technology or in one of the recognized special fields of technology. A certificate is awarded to dental laboratory technicians who have fulfilled these requirements and who have passed examinations prepared by the certification board to evaluate the level of the applicant's knowledge and skill. Although the certificate is in no sense a licence, it attests to the high standards of performance, skill and knowledge that the holder has achieved.

Dental Assistant.—About 65% of all the dental auxiliaries are dental assistants, and most of these are women; male dental assistants are used by the armed forces, but few, if any, continue in this vocation as civilians. The duties of a dental assistant vary extensively according to the degree to which the dentist elects to delegate the duties of his practice that do not require professional knowledge. In general, however, the assistant is expected to receive and prepare patients for dental treatment; to prepare materials and equipment for use by the dentist, including sterilizing and laying out instruments; to know instrument and equipment nomenclature; to keep records of appointments, examination, treatments and supplies. A growing number of assistants are being trained to assist the dentist at the chair in restorative dentistry, in surgical operations and in prosthetic dentistry; many also are being trained to perform dental X-ray work. Regardless of specific assignments in the dental office, all assistants need to have the ability to work in a clinical atmosphere, to follow written and oral instructions and to handle delicate instruments and materials without damaging them; all should be able to demonstrate tact, courtesy and understanding in dealing with the dental patient.

Many dentists train assistants in their own offices, but increasing numbers who enter this field do so through formal educational programs. These formal courses vary, in the United States, from about six months in length to two or more years of college work; there is no well-defined curriculum for the dental assistant. A large number of dental assistants take a short, 104-hour extension study course (frequently given as a night school study program) to prepare for examinations leading to a certificate in dental assisting. Dental assistants may be certified by the Certification board of the American Dental Assistants association. The certificate demonstrates that the assistant has attained the requisite amount of education and experience and has a high standard of knowledge and skill; it is in no sense a licence, but it recognizes proved accomplishment. (SR. PN.)

Great Britain.—In Great Britain, taking the conditions described that apply to the United States as a basis, the dental

hygienist, the dental laboratory technician and the dental assistant are the classes of assistants who help the dentist. The term dental auxiliary is used separately for a fourth class of assistant who is an ancillary worker, for whom an experimental scheme was begun in Great Britain under the Dentists act, 1957. The dental auxiliary was to be permitted to carry out certain types of dental treatment under the supervision of a dentist in the local education and health authority dental services. In most countries with an efficient dental service, there has been much opposition to this category of dental auxiliary, though, because of the shortage of dentists, it was introduced in New Zealand in 1921 under the title of dental nurse. British dental auxiliaries can carry out the same dental work as dental hygienists, but, in addition, they are permitted to extract deciduous teeth under local anesthesia and to undertake simple dental fillings likely to be required up to the time of leaving school. The course should extend over two years, and be followed by an examination.

Courses of training in dental hygiene and the use of dental hygienists were started first in the Royal Air Force in 1943. After World War II training was also given under the auspices of the ministry of health, after which the hygienists were employed in hospitals under a registered dentist. Following the Dentists act, 1957, the course of instruction given by training bodies should extend over not less than nine months, and be followed by an examination. The great majority of hygienists are women, and the types of dental work that they are permitted to carry out are similar to those outlined above; they do not visit schools for the purpose of examining children and referring those requiring treatment to a dentist, but they might visit to give advice on matters relating to oral hygiene. They are permitted to work under the direction of a dentist in his practice.

Dental laboratory technicians are mostly trained and perform duties as in the United States; they are chiefly men and serve an apprenticeship, usually for five years. Few have taken a recognized technical examination. The City and Guilds of London have organized a schedule of instruction in a wide range of subjects to be given in local polytechnical schools, and also grant a certificate to candidates who have been successful in passing the test examination. Dental technicians carry out the mechanical procedures that have already been described, and it is illegal for them to undertake any work in a patient's mouth, such as taking impressions or fitting dentures.

Dental chairside assistants are practically always women, and the duties are similar to those of assistants in the U.S. Most of them receive their training from dentists, but formal courses of instruction are available in some dental hospitals. The length varies from six months to two years, and is followed by an examination by the training body. There is also a certificate examination, available equally to those trained in private practice and hospitals. This examination is organized by the Dental Nurses and Assistants' society.

DENTATUS, MANIUS CURIUS (3rd century B.C.), Roman general, conqueror of the Samnites and of Pyrrhus, king of Epirus, was born of humble parents, and was possibly of Sabine origin. In 290 B.C., when consul with P. Cornelius Rufinus, he gained a decisive victory over the Samnites, which ended a war that had lasted 50 years. He also reduced to submission the Sabines, who were in revolt, and who subsequently were incorporated into the Roman state and received Roman citizenship without the right of voting. With the proceeds of the spoils Dentatus cut a channel to carry off the waters of Lake Velinus, so as to drain the valley in which the town of Reate (modern Rieti) lay. In 284 he was elected to take the place of the consul L. Metellus Denter, killed by the invading Senones, and defeated them. He also defeated the Lucanians. In 275, after Pyrrhus had returned from Sicily to Italy, Dentatus (again consul) took the field against him and defeated him finally near Beneventum (Benevento). Dentatus was consul for the last time in 274. As censor in 272 he began to build an aqueduct to carry the waters of the Anio river into the city, but died (270) before its completion. Dentatus was idealized as a model of old Roman simplicity and frugality by later writers.

BIBLIOGRAPHY.—Livy, epitome, 11–14; Polybius, ii, 19; Valerius Maximus, iv, 3, 5; Cicero, *De senectute*, 16; Letters, *Ad Atticum*, iv, 15, 5; Plutarch, *Pyrrhus*, 25.

DENTIL, in architecture, a small, rectangular block, used in a row as a decoration for the bed molding of a cornice. It was undoubtedly a decorative interpretation in stone of projecting beam ends in earlier wooden construction, and many of the famous rock cut tombs of Lycia, in Asia Minor, which represent wooden structures, show similar forms. Moreover, the tomb of Darius at Nakshi Rustan (*c.* 486 B.C.), which represents the entire front of a Persian palace, plainly shows the beam ends appearing as a dentil band. In ordinary classic usage the dentil decorates the cornices of the Ionic and Corinthian orders (*see* ORDER). The Attic custom, followed generally by the Romans and the Renaissance architects, kept the dentil relatively small, and spaced the dentils with an interspace of about half the width of the block itself. Occasionally, as in the Pantheon at Rome (*c.* 120), an unbroken band, known as a dentil band, replaced the separate dentils.

In the Hellenistic temples of Asia Minor, such as the great temple of Athena Polias at Priene (*c.* 334 B.C.), the archaic type heavy Ionic entablature was used, in which the dentils were much enlarged, more widely spaced and resembled brackets. The Byzantine dentil was a specific type of band ornament, possibly with little relation to the classic dentil, and was used especially as a border for panels. It consisted of an alternation of projecting blocks with splayed faces between, usually arranged in a double band, with the blocks on one side of the centre, in every case opposite the splays on the other. It is so found bordering the marble panels of Hagia Sophia at Constantinople (6th century), and became a favourite ornament in Venice, where it was used as a panel mold, as a horizontal band and around arches.

DENTISTRY is the healing art concerned with the health of the mouth, especially the teeth. It is also the profession practising this art.

Of the many conditions of the mouth treated by the dentist, the three that occupied most of the profession's attention throughout its history are dental caries (or decay of the teeth) and its consequences, disease of the supporting and investing structures of the teeth (periodontitis, commonly called pyorrhea) and irregularities (malpositions) of the teeth.

Caries, the principal problem of dentistry, is produced by acid dissolution of the calcium salts which constitute most of the tooth. W. D. Miller showed, 1880–90, that microorganisms participate in the formation of the acid. Destruction begins in spots on the surface where the microorganisms are undisturbed; and the action is believed to occur within a few minutes after carbohydrate foods, especially sugars, are taken into the mouth. In saliva, these are transformed, through products of the microorganisms, into lactic acid or other organic acids. Caries, from its inception, is a liability of the tooth, because it may lead, successively, to loss of part or all of the crown, involvement of the dental pulp, infection of the structures about the end of the root, loss of the entire tooth, or impairment of health by dissemination of the infectious influence through the circulation. Dentistry may prevent or remedy, by treatment, all of these conditions. Preventive measures, although logically the first step in combating caries, were largely neglected until the early years of the 20th century. The historical order in which measures were taken against the destruction of caries was probably: (1) use of medicinal applications to the teeth when toothache was present; (2) removal of affected teeth after the inefficacy of medicinal remedies became generally apparent, and the substitution of artificial teeth; (3) removal of the decay and restoration artificially of the lost part—the means most largely employed after the early 19th century; and (4) steps to prevent the disease or arrest it at an early stage.

Operative Dentistry.—This phase of dentistry aims to conserve the tooth and restore it, when carious, before the crown is lost. The first step in filling is preparation of the cavity. Before 1800 the preparation was limited to gaining access to the cavity and to removing the decay. From 1800 to 1860 attention was given to modifying the cavity so that the filling would not be displaced. From 1891 to 1900, largely through G. V. Black, cavity

preparation was systematized and modification of the cavity outline, called extension for prevention, was introduced to prevent recurrence of decay. After 1907, slight modifications were made for the cast-gold inlay.

The earliest fillings known, placed during the middle ages, were resins, waxes and gums. In the late middle ages leaf metals—particularly lead and gold—were employed. Gold was used as early as 1450. In 1855 Robert Arthur introduced the technique of cohesive gold foil, in which the foil was heated to render the surface pure, and cold welded in the cavity under pressure of hand instruments. When the cohesive property was understood and a control of saliva was found in the rubber dam (invented by S. C. Barnum in 1864), cohesive gold became, by 1875, the preferred filling, since by it alone the form of the tooth could be restored. Cohesive gold serves perfectly as a preserver of the tooth, but because of the tediousness, for patient and dentist, of placing it, it was partly superseded, after about 1910, by silver amalgam and the cast-gold inlay. Amalgam was introduced by 1828. It consists of silver or some of its alloys combined with mercury to make a plastic mass that can be adapted to the cavity and will harden within a reasonable time. Because of leaky margins of fillings and the unfounded belief that the contained mercury could affect the patient's health, amalgams were not altogether in good repute until after 1895. Then the experimental work of G. V. Black placed them upon a scientific basis. In posterior teeth, amalgams are satisfactory fillings and are the most frequently placed.

In 1907 William H. Taggart introduced a practical method of making cast-gold inlays. An impression of the cavity is taken in wax; after this has been invested with an artificial stone material to form a mold, and the wax burned out, molten gold is forced into the mold. The resulting casting is cemented into the cavity. Methods of compensating for the shrinkage of gold upon solidifying made the gold inlay a satisfactorily fitting restoration, and the advantage of restoring the anatomical contours of the tooth often gives it preference. The gold inlay largely restricted the use of gold foil. An ideal filling material unites durability with appropriate colour. The durable materials, mentioned above, are all lacking in tooth colour; the materials with aesthetic properties lack durability. Baked porcelain inlays (*c.* 1889) and silicious cement (1904), improperly called synthetic porcelain, have been extensively employed. About 1938 inlays and fillings of synthetic resins began to be tried. These restorations have high aesthetic properties but lack hardness comparable with tooth structure. Other materials—oxychloride of zinc cement (1860), zinc phosphate cement (1878) and gutta-percha (1848)—have been used for temporary or special purposes.

Endodontics.—When caries penetrates to the pulp, toothache usually occurs, and the actual or potential diseased condition of the pulp must be considered in the treatment. In children's teeth, where the root end is not completed, sometimes capping of the pulp with filling material has been resorted to. In other cases, ordinarily, the pulp is removed if the tooth is retained. Until about 1880, extirpation of the pulp was regarded as out of harmony with current pathological principles; nevertheless, after 1836, with the introduction of arsenic by J. R. Spooner to destroy the pulp, the practice of pulp removal increased greatly because the operation became almost painless. Recognition, after 1880, that microorganisms are responsible for pulp disease was thought justification for pulp extirpation on theoretical grounds; and for the next 30 years, drastic germicidal methods were employed to sterilize root canals. About 1910 dentists began to realize that these methods often lead to injury of the structures about the root end, with the result that this region becomes vulnerable to further infection, which may be extended to other parts of the body.

An address by William Hunter criticizing dental practices, especially in crown and bridgework, and disregard for dangerous septic conditions prevailing in the mouths of patients greatly influenced dentists and physicians to consider general health in relation to conditions of the teeth. X-rays played an important part in the discovery of these conditions. As a result, some dentists advocated extraction of all teeth with involved pulps. Others resorted to more conservative measures of pulp removal, using milder antiseptics, and in general substituting an aseptic technique for more drastic antiseptic measures. In place of arsenic, cocaine (1890) and procaine (1906) were employed for anesthetizing the pulp for removal. When the pulp is removed the root canal should be completely filled to the apex of the tooth, and for this purpose gutta-percha was generally employed after about 1870. (*See* ENDODONTICS.)

Prosthodontics.—This is the dental specialty concerned with the making and fitting of artificial teeth (dentures). It includes the artificial replacement of tissue in cases of oral malformation, such as cleft palate. (*See* PROSTHODONTICS; TEETH, ARTIFICIAL.)

Removal of Teeth.—Extraction was practised in ancient Greece, for it was recommended in the Hippocratic literature (5th century B.C.). Until about A.D. 1400, surgeons believed in extracting only loose teeth, and relied on crude prying instruments and ill-adapted forceps. During the period 1400–1750 new and powerful instruments—such as the "pelican" and the "turnkey"—made possible the removal of firm teeth quickly, but not always without injury to the jaw or other teeth. From 1830 to 1840 improved forceps designed for the various types of teeth ensured more scientific extractions. The introduction of general anesthesia, after 1844, made possible the painless and careful removal of teeth in accordance with surgical principles known, but inapplicable, in antiquity. The use of local anesthetics after 1905 still further facilitated extraction. X-rays aided proper extraction of the teeth by revealing the shape and condition of the root to be removed. Because extraction of septic teeth may have serious complications, some oral surgeons, about 1915, recommended alveolectomy, or surgical extraction; *i.e.*, removing surgically the bone overlying the root, and lifting the tooth from its socket, instead of the usual forceps removal.

Preventive Dentistry.—Preventive dentistry aims to anticipate and control all forms of dental trouble. It was given attention in 1743 by Robert Bunon, but was not stressed until after 1910. The commonest preventive measures, practised from early times, are oral hygiene such as toothbrushing by the patient and prophylaxis, or cleaning of the teeth, by the dentist. These measures are helpful in preventing caries and periodontitis, but have not proved sufficient. Operative measures were also employed; *i.e.*, permanent separation of the teeth by filing away their contacts (1800–80), Black's extension for prevention, and the cutting out and filling of fissures of the enamel on the chewing surfaces. After 1846 silver nitrate was applied to tooth surfaces to immunize them temporarily against caries. In 1936 efforts began to combat caries by the use of chemical substances. These were intended either to interfere with the chain of reactions which caused acid to be formed on the teeth, or to make the teeth less soluble to acid, or to reduce the number of microorganisms involved in the production of acid. The chief substances that have been used are fluorides, ammonium compounds, penicillin and so-called antienzymes. These substances have been added to some dentifrices. Sodium fluoride has been added to the drinking water of many communities to raise the fluoride concentration to about 1 part per 1,000,000. This measure has reduced the incidence of caries by as much as 60%. Fluoride solution has also been applied topically to the teeth. Reduction of sugar consumption has been recommended as a means of reducing incidence of caries.

Public Health Dentistry.—This is concerned with the provision of dental service to groups of persons through agencies other than private practice. About 1910 began an increased tendency to regard dentistry from the viewpoint of prevention and public health. Oral disease prevalent throughout the world had not received adequate care, and the supply of dentists was insufficient to furnish the care needed. In some countries, as Sweden, the state undertook to provide dental service to persons unable to pay the charges of dentists. In England, beginning in July 1948, the government, under the National Health Service act, provided from the public funds complete dental service to all applicants.

In the U.S. many different agencies began to furnish dentistry to groups, but no large integrated system was instituted. The emphasis was placed upon limited dental service to children. A. C.

Fones, in Bridgeport, Conn., between the years 1914 and 1924, was responsible for the maintenance of dental service for the school children of that city. This project resulted in important decrease of dental disease and in reduction of the number of children failing in school. Fones inaugurated the education and employment of dental hygienists to inspect and clean teeth and instruct in the schools. Dental hygienists have been employed throughout the United States, and many states have given them a legal status.

Privately endowed clinics were established in several localities. Among these were the Forsyth dental infirmary (1915) in Boston; the Walter G. Zoller Memorial dental clinic (1936), Chicago; the Rochester dental clinic, endowed by George Eastman (1915); various other dental clinics in large European cities, also endowed by Eastman; the Guggenheim dental clinic in New York city; etc. Other private organizations and funds—such as the W. K. Kellogg foundation (1930) and the Children's Fund of Michigan, created by James Couzens (1929)—supported dental public health work. Large industries began to give employees dental service. City and state governments, the United States public health service and the children's bureau (under the Social Security act of 1935) also instituted or supported public health dentistry. The nature and extent of the service is extremely variable. Educational work and dental inspections are common in public schools; prophylaxis is sometimes included; fillings and extractions are less commonly provided. Buenos Aires, Arg., established (1934) municipal clinics furnishing all services, including orthodontics.

Professional Development.—Dentistry as a vocation existed in ancient Roman times; Martial mentions one Cascellius who "removes or restores a bad tooth." Dentistry received some recognition as a profession in France during the 18th century, but institutions characteristic of a profession did not appear until 1840. Previously, dental education was secured largely through apprenticeship to dentists and technical craftsmen. In 1839–40, in the United States, the first regular dental school (the Baltimore College of Dental Surgery), the first dental journal (the *American Journal of Dental Science*) and the first national dental organization (the American Society of Dental Surgeons) were established. Similar developments took place a few years later in England, Germany and France. Considerably later, effective measures for licensing dentists by government agencies were instituted. Technical literature on dentistry began with Pierre Fauchard's *Chirurgien Dentiste*, in 1728. It was followed by a continuous issue of professional books in France, England, Germany and other countries. The earliest notable work in the United States was Chapin A. Harris' *Dental Art* (1839). In England the outstanding work was John Tomes' *Dental Physiology and Surgery* (1848). Periodical publication increased enormously throughout the world during the 19th century.

Dental education in the United States is carried on independently of medicine and surgery. From a few months, the dental course was gradually lengthened until, by 1940, it consisted of two years' predental study in college and four years in dental school. The course covers basic sciences, medical sciences and technical training, as well as clinical practice. In England the first licences were issued by the Royal College of Surgeons in 1859, and the dental profession remained largely under medical control. Two views of dentistry competed for supremacy throughout its history, especially in Europe—that of the stomatologists, who consider dentistry as a specialty of medical practice, and that of the odontologists, who hold that dentistry is a distinct practice. Dentistry is completely organized in professional societies in most countries of the world. In the United States, the American Dental association is the national organization. In England, the British Dental association is the official society.

Specialization.—Specialization in the practice of dentistry developed largely in the 20th century. The specialties recognized by the American Dental association are: (1) orthodontics (*q.v.*), the straightening of teeth; (2) oral surgery (*q.v.*); (3) periodontics, the care of the supporting tissue of the teeth; (4) pedodontics (*q.v.*), children's dentistry; (5) prosthodontics; (6) public health dentistry; (7) oral pathology. Other services which are sometimes supplied as exclusively restricted practices are radiodontics (X-ray diagnosis), crown and bridge work, implant dentistry, dental ceramics (porcelain work), and exodontics (extraction of teeth).

The technical and scientific progress of dentistry closely paralleled the progress of science and technology generally throughout the 19th and 20th centuries. The inventions and discoveries in physical, biological and medical sciences particularly pertaining to dentistry have been, in the main, the work of dentists or persons closely associated with that profession. *See* DENTAL AUXILIARIES.

See also PERIODONTAL DISEASES; TEETH; and references under "Dentistry" in the Index.

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DENTON, an urban district of Lancashire, Eng., comprising the townships of Denton and Haughton, lies in the extreme southeastern corner of Lancashire, 5½ mi. E.S.E. of Manchester. The river Tame, a tributary of the Mersey, forms the southerly and easterly boundaries of the district. Pop. (1961) 31,089. Records of Denton date back to the 13th century, but of the three ancient halls—Denton, Hyde and Haughton—only Hyde hall, former house of the Hydes of Denton, remains. It is a black-and-white half-timbered house dating from the 15th century. The main industry, from the 17th century, has been the manufacture of felt hats; others include the making of plastics, storage batteries, rubber, leather and cotton. Denton contains reservoirs of the Manchester water system.

DENTON, a city and seat of Denton county, Tex., U.S., is located at the northern apex of the Dallas-Fort Worth metropolitan area, about 30 mi. from each city. Denton county was created in 1846 from Fannin county and named for John B. Denton, early Texas frontiersman, Indian fighter and aide to Gen. Edward H. Tarrant. The town was settled in 1857 and incorporated in 1866.

The economy of the county is changing from agriculture to industrial urbanization. Industries include flour mills, concrete, clothing, brick, furniture and beverages. However, the city, home of Texas Women's university (1901), North Texas State college (1890) and the Denton State school, is predominantly an educational and cultural centre. The scholastic population has consistently maintained a ratio of approximately one to three of the city total. The educational, cultural and recreational advantages, together with the city's proximity to Dallas and Fort Worth, attract many middle-income home owners. Two artificial lakes, Garza-Little Elm, 10 mi. E., and Grapevine reservoir, 10 mi. S. of the city, provide water and recreational facilities. Denton has an annual agricultural fair and a rodeo.

For comparative population figures *see* table in TEXAS: *Population.* (S. B. McA.)

D'ENTRECASTEAUX ISLANDS, a group of three large islands off the eastern tip of New Guinea, are administratively part of the Milne bay territory of Papua. Pop. (1961) about 30,065. Area 1,213 sq.mi. Discovered and named by the French navigator Bruni d'Entrecasteaux during his search for J. F. La Pérouse in 1793, they were more accurately charted and individually named (Normanby, Fergusson, Goodenough) by John Moresby in 1873. The islands are volcanic, mountainous (5,000–8,350 ft.), and forest-clad. Indigenous and plantation copra is produced in fertile coastal patches, and numbers of the natives are employed as contract labourers in the New Guinea goldfields. Like the Trobriands, and other adjacent islands, the D'Entrecasteaux have attracted anthropological attention.

See R. F. Fortune, *Sorcerers of Dobu* (1932). (O. H. K. S.)

DENVER, capital of Colorado, U.S., the seat of Denver county, and the largest North American city between the Missouri river and the Pacific states, is located at the western edge of the Great Plains and is the commercial, financial and transportation centre for much of this area. The altitude of Denver is one mile above sea level, and the favourable climate is one of the city's

distinctive characteristics. Humidity is low, averaging 52%; average annual precipitation is 14.2 in. with 249 days of sunshine yearly.

West of Denver, a 150-mi. panorama of the Rocky mountains extends from Pikes peak on the south to beyond Longs peak on the north, many of the peaks retaining areas of snow cover through the summer. This combination of climate and nearby mountains has made tourism a major industry.

History.—Denver was founded in what was called the "Pikes peak or bust!" gold rush of 1859. The site had been a stopping place for Indians, fur trappers, traders and explorers. The first gold was discovered as early as 1807, and additional traces were found in the early 1850s. Reports of these finds, greatly magnified, led to serious prospecting in 1858. Rumours of success, again much exaggerated, resulted in the rush of 1859–60, in which 150,000 persons crossed the plains. The first settlements in 1858 were called Placer Camp and Montana. These gave way to rival towns straddling Cherry creek: Auraria on the southwest and St. Charles on the northeast. St. Charles, which was in the western reaches of Kansas territory, was renamed Denver City for James W. Denver, then governor of the territory. Auraria and Denver consolidated in 1860. Colorado became a federal territory in 1861, and Denver was designated the permanent capital in 1867.

The first newspaper, the *Rocky Mountain News*, was founded April 23, 1859, and was published continuously thereafter. The *News* received word of the election of Lincoln by pony express from St. Joseph, Mo., 660 mi. away, in four days. Telegraph lines reached Denver in 1863, but Indians, buffalo and storms frequently severed the wires.

Placer mining in the immediate vicinity never yielded gold in quantity. Many Pikes peakers went home as "gobacks," but just when it appeared that Denver would be depopulated by the reverse rush, rich strikes were made in the mountains in May 1859. The town was almost destroyed by fire in 1863, and a year later a flash flood in Cherry creek, which joins the South Platte river at Denver, swept away many buildings, including the city hall. Indian wars on the plains in the 1860s also were retarding factors in the city's growth and at times Denver was cut off from the nearest towns on the Missouri. Some felt Denver had been dealt a mortal blow when the transcontinental railway was built through Wyoming, but citizens organized their own railway to connect with the Union Pacific at Cheyenne. It was completed in June 1870, and shortly thereafter the Kansas Pacific also reached Denver. The coming of railways produced an immediate boom. In 1870 the population was 4,759; 20 years later it was 106,713.

During the 1870s and 1880s silver emerged as more important than gold. Rich mines poured wealth into Denver, mining kings were created almost overnight, and an opera house was built. This period of opulence ended with the 1893 silver panic. Banks failed, smelters shut down and silver kings became paupers. New gold discoveries helped prevent a major decline, and farming, cattle and sheep ranching and commerce began to provide a more stable economy.

The community chest plan for financing charities originated in Denver in 1887, and Denver's juvenile court, under Benjamin Barr Lindsey (*q.v.*), county judge 1901–27, was a pioneer in its field. Airplane service at Denver began in 1926. Fitzsimons army hospital was opened in 1918 and Lowry air force base in 1937. Other military installations include the U.S. Air Force academy (50 mi. S.), Rocky Mountain arsenal, Denver naval air station, the national air force finance centre, the Titan guided missile plant and Rocky Flats atomic energy project. The Denver branch of the U.S. mint produces approximately 75% of U.S. coinage and is the second largest U.S. gold depository.

Streets in the residential sections of Denver are tree lined and there is an extensive system of parkways and boulevards. Building regulations require that dwellings be set apart and back from streets, and as a result there are lawns and gardens around each home. Disastrous fires in the early days and the shortage of quality lumber led to other building regulations which make Denver a city of brick and stone construction. The state capitol (built 1887–95) and city and county building (1931–32) face each other across the 40-ac. Civic centre. The 272-ft. dome of the capitol is plated with gold leaf. Denver is youngest among the 25 largest U.S. cities and its appearance is new. The business-district skyline is relatively low. Principal features are a 330-ft. replica of Venice's campanile and several modern-style buildings of approximately the same height. Dominant structures in the skyline profile were built after 1950, the tallest being the First National bank of 28 stories (365 ft.), completed in 1958. (*See* also COLORADO: *History*.)

Administration and Finance.—Denver, with a land area of 71.0 sq.mi., has been a coextensive city and county since 1902. Government is by mayor and nine-member council. A commission government was in force briefly following 1912, but the mayor-council form was restored in 1916. The city is divided into councilmanic districts.

Commerce, Industry and Transportation.—The principal trade area embraces the Rocky mountain states and approximately 100 companies engage in foreign trade. Industry is light. The two largest individual manufactories produce rubber goods and luggage. Denver Union stockyards is among the nine largest U.S. cattle markets and is the largest sheep market. Other major industries include food processing, milling, printing and publishing, steel processing and machinery manufacture. Administrative and service industries include insurance, beet sugar, oil exploration, coal, metal mining, wholesaling and automobile distribution; over 30 federal agencies have offices in Denver. The city is served by several railroads, and the municipal airport is one of the most active civilian airports in the U.S.

Education and Cultural Life.—The public-school system includes elementary, junior high and senior high schools, with an annual enrollment of about 85,000. Among institutions of higher learning are the University of Denver (Methodist, founded 1864), Regis college (Roman Catholic, founded 1888), Colorado Woman's college (American Baptist, established 1909), Iliff School of Theology (Methodist, founded 1892), Loretto Heights college (Roman Catholic, founded 1918), and the medical school and an extension centre of the University of Colorado. The Colorado School of Mines is 14 mi. away, at Golden.

The Denver Public library circulates 600,000 books and 300,000 documents. There are art, natural history and historical museums and a symphony orchestra and civic theatre are maintained.

Parks and Recreation.—There are almost 100 parks and more than 50 supervised playgrounds within the city limits and 28 mountain parks, aggregating approximately 13,500 ac. One of the mountain parks contains a natural amphitheatre seating 10,000 persons and is used for music festivals.

Population Characteristics.—The population enjoys income and educational levels above national medians. In the 1960s foreign-born residents constituted less than 5% and nonwhites numbered 35,270 or about 7%. There was a considerable Spanish American population. Metropolitan area growth following World War II created a ring of satellite communities. Principal suburban entities, all primarily residential suburbs, were Arvada, Aurora, Brighton, Englewood, Golden, Hoffman Heights, Lakewood and Wheat Ridge. Denver experienced a marked growth following World War II, reflecting the westward shift of U.S. population. The city's population was 493,887 in 1960, with 929,383 persons in the standard metropolitan statistical area, comprising Denver, Adams, Arapahoe, Boulder and Jefferson counties. For comparative population figures *see* table in COLORADO: *Population*.

(RT. L. PN.)

DEODAND, a legal term formerly used to denote any item of personal property that had acted or had been used to cause the death of a human being. At common law in England such property was forfeited to the king in expiation for the soul of the person whose life was taken. The literal meaning of the term was "a thing given to God." A deodand might be animate or inanimate. Imputation of guilt to things incapable of reason was of ancient origin and can also be seen in the equally ancient custom of formal trials for animals accused of crime. The doctrine was a part both of the civil and criminal law.

Regardless of its pious origin, deodand became a mere forfeiture.

While originally the thing itself had to be handed over, later the forfeiture could be measured by the value of the thing as determined by a jury. By finding the value to be trifling, the jury could defeat inequitable forfeitures. Deodand came to involve many subtleties. If the thing that caused the death was in motion, its whole value was forfeited, whether the victim was an adult or an infant. If the thing was at rest and the victim an infant, there was no deodand. If the thing was not in motion and the victim an adult, the part that did the killing, like a falling cart wheel, was forfeited. Deodand could not arise at sea. Deodand as a legal concept is irreconcilable with principles of responsibility based on intent or negligence. It was never part of the law of the United States and was abolished in England in 1846. *See* also NEGLIGENCE. (G. M. Jo.)

DEODAR, or God tree (*Cedrus deodara*), is a species of coniferous evergreen tree closely allied to the cedar, its timber being of considerable value. It forms extensive forests in the Himalayas and is also found in Afghanistan and north Baluchistan. *See* CEDAR.

DEODORIZER, a substance that destroys, counteracts or masks an offensive odour, and which may or may not be a disinfectant or antiseptic. Unpleasant odours can largely be prevented by thorough cleanliness, proper refrigeration of foods, destruction of waste materials and the admission of fresh air and sunlight. However, owing to cooking, the use of tobacco, the presence of certain fabrics, pathological conditions, etc., absolute prevention is practically impossible, and substances to destroy, neutralize or mask obnoxious odours have been developed.

The glycols are chemical agents that act as solvents for many air-contained odorous substances. In spray form, minute glycol droplets dissolve or absorb the odorous molecules in the atmosphere. In vapour form, the glycols have a germicidal effect and can prevent development of odours caused by the action of microorganisms. Very low concentrations of glycols can kill air-borne bacteria.

Offensive gaseous and vaporous molecules can also be overcome by adsorption in certain solids, of which activated carbon is a versatile example. Within the carbon are innumerable cavities or capillaries that exert a powerful attraction on molecules of obnoxious substances in the atmosphere. Some other solids that have adsorptive power are silica gel, kieselguhr and fuller's earth.

The volatile molecules of such chemicals as formaldehyde or acetaldehyde in aqueous solution counteract the effect of a malodorous gas or vapour in the atmosphere, by physical attraction, molecule for molecule. When blended, the two substances lose their individual odours and produce a new odour complex. These chemicals tend to irritate the nasal membranes and have a narcotic effect on the olfactory nerve, so that an odour may be undetectable, although pungently present. In commercial preparations the quantity of chemical present is too small to produce narcosis. Frequently, essential oils are added to the solution to lend their fragrance to the air. Perfumes and incense materials used alone serve only to mask the offensiveness of the atmosphere.

Disinfectants and antiseptics deodorize only by destructive contact with the microorganisms causing malodorous conditions. Some commonly known disinfectants and antiseptics are the coal-tar derivatives, cresol and phenol; such oxidizing agents as hydrogen peroxide and potassium permanganate; certain acids, such as boric acid and salicylic acid; the halogens, chlorine, bromine and iodine; and metallic salts, such as silver nitrate, mercuric chloride and potassium mercuric iodide. (E. L. Y.)

DEONTOLOGY is the title of a book by Jeremy Bentham (*q.v.*), who introduced the term to denote a utilitarian system of ethics. The name has since then come to be applied to a system of ethics in which prominence is given to ideas of duty rather than to those of right or goodness.

DEORIA, a town in Uttar Pradesh, India, is the headquarters of Deoria district. Pop. (1961) 28,407. It is connected by railways with Gorakhpur on the northwest, with Varanasi (Benares) on the southwest and with Bihar in the east. Roads connect it with Gorakhpur, Varanasi, Fyzabad and Azamgarh.

DEORIA DISTRICT covers an area of 2,087 sq.mi. Pop. (1961) 2,375,075. The density of population (1,138 per square mile) is one of the highest in India. On the south it is bounded by the Rapti and Gogra rivers, on the west by the district of Gorakhpur and on the northeast by the Gandak river. It is in the Terai region and the whole area is a level plain gently sloping toward the southeast. (*See* TARAI). The northern tip has a monsoon type of forest, the soil is a fertile alluvium and the climate is of monsoon type (annual average rainfall 51 in.). About 86% of the population is engaged in agriculture, a large number of persons being employed in the 16 sugar-processing factories of the district. Other crops are rice, pulses and oilseeds. (M. N. K.)

DEOXYRIBONUCLEIC ACID (DNA): *see* CYTOLOGY; GENE: *Gene Composition and Replication;* NUCLEIC ACIDS.

DEPARTMENT, a division or part of a system; one of the branches of the administration in a state or municipality. In the United States many of the principal executive organs of government are known as departments; for example the department of state, the department of justice, etc. The subordinate components of the U.S. governmental departments are usually known as "bureaus." In Great Britain the term is commonly applied to the subordinate divisions of the chief executive offices of state, such as the savings bank or other department of the post office, the mines department of the board of trade.

In France the word is also used for a territorial division corresponding loosely to an English county. Previous to the French Revolution the local unit in France was the military *gouvernement*, roughly corresponding to the old provinces, such as Franche Comté, Provence, Bourgogne, Bretagne, etc. This division was too closely bound up with the administrative mismanagement of the old regime, however, and at the suggestion of Mirabeau, the "provinces" were divided into *départements*, as nearly as possible equal to a certain average of size and population, and deriving their names principally from rivers, mountains or other prominent geographical features. In 1860 three new *départements* were created out of the newly annexed territory of Savoy and Nice. The three *départements* of Bas-Rhin, Haut-Rhin and Moselle, which were lost after the Franco-German War in 1871, were restored in 1919. Each *département* is presided over by an officer called a prefect and is subdivided into *arrondissements*, each in charge of a subprefect. *Arrondissements* are again subdivided into cantons and these into communes, somewhat equivalent to the English parish. *See* FRANCE: *Administration and Social Conditions.*

DEPARTMENT STORE, a retail establishment which sells a wide variety of goods arranged in several departments. It features mainly shopping and specialty goods, including women's and misses' ready-to-wear accessories and apparel; men's and boys' ready-to-wear apparel and accessories; yard goods and household textiles; small household wares; furniture; and electrical appliances and accessories. Many department stores also have a food section and a restaurant. The organization of a department store is characterized by separation of merchandise assortments into divisions and departments supervised by individual divisional managers and department buyers; departmental divisions of merchandising, advertising, service, accounting and budgetary control functions; and varying degrees of integration with wholesaling and manufacturing establishments and functions.

The department store may be located in the business section of a large city or in a suburban one-stop shopping centre. The distinction between the department store and the general merchandise or the dry-goods store, which is often organized on a departmental basis and renders similar service, is commonly understood as one of size.

In Great Britain, the board of trade defines a department store in wide and general terms. For the purpose of retail sales analysis, it regards as a department store any large shop actively engaged in the sale of a wide range of commodities, one of which must be clothing. Department stores usually sell women's clothing, household textiles, furniture and domestic hardware. They may also sell men's wear, food and other items. Going beyond this wide description was an attempt to define in terms of size. In 1950 the definition of size was on the basis of turnover, £100,000 being the

minimum. In 1957, the basis was altered to the number of employees engaged, and a shop with 25 or more employees would qualify as a department store provided that it satisfied the other criteria. The English approach in fact followed the pattern of the United States. In 1939 the bureau of the census had taken annual sales of $100,000 or more as the basis, but in 1948 had adopted as its definition of a department store the "normal employment" of 25 or more persons.

History.—The best authorities ascribe the beginnings of the department store to the Bon Marché in Paris, founded as a small shop in the early 19th century, which by the 1850s or early 1860s began to assume the proportions of a department store. In the 19th century many general merchandise stores, by broadening stocks and by setting up departments, converted to department stores. An example is A. T. Stewart's (now Wanamaker's) in New York city, started in 1826 by Stewart and later sold to John Wanamaker (*q.v.*). Lord and Taylor in New York also originated in 1826; among later stores were Macy's in New York (1858), Strawbridge and Clothier in Philadelphia (1868), Emery-Bird-Thayer in Kansas City (1863) and the store in Chicago organized in 1865 by Marshall Field (*q.v.*). Field's shortly became the largest department store in the world. Harry Gordon Selfridge, who started his career there, moved to London and in 1909 started Selfridge's, now as well known as Harrod's, an older English department store.

By 1900 the department store was fully established in the larger cities of the U.S., and its development was given impetus by the increasing growth of large population centres, better transportation and the harnessing of electricity for power and lighting. By 1929 the department store had reached the peak of its importance (about one-eighth to one-tenth of total retail sales, depending upon definition and data used); since that year, its importance in retail selling in the U.S. has been substantial but reduced below the 1929 level.

Up to 1920, the principal type of department store in the U.S. was the single-unit form with no branch store operations. But by 1924–25, the first chain department stores, introduced by J. C. Penney company, were joined by Sears, Roebuck company, which began opening department or semidepartment stores in various cities (*see* CHAIN STORE). Beginning in 1929, and proceeding rapidly during the 1950s, many department stores opened branch stores to serve the growing suburban population. In addition, increasing numbers joined so-called "ownership groups" or buying groups, such as the Allied Merchandisers of Canada, in order to pool buying talent and financial resources. For such departments as millinery, foods and drugs, many department stores leased departments, owned by outside management but operated as though part of the department store.

Department stores or similar stores are found in almost all countries of the world, although their management and organization may differ somewhat. Moscow's famous GUM department store is entirely state controlled and therefore quite different. A distinctive feature of Canadian economy is the operation of a few department store chains, each of which has stores across the country. The T. Eaton company and Simpsons-Sears have outlets throughout Canada and do a large mail-order business as well. The Hudson's Bay company stores are mostly west of Winnipeg. In Great Britain, there is a growing tendency for department stores to be grouped. Thus Debenhams Ltd., The House of Frazer and Lewis's Investment Trust each control many department stores operating throughout the country. In all cases, general control has been centralized, but many of the stores exercise their own merchandising policy and maintain their own peculiarities and individuality.

Management.—*Competitive Advantages.*—The great appeal of the department store to customers derives from its use of the principles of functional specialization and product departmentization. Originally, central downtown locations offered accessibility to enough customer traffic to support the product assortments carried and to afford comparative shopping with other retail units. Another aspect was the offering of a wide range of "free" services such as deliveries, liberal credit arrangements, merchandise return privileges, nursery facilities and elaborate waiting rooms. Before the second half of the 20th century, considerable emphasis was placed upon introducing new types of merchandise and featuring products not traditionally handled by department stores. Such assortments were enhanced by modern building facilities, elaborate displays in windows and in departmental facilities and skilful advertising in newspapers, "shopping news" and other media.

Competitive Disadvantages.—Many of the competitive advantages outlined above have disappeared or have created offsetting disadvantages, which help account for reduction in importance of this kind of store in the U.S. after 1929. The so-called free services caused many department stores to be among the highest cost retailing institutions. Department stores have acted as a fertile training ground for management talent for competitors. The deterioration of rapid transit in cities and the congestion created by the increased use of the automobile have tended to penalize department stores located in the older business areas.

The large-scale organization also created several disadvantages. Turnover of sales personnel, caused in part by the high proportion of women employed and the continuous managerial pressure for sales volume, has led to some increasing impersonality of service to customers. With such impersonality of contacts, executives must depend on secondhand reports or upon impersonal statistical and accounting control devices.

Although department stores developed the use of newspapers as an advertising medium to a high degree, many stores did not develop skill in evaluating such advertising. The composition of the advertisements did not always compare favourably with the distinctive format of other specialty and shopping-goods stores. Nor were the department store prices always low enough.

Finally, the reduced importance of the department store may be reflected in the following difficult-to-measure but illustrative indicators: the relative competitive tactics taken by the most rapidly growing types of stores *v.* department stores; the increasing sameness among many department stores in their approach to organization, store layout and price policies; and the competitive impact of such basic trends as large shopping centre developments and discount house operations.

Department store management has taken many steps designed to improve its competitive position. Extensive modernization programs, branch store operations, improved training of sales personnel, application of self-service or partly self-service departmental layouts and more aggressive pricing have been used. Branch stores have been given more organizational autonomy. Chain department stores have expanded unit operations. Partial department store units have been used. Yet competing stores have cut into sales by expanded product assortments and by other tactics.

See also DISCOUNT HOUSE; MARKETING; RETAILING.

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DEPEW, CHAUNCEY MITCHELL (1834–1928), U.S. railroad lawyer, orator and politician, was born in Peekskill, N.Y., on April 23, 1834. He graduated from Yale in 1856 and was admitted to the bar in 1858. He entered politics as a Republican, served as a member of the New York assembly (1861–62) and as secretary of state of New York (1864–65). In 1866 Depew became attorney for the New York and Harlem railway and in 1869 was appointed attorney of the newly consolidated New York Central and Hudson River railway, of which he became a director and second vice-president. In 1875 he became general counsel for the entire Vanderbilt system. Depew became president of the New York Central and Hudson River railway in 1885, and in 1898,

chairman of the board of the Vanderbilt system. Depew joined the Liberal Republican movement in 1872 and ran for lieutenant governor of New York but was defeated. In 1899 Depew was elected to the U.S. senate and served until 1911. Depew's fame rests on his ability as an orator and after-dinner speaker. He died April 5, 1928, in New York city.

See C. M. Depew, *Orations, Addresses and Speeches*, 8 vol. (1910), *My Memories of Eighty Years* (1922). (F. M.)

DEPORTATION AND EXILE. Both in the United States and the United Kingdom the term deportation is used to refer to the expulsion of an alien by an agency of the executive (in the U.S. by the immigration and naturalization service of the department of justice, in England by the home office) (*see* ALIEN; IMMIGRATION LAW; MIGRATION). Transportation refers to a system of punishment for crime involving the removal of the criminal to a penal settlement outside his own country. Exile is applied to prolonged absence from one's country either by authority of the sovereign or by voluntary action of the individual; the person who is outside his country under these circumstances is referred to as an exile. Deportation and exile are to be distinguished from exclusion and extradition. Exclusion is the process whereby the governing authority of a country refuses to admit an alien to its shores or rejects him. Extradition (*q.v.*) is the procedure which is invoked to secure the removal of a criminal to the state or country from which he has fled and which has jurisdiction over the crime committed by him.

Origins.—Exile or banishment may be traced from the biblical account of Adam and Eve's expulsion from the Garden of Eden to the punishment of tribal law declaring the tribal member an outcast and through the penal exile of the ancient Greeks and Romans. Thereafter came the outlawry for offenses in Anglo-Saxon law and the practices of many European countries of removal of criminals to penal settlements like the notorious Devil's Island and Siberia. In modern times, revolutions overthrowing dictatorships have added to the number of history's exiles.

The practice of exile and banishment probably originated as a primitive punishment of tribal law declaring an offending person an outcast and depriving him of the comfort and protection of his tribe. The Greek city-states borrowed banishment from their Ionian, Aeolian and Dorian ancestors. Among the ancient Greeks exile was chiefly known in connection with cases of homicide. The punishment of the murderer was originally the duty and the privilege of the relatives of the murdered man. Unless the relatives could be induced to accept a money payment as compensation, the criminal's only means of escaping punishment was flight and exile in a foreign land. If, during his self-imposed exile, the relatives agreed to accept the indemnity, he was at liberty to return and resume his position in society. Later, exile for life with confiscation of property was inflicted as a punishment for particular crimes. In time, exile came to be the established legal punishment for homicide in Greece and was imposed by the tribunal known as the ephetae. Under a law of Solon it was also the penalty meted out to those who remained neutral during a sedition. At times exile was a political measure adopted especially during civil disturbances, and a special form of banishment known as ostracism (*q.v.*) was sometimes imposed upon those considered dangerous to the welfare of the state. Greek citizens of Athens sometimes left the state for other reasons, such as debt or inability to pay a fine. Since extradition was utilized only for serious crimes, the fugitive was not troubled by the authorities and was free to return after a certain time had elapsed.

Originally there was no such thing as expulsion from Rome. A person, however, might be cut off or interdicted from fire and water (*aquae et ignis interdictio*), the symbols of civic communion and the necessities of everyday life. This, for all practical purposes, forced the individual to leave the country. The interdiction of fire and water was inflicted by the Roman assembly of the centuries (*comitia centuriata*) and later by a judicial commission appointed to try certain serious offenses such as treason, arson and poisoning. Exile in Rome was originally not a punishment but a means of escaping punishment. Before judgment had been finally pronounced, it was open to any Roman citizen condemned to death to escape the penalty by voluntary exile. If he broke the exile and returned anyone had the right to put him to death. Subsequently (probably at the time of the Gracchi) the interdiction of fire and water became a recognized legal penalty, practically the equivalent of exile, and took the place of capital punishment. The criminal was permitted to withdraw from the city after sentence was pronounced, and his withdrawal was sanctioned by a decree of the people which declared his exile permanent. Authorities are not agreed whether this exile by interdiction automatically involved loss of citizenship and all civil rights. It is, however, clear that only in rare cases was it accompanied by confiscation of property.

Under the Roman empire, interdiction by fire and water was replaced by two types of banishment known as deportation (*deportatio*) and relegation (*relegatio*). Deportation consisted in transportation for life to an island (or someplace prescribed on the mainland, but not of Italy). Since deportation was generally to an island, the Romans came to refer to this type of banishment as *deportatio in insulam*. It was accompanied by loss of citizenship, loss of civil rights and confiscation of property. The most dreaded places of exile were the islands of Gyaros, Sardinia and an oasis in the desert of Libya; Crete, Cyprus and Rhodes were considered more tolerable. Expulsion of large groups of persons was accomplished by transportation to these places of exile. Thus, Tiberius sent about 4,000 freedmen to Sardinia for Jewish or Egyptian superstitious practices. Deportation was originally inflicted upon political criminals. In the course of time it became more particularly a means of removing those whose wealth and popularity rendered them objects of suspicion. Deportation was also a punishment for adultery, murder, poisoning, forgery, embezzlement, sacrilege and certain cases of immorality. Relegation was a milder form of punishment than deportation. It either excluded the person banished from one specified district (in imperial times the banishment would be from Rome) with permission to choose a residence elsewhere, or the place of exile was fixed. Relegation might be temporary or for life, but in either case it did not carry loss of citizenship or property, nor was the exile under military surveillance as in the case of deportation. Some Roman writers use the Latin equivalent of exile (*exsilium*) in the sense of all three of its Roman forms: interdiction of fire and water, deportation and relegation.

England.—According to Sir William Blackstone's *Commentaries*, exile and transportation were punishments unknown to the common law of England. However, even prior to the enactment of statutory law in England, the practice originated of granting an arrested man permission to abjure the realm. He would take an oath to depart and to never return. It is speculated that the origin of this practice may be traced to the Anglo-Saxon penalty of outlawry (*q.v.*). As in the days of the ancient Greeks and Romans, an Englishman might save himself from death by abjuring the realm. Transportation or exile was a conditional pardon and an alternative to execution. The English Vagrancy act of 1597 was the first statutory authorization in Great Britain to banish offenders and order them transported to assigned lands beyond the seas. It authorized banishment out of the realm of "such Rogues as shall not be thought fit not to be delivered." Toward the end of the 17th century transportation of criminals was used as a regular part of the English penal system and as a substitute for capital punishment. Its use in this way became more frequent as people realized that the criminal law was unduly severe. Pardons were frequently granted to capital offenders on condition that they consented to transportation. The Habeas Corpus act of 1679 recognized this procedure and provided that except in special cases persons could not be imprisoned beyond the seas. In 1717 the courts were authorized to order transportation as a direct punishment, and in 1768 the power of judges to reprieve capital convictions and to substitute transportation was confirmed by parliament and the procedure was simplified.

Large-scale transportation to the American colonies followed until 1776 and many of those transported were identured servants. After 1776 convicts ordered transported were for a time employed at hard labour at home or detained in prison ships. In 1779 trans-

portation was resumed to Africa but this was terminated because of climatic conditions. Beginning in 1787 the practice was established of sending English criminals to Australia, Tasmania and Norfolk Island. There, military control of the convicts was maintained, and they were put to work at heavy labour in penal colonies, building roads, bridges and other facilities. The early advances of Australia were in part attributable to their service to the young colony. After a time, with the influx of increasing numbers of convicts, a policy of "assignment" was adopted whereby convicts were freely loaned to anyone who would relieve the authorities of responsibility for them. This system developed abuses and there is a long story of failures, investigations and scandal. Because of the protests of the colonists themselves and of those opposed to the inhuman treatment of convicts sentenced to penal servitude abroad, the system of transportation was eventually abolished by the Penal Servitude acts of 1853 and 1857.

Continental Countries.—Spain and Portugal punished criminals by transportation to hard labour in mines and by imprisonment in military fortresses prior to the adoption of the practice in England. Portugal first sent criminals in 1415 to work on fortifications in north African posts taken from the Moors. Its policy of transporting criminals was continued throughout its colonial history and produced some of the earliest settlers of Brazil. In Spain during the reign of Ferdinand and Isabella convicts were punished by transportation to the mines of Hispaniola. Later, Spain also transported criminals to military fortifications in Africa.

France first adopted deportation of its criminals during the Revolutionary period. In 1797 a small group of political prisoners was deported to French Guiana, and in the following year 500 prisoners were sent there. However, this practice did not work out satisfactorily and the transportation of convicts to Guiana was condemned by publicists and the government. In 1854 it was reintroduced into the French penal code but again brought deplorable results. Nevertheless, deportation to Guiana was not entirely abandoned; instead of native-born Frenchmen, only convicts of subject people were sent there, but with no better success as regards colonization. New Caledonia, an island in the Pacific, was annexed by France in 1853 and ten years later became a new settlement for convict immigrants. However, in time it was feared that transportation to New Caledonia, with its fairly temperate climate and fertile soil, did not provide a sufficient deterrent against crime. The French administration, therefore, resumed the deportation of French-born persons to Guiana, which was notoriously unhealthy. Convicts who showed some promise of rehabilitation were still sent to New Caledonia, but those with the worst records were sent to the settlements on the equator. After 1897 no more convicts were transported to New Caledonia, though some were still transported to Guiana in the 20th century. Disclosures were made of the dreadful conditions on the islands near Cayenne where prisoners were held, particularly the notorious Devil's Island. In 1938 France abolished transportation, although persons already transported were still detained. The penal colonies in French Guiana were finally abolished by a decree of the Free French government during World War II.

Italy introduced deportation to various agricultural penal colonies around its coast. Under the Fascist regime, thousands of political prisoners were sent to the nonagricultural islands off the coast of Sicily.

Peter the Great of Russia ordered the first political prisoners to Siberia in 1710. From 1823 onward, Russia directed continuous streams of offenders to Siberia, and at one time the yearly average was 18,000. Transportation of Russian convicts to Turkistan and to the island of Sakhalin in the far east was also practised. Sakhalin, like Australia and New Caledonia, was hopefully intended as an outlet for released convicts. The result, however, was identical with the British and French experience, and before World War I it was recognized in Russia that transportation had failed. Under the Communist regime a special board attached to the people's commissariat for the interior and known as *osoboe soveshanie* is authorized to banish persons from localities, to impose banishment with settlement elsewhere, to confine in correctional settlements and to deport abroad. Exile can be imposed with or without confinement. According to H. E. Barnes and N. K. Teeters in *New Horizons in Criminology* (Prentice-Hall, Inc., New York, 1951), under the Communists "the Czarist system of sending prisoners to Siberia has been continued . . . on an ever greater scale, and, apparently with just as much brutality. There is, however, one difference. Under the Czars a large portion of those exiled were criminals in the conventional sense. Under the Soviet rule, most of those sent to Siberia have been political prisoners." In the view of these writers, "after making all qualifications necessary for the exaggeration of the bitterly anti-Soviet writers, it seems likely that the conditions in the Soviet labor camps in Siberia are as brutal and degrading as anything which was the rule under the Czars."

Other countries have adopted the practice of transportation of criminals. The Netherlands has had penal settlements in Batavia, the Moluccas and Penguin Islands; Denmark utilized Greenland for a brief period, and both Chile and Ecuador have had penal colonies on Pacific islands.

M. Grünhut observes in *Penal Reform* (Oxford University Press, Oxford, 1948) that the "tendency to get criminals out of sight goes back to primitive stages of criminal law." Transportation of convicts must be regarded as a most primitive solution to the problem of punishment and rehabilitation of criminals. Moreover, it is a solution likely to be accompanied by inhuman and deplorable conditions, as well as one most unlikely to succeed. Indeed, the general consensus is that it has proved a ghastly failure wherever it has been tried.

United States.—In the United States, transportation of criminals to penal settlements abroad has not been adopted either in practice or by statutory enactments. Deportation proceedings are considered civil in nature and, unlike the policies of most countries, this type of banishment can only be imposed upon aliens; *i.e.*, persons who are neither native-born or naturalized citizens of the U.S. Moreover, deportation is always to a foreign country, and the United States completely releases control over the individual once he has been transported abroad. An important distinction is to be made between aliens who are refused admission at the borders of the United States and those who have entered and are deported afterward. The former are excluded, while the latter are expelled or deported. The excluded alien can only be returned to the foreign country from which he came; the deported alien can be sent to any country willing to accept him. The grounds for the deportation of aliens is set forth in the Immigration and Nationality act of 1952, also known as the McCarran-Walter act. Provision is made for the deportation of aliens who entered illegally or without proper passports or visas, for those who became illegal residents by overstaying their temporary visits, for those who become public charges, commit crimes involving moral turpitude, engage in immoral conduct or who are considered subversives.

Aliens in the United States are entitled to full protection under the constitution and, in a deportation proceeding, enjoy the benefits of procedural due process. However, it has been said that the right of an alien to remain in the United States may be revoked by congress in its discretion (*Harisiades* v. *Shaughnessy*, 342 U.S. 580 [1952]). With rare exceptions, there are no limitations in point of time (statute of limitations) restricting the government's power to deport. Upon the ground that the deportation statute is considered a civil enactment, retroactive or ex post facto deportation legislation has been upheld against attack. Nevertheless, the supreme court has recognized that "deportation is a penalty—at times a most serious one" (*Bridges* v. *Wixon*, 326 U.S. 135 [1945]) and that deportation "can be the equivalent of banishment or exile" (*Delgadillo* v. *Carmichael*, 332 U.S. 388 [1947]). It has also been said that deportation is "a dreadful punishment abandoned by the common consent of all civilized peoples" (*U.S. ex rel Klonis* v. *Davis*, 13 F.2d 630 [C. A. 2, 1926]). Until a person has been admitted to citizenship, no matter how long he has been a resident of the United States and regardless of his family ties, he may be deported if he violates the deportation statute. In some cases where he has close family ties and can establish unusual hardship, the alien may be granted permanent residence despite

his deportation violation. The alien who becomes a naturalized citizen can be subjected to deportation if he loses his citizenship and commits a deportable offense. Aliens who enter the United States unlawfully, surreptitiously or fraudulently, who enter as stowaways, who re-enter after deportation without permission, who unlawfully remain after entry as crewmen, or who willfully fail or refuse to depart from the United States after being ordered deported as criminals, subversives, narcotic violators or by reason of identification with prostitution are subject to prosecution for violating the criminal provisions of the laws of the United States.

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DEPOSIT, CERTIFICATE OF, a written receipt from a bank acknowledging the deposit therein of a certain sum of money. Under such certificate, money may be deposited either on a demand basis or a time basis, but in either case it cannot be drawn against by check. To withdraw funds deposited under a certificate of deposit it is necessary to present the certificate itself, properly endorsed. In the United States certificates of deposit are negotiable when properly endorsed and are usually acceptable as security for loans.

DEPOSIT INSURANCE. This special type of insurance, under which depositors are guaranteed against loss in the event of a bank failure, developed in the United States during the depression of the 1930s to meet the serious problems created by frequent bank suspensions. Between 1863 and 1933, more than 17,000 U.S. banks closed their doors and depositors suffered heavy losses. Even in the prosperous years from 1921 to 1929, 5,411 banks closed and during the next four years the depression caused the failure of 8,812 more, with losses to depositors of more than $5,000,000,000.

Some states had set up plans to insure depositors against loss as early as 1829 but none proved fully successful. Congress rejected many proposals to place deposit insurance on a national basis until the disastrous collapse of the banking system in 1932 made action to protect depositors imperative.

The federal insurance program came into being in 1933 with the creation of the Federal Deposit Insurance corporation (FDIC) with authority to insure bank deposits in eligible banks up to a maximum of $2,500 for each depositor (later raised to $5,000 in 1934 and to $10,000 in 1950), and to regulate certain banking practices. Costs of the FDIC were to be met out of regular premium payments by insured banks. All members of the federal reserve system were required to insure their deposits, while nonmember banks—about half the United States total—were permitted to do so if they met FDIC standards. The plan proved so attractive that within a few years over 90% of the deposits in commercial banks and a majority of those in mutual savings banks were insured. The deposit insurance principle was also adopted by federally chartered savings and loan associations.

FDIC was able to eliminate losses to depositors in suspended banks almost completely, and—perhaps more important—to prevent failure of many banks which have encountered difficulties. Deposit insurance and other banking reforms in the Banking acts of 1933 and 1935 made insured deposits virtually as safe as any direct obligation of the federal government. (JA. A. C.)

DEPOT, a place where goods may be stored or deposited. In the U.S. the word is also used to denote a railway or bus station, whether for passengers or goods. In Great Britain, when the word is used in this sense, it applies only to goods (freight) stations. In military language the term applies to any storage point for supplies. Large depots not only store supplies but also classify, repair, maintain and salvage matériel and issue it to troops. A particular type of depot is one where recruits are received and undergo preliminary training before joining active troops. Such depots are maintained in peacetime by armies which supply distant or overseas garrisons; in an army raised by compulsory service and quartered in its own country, the regiments are usually stationed in their own districts and on taking the field for war leave behind a small nucleus for the formation and training of drafts to be sent out later. These nucleus troops are generally called depot troops.

DEPRECIATION, an accounting charge for the decline in value of an asset spread over its economic life. Depreciation covers wear and tear from use and physical deterioration from age and exposure to the elements. It also includes obsolescence, *i.e.*, loss of usefulness arising from availability of newer and more efficient types of goods serving the same purpose. It does not cover losses from sudden and unexpected destruction of the usefulness of property as a result of fire, accident, theft, war damage or adverse court decisions, or from declining price levels. Depreciation applies both to tangible property such as machinery and buildings and to intangibles of limited life such as leaseholds and copyrights.

Similar costs are involved in two other accounting terms: depletion and maintenance. Depletion is depreciation on property which cannot be reproduced, such as a body of ore being mined or a stand of timber being cut and not reforested. Maintenance is cost incurred in keeping property in good condition, as by painting a house or replacing defective parts in a truck. Tangible property subject to depreciation also involves maintenance. Where "full maintenance" aims to keep the property intact without deterioration, however (as with a railway roadbed), there may be no depreciation charge. A main object of keeping these costs is to measure income correctly so that if the whole supposed income of a business is withdrawn for the private use of the owners it will not later be discovered that the assets of the business have dwindled away. This leads to the rule that depreciation during the working life of a piece of property must equal the original cost of the property, less ultimate scrap value. For convenience, depreciation accounts are usually kept for groups of assets with similar characteristics and working life; and the estimated average working life of the group is used in figuring depreciation. Since this average can take into account minor losses from fire, etc., depreciation covers such losses insofar as they are self-insurable within the business in question.

The general rule of charging off a depreciable asset during its life does not determine what the charge will be each year. Allocation among years is recognized as arbitrary and in practice is strongly influenced by income tax regulations. Straight-line, fixed-percentage and, more rarely, annuity methods of depreciation—giving respectively constant, gradually decreasing and gradually increasing charges—are standard. Sometimes charges vary with use (for instance, with the number of miles per year a truck is driven). Special rules allow depletion for tax purposes to exceed original cost.

Basing depreciation on historical cost rather than on probable replacement cost, and on arbitrary rules rather than on actual use, is presumably necessary for definite tax liability and audits of accounts. But very imperfect measurement of the actual using up of property results in times when price levels change. Thus after a fall of prices, depreciation overrates the using up of capital; and consequently current income and the proportion of new buildings, machinery and other property which exceeds replacement requirements ("net capital formation") are overstated; after a rise of prices the opposite is true, as for example during the inflation following World War II. (A. G. HT.; X.)

DEPRESSION, a term used in economics to denote a major downswing in the business cycle. A depression is characterized by sharply reduced industrial production, widespread unemploy-

ment and a general contraction of business activity. Periods of prosperity and depression have succeeded one another at irregular intervals in the United States, Great Britain and other industrialized nations since the latter part of the 18th century. The depression that began in 1929 was the most severe and widespread economic decline of the first half of the 20th century. Shorter and less severe contractions of business activity are commonly referred to as recessions. *See* Business Cycle; Panic; United States (of America): *History.*

DEPRESSION (IN PSYCHIATRY) is not an illness. It follows no regular course and has no particular or specific outcome. It may be fleeting or permanent, mild or severe, acute or chronic. There is no clear line of distinction between normal and abnormal in depression; degree of intensity determines whether a depression is pathological. It is a type of emotional reaction with distinctive characteristics; the roots of these characteristics exist in everyone.

Depression nevertheless has specific characteristics which distinguish it from all other emotional states. It represents a whole class of disorders whose chief features are a reaction to a sense of loss. The reaction is typified by an emotional or psychic state which is expressed by a loss of interest in the world outside the self, loss of activity, loss of capacity to love and loss of feeling of self-regard to a point that finds expression in self-reproach and self-reviling and may culminate in extreme instances as a delusional expectation of punishment and as suicidal impulses. Profound mourning differs from this picture only in that the fall in self-esteem is absent in grief. The findings reported by Sigmund Freud in 1917 in his paper on "Mourning and Melancholia" remain as the basis of all subsequent serious dynamic studies of the psychology of the subject.

The responses to a sense of loss are part of a series of integrated sequential psychic phenomena which are best understood collectively as a loss-complex. This manifests itself in various ways at different phases of psychosexual development and may produce profound changes in the emotional life of the person, wherein some effects are consciously perceived, others are unconscious. The characteristic pathological forms of depression, however, only begin to appear in puberty. It is commoner in adult life than in the younger years. Young adult men react with depression more commonly than young women, whereas toward middle age women are more frequently affected.

The occurrence of psychic depression is as widespread as anxiety, and hence it may be found to a greater or lesser degree as an accompaniment to all other emotional and bodily disorders. It would be a rare affliction that was not accompanied by some elements of depression. Although the prevalence of depression is wide and the incidence high, most cases go unrecognized. One of the most remarkable aspects of depression is that it may pass off without leaving a trace and with no manifest remains. A further peculiarity is that the symptomatology may turn into its complete opposite, elation; although this is not true of most cases, elation does occur frequently and often unpredictably. Once a cyclic pattern with alternating depression and elation is established, there is a tendency to repeated and intermittent recurrence. After recovery no gross signs may remain.

Even as late as puberty and in young adults elation and mania are rare. Because of the extreme variability, the difficulty in recognizing the disorder and the fact that recovery often leaves no manifest signs, statistics as to prevalence, incidence and recovery have only limited value.

Depression has been well known and described unmistakably from at least the time of Hippocrates, who called it melancholia. The classification of depression into reactive, neurotic, hypochondriacal, manic-depressive, involutional and senile is essentially based upon pre-20th-century descriptive and prognostic concepts; it does not rest on a psychodynamic understanding.

Much psychoanalytic work after 1917 concerned itself with dynamic understanding of the psychological content and meaning of depression. The differences between cases of depression are often more a matter of degree than of kind. The secondary symptoms—such as restlessness or its opposite, insomnia or drowsiness, voracious appetite or no desire for food—are variable, while the basic conflicts are the same.

A significant focus of investigation is the emotional development in childhood, with emphasis upon early forms of reaction to loss in that period. Young children responding actively to a sense of loss, which occurs in reality or in fantasy, may in fact produce pathological reactions. These are exemplified by severe apathy and unresponsiveness to the environment, failure in various aspects of ego development, retardation in intellectual growth, restlessness characterized by overactivity, and periods of sadness and grief. However, the failure of investigators to find the adult form of reaction in childhood supports the contention that responses to the sense of loss in the early years of life are not characterized by depression.

The criteria for depression are not found in this period. Central in the disorder, and by far the outstanding feature, is self-criticism by the conscience. The child, in contrast to the adult, not having a fully developed conscience, responds only to a limited degree in this way, and hence the central feature of depression is essentially absent.

It is this severe self-criticism which compellingly drives the person to represent himself as worthless. His criticisms are extended beyond the present and into the past. In this frame of mind he is frequently sleepless, worried and shows little desire for food or even for life. In many instances the self-accusations, however well they may apply to the person, actually seem more "characteristic of someone who is loved or should have been loved and the reproaches against such a person are not directed to the person but shifted to the self" (Sigmund Freud, "Mourning and Melancholia," in *Collected Papers of Sigmund Freud,* vol. iv, p. 158; The Hogarth Press, London, 1948) and are expressed as self-accusations.

This is the key to the disorder. Upon close study, the attacks on the self are revealed to be unconscious expressions of disappointment and anger or hatred toward another person, or even a circumstance or a thing, deflected from their real direction onto the self. The aggression, therefore, directed toward the outside world is turned against the self; in this process the objects of the aggressive impulses come to be viewed consciously with a sense of loss, with feelings of deprivation, and a mood and expression of despair pervades. The torment to the self in its fuller meaning becomes apparent. Hence, it is asked of the person who harbours active suicidal wishes, whom does he really wish to kill or what does he really want to destroy? What is further revealed is that the feeling of love is complicated by an admixture of hatred. The latter, operating often at an altogether unconscious level, leaves no conscious awareness, and directed toward the self is expressed in suicidal wishes or fantasies.

Thus there are three cardinal psychodynamic considerations in depression: (1) a deep sense of loss of what is loved or valued, which may be a person, a thing or even liberty; (2) a conflict of mixed feelings of love and hatred toward what is loved or highly valued; (3) a heightened overcritical concern with the self. The relative intensity of one factor over another may prevail in individual instances, but in any case the person is divided against himself. The conscious aspects are only a portion of the depression; the unconscious is responsible for most.

There are two chief methods of treatment of depression. One is psychotherapy, addressed to the secondary symptoms; it is aimed at being supportive, watchful and careful, waiting for the condition to pass over. The other is psychoanalytic treatment, which aims at a resolution of the basic conflicts of the reaction. In psychotherapy the use of sedation and anxiety- and tension-reducing drugs is often helpful. In patients who are unresponsive, or for the more severely depressed and often for older persons, shock therapy also may be used adjunctively. Most patients can be treated outside the hospital and often can continue their work, although at a reduced efficiency. Many require hospitalization, since they are unable to care for and may even be dangerous to themselves. The older the patient, the less likely is complete recovery.

See Sigmund Freud, "Mourning and Melancholia," in *Collected*

Papers, vol. iv (1948); Gregory Rochlin, "The Loss-Complex," *J. Amer. Psychoan. Ass.*, vol. vii, no. 2 (April 1959). (GY. RN.)

DEPRETIS, AGOSTINO (1813–1887), Italian statesman, important chiefly as a leading exponent of the parliamentary tactics known as *trasformismo*, was born at Mezzana Corti in Lombardy on Jan. 31, 1813, of a wealthy family of farmers. As a law student at Pavia university in 1834 he was involved in a Mazzinian escapade directed against the Austrian government. He spent many years managing the family estates, developing the administrative and financial abilities for which he later became famous. In politics he followed Mazzini as a fervid nationalist and a radical well over to the left.

In the revolutionary year of 1848, Depretis, though a Lombard, entered the Piedmontese parliament at Turin, siding with the democratic opposition against Cavour, remaining in touch with Mazzini and active in journalism. But in 1853 he opposed Mazzinni's attempt at insurrection in Lombardy and showed that he was ready to abjure republicanism and accept the house of Savoy. Nearly always he continued to vote against Cavour, and he opposed joining the Crimean War. After Cavour's resignation in 1859 he became governor of Brescia in the newly annexed province of Lombardy. In 1860 Garibaldi chose him as his pro-dictator in Sicily, but there Depretis worked for Cavour in trying to secure the annexation of Sicily to Piedmont and had to resign when Garibaldi opposed it.

Depretis joined Urbano Rattazzi's cabinet in 1862 as minister of public works. This cabinet encouraged Garibaldi to try to march on Rome, but the matter was mishandled, and in the general outcry the army had to put down Garibaldi's rebellion at Aspromonte. His second ministerial post was also unlucky, for in 1866 he was minister of marine under Bettino Ricasoli when the Austrians defeated a superior Italian naval force at Lissa. Like all Italian ministers of the period, he was in office for too short a time to be responsible for the fleet's poor commanders and equipment; but he had been ill-advised to order Adm. Carlo Persano out of harbour on this occasion. Then in 1867 he was minister of finance for two months when the government connived at Garibaldi's further rebellion, which led to defeat at Mentana.

When Rattazzi died (1873), Depretis succeeded him as head of the left in parliament and developed the "program of Stradella" which called for wider suffrage, social reform and lower taxes. In 1876 Marco Minghetti was defeated in parliament and the left came to power with Depretis as prime minister. For the next 11 years he was the dominant force in Italian politics. Using every legitimate and some illegitimate means, he built up a huge majority in the 1876 elections. He resigned for a few months in 1878, but was premier again in 1879, and there was little noticeable difference between his policy and that of Benedetto Cairoli, who had intervened. Indeed, even the actual ministers themselves did not then normally change when one government technically followed another. Cairoli succeeded again, but Depretis was back in 1881 and formed a succession of different ministries until his death at Stradella on July 29, 1887.

By 1883 Depretis had perfected the art of the *trasformismo* ("transformism") by which, in order to build up his own personal following in parliament, he ignored party labels and took ministers from both right and left. Cavour and others had done much the same, but now it became the established technique of Italian parliamentarism. For a time, Crispi and the left reviled it as a means of confusing all political principle and establishing a personal "parliamentary dictatorship," but by 1887 Crispi himself had been cleverly brought inside this shifting governmental coalition. It was a clever scheme by which a prime minister could stay in office by confusing issues and developing a group system of politics which made persons more important than issues and principles.

During his term of office Depretis carried out many more reforms than his predecessors from the right: educational reforms, abolition of the harsh grist tax and the increasing of the electorate from 500,000 to nearly 3,000,000. The triple alliance with Germany and Austria was signed in May 1882 and renewed in Feb. 1887, thus ending Italy's isolation and diminishing the Italian irredentist claims against Austria. The occupation of Massawa in Eritrea (1885) launched Italy on a colonialist career, and the defeat of the Italians by the Ethiopians at Dogali (1887) showed the dangers of exaggerated nationalism. Depretis gravely impaired the stability of the budget after Minghetti and balanced it in 1876. By his *trasformismo* he helped to corrupt parliamentary liberalism.

See L. Breganze, *Agostino Depretis e i suoi tempi* (1894). (D. M. SH.)

DEPTFORD, a metropolitan borough of London, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Lewisham to form the new London borough of Lewisham (*see* LONDON). Deptford metropolitan borough is bounded by Bermondsey, the river Thames, Greenwich, Lewisham and Camberwell. Pop. (1961) 68,829. Area 2.4 sq.mi. The name (Depeford, "deep ford") is associated with a ford over the Ravensbourne, a stream entering the Thames through Deptford creek. In 1885 the parish of St. Nicholas, which included the village of Lower Deptford and also a large stretch of water frontage west of the creek, the old cattle market and part of the former gardens of Sayes court, was transferred to Greenwich. Since then Deptford has comprised only the parish of St. Paul, the church of which dates from 1712–30.

Southward from the river the land rises, on a low gravel terrace, to 154 ft. on Telegraph hill. The southern part of Deptford is largely residential, factories increasing in number toward the river. There is a variety of industries, one of the chief of which is the timber import-export business that Deptford shares with Rotherhithe, the adjoining district up the river; many timber wharves front the Surrey canal that leads down to the Surrey docks in Rotherhithe.

Henry VIII established a royal naval dockyard at Deptford in 1513 and the shipbuilding industry flourished until wooden ships gave place to iron. Later it became the Royal Victoria Victualling yard and is now an army supply depot. Trinity House (*q.v.*) was founded in 1514 by Henry VIII but moved to Stepney in the 17th century and to Tower hill in 1795. Sayes court was demolished in 1729, after having been the residence of the duke of Sussex in the reign of Elizabeth I, of John Evelyn in the 17th century and of Peter the Great during his short stay in Deptford in 1698. Part of the gardens is now Deptford park (17 ac.). The Goldsmith's college, New Cross, was built in 1843 and the town hall in 1900–03.

DEPTH SOUNDER: *see* ECHO SOUNDER.

DE QUINCEY, THOMAS (1785–1859), the author of *Confessions of an English Opium-Eater*, was born on Aug. 15, 1785, at Manchester, and was the fifth of the eight children of Thomas Quincey. He hardly knew his father, a prosperous gentleman-merchant who died when his son was seven, and was brought up by his mother, who added the prefix "De" to the family name. Throughout his life he was profoundly influenced by his early experiences, as he reminds us again and again in his writings; but here only the main outward events can be recorded. He was deeply moved by the death of one of his sisters when he was six (another sister had died when he was two). At Bath grammar school he was already remarkable for his precocious knowledge of Latin. After a period of tuition and a brief spell at a small private school he was sent to Manchester grammar school, where he was (on the whole) kindly treated, but continued to be unhappy. After 18 months there he ran away, and there followed eight months in Wales and London which were of central importance in his development. His money was soon exhausted and he experienced a series of adventures which culminated in his close but innocent friendship with Ann, a young prostitute for whom he afterward searched London in vain. At the end of 1803 he went to Worcester college, Oxford, then a hard-drinking society where (as at school) he felt himself to be an outcast or "pariah." About this time he abandoned his early poetical ambitions, wishing instead to become "the intellectual benefactor" of mankind by being "the first founder of a true Philosophy." It was in March 1804 that he first took opium, to relieve the pain of acute facial neu-

ralgia. This was the initiation that was to have so much to do with shaping his whole future life.

De Quincey was one of the first to appreciate the importance of the *Lyrical Ballads* and during the second period of his life he was for a while closely associated with the Lake community. He first met Wordsworth and Coleridge in 1807: two years later he rented Dove cottage, Grasmere, which was to remain his headquarters on and off until 1833. In 1813 he became "a regular and confirmed opium-eater," keeping a decanter of laudanum by his elbow and steadily increasing the dose. Meanwhile he became estranged from the Wordsworths and married Margaret Simpson, a beautiful local girl who had already borne him a son. His financial affairs went from bad to worse and after many invitations to contribute to periodicals he wrote two articles called *Confessions of an English Opium-Eater* which appeared in Taylor and Hessey's *London Magazine* in 1821 and were reprinted as a small book the following year. The first version of the *Confessions* is very different from the text usually reprinted. One notices particularly the unusual combination of introspective penetration and an unexpected journalistic astuteness. We are going to hear of forbidden things, but only for our own good: it is time that the thinking part of the community should know of the growing menace of opium-eating. De Quincey refuses to accept any blame for his own opium-eating, however, and in the same way he insists on the innocence of his association with the outcasts and prostitutes who had been his friends in London. There is something reassuringly domestic about the whole thing: "These troubles are past," he writes, addressing his wife (whom he calls his Electra): "and thou wilt read those records of a period so dolorous to us both as the legend of some hideous dream that can return no more."

In fact, as he confessed in an appendix, De Quincey had not made his escape from opium. He was to remain an opium-eater for the rest of his life and it is not surprising that near the end of it he should have seized the opportunity provided by the appearance of a collected edition of his works to revise the book that had made him famous. He wished its "crowning grace" to be an account of the "dreams and noonday visions" that had come as a result of opium; but when he found that he had lost most of the accounts which he had been keeping of his visions he had to expand the book in some other way. He therefore lengthened the account of his early years, added numerous digressions and rewrote the whole book in a more elaborate (and frequently verbose) style. The result is less unified than the *Confessions* of 1822 and closer to ordinary autobiography: two-thirds of the book are over before opium makes its appearance. The differences of emphasis and opinion between the two texts are of great interest. De Quincey's attitude to opium (for example) has changed. In 1822, though there are inconsistencies, his main aim is to warn his readers of the dangers of opium: in 1856 he is mainly concerned with the medical value of opium and (more particularly) its mysterious powers "over the grander and more shadowy world of dreams."

The more highly wrought and involved style of the *Confessions* of 1856 throws light on De Quincey's own development and on changes in English taste in the Victorian period. Words and turns of phrase that might be regarded as colloquial or vulgar are softened or replaced by circumlocutions, notably in the passages dealing with the London prostitutes. Although some passages are revised for the better, the 1822 text is in general more impressive than that of 1856 and it is with the earlier form of the *Confessions* that a reader new to De Quincey should begin.

During the period of nearly 40 years left to him after the original publication of his *Confessions*, De Quincey led a wandering life, moving from one friend's house to another, one set of lodgings to another, in London, Edinburgh and Glasgow. He fought a losing battle against insolvency, contributing voluminously to *Blackwood's* and other periodicals of the day. Editors treated him with remarkable forbearance and although he shunned society those who met him were charmed by his old-fashioned politeness and the astonishing flow of his conversation when he felt himself to be among friends. He had frequently to take refuge from his creditors at Holyrood and it was there that his wife died in 1837. His last task was to revise his work for a collected edition. He died in Edinburgh on Dec. 8, 1859.

As his writings remind us, De Quincey was—as he himself said of Coleridge—a "*Polyhistor*, or catholic student." He wrote on history, biography, economics (stimulated by Ricardo) and many other subjects. Of his works, the more significant are his autobiographical writings, his literary criticism and the unfinished *Suspiria de Profundis*. In the *Autobiographic Sketches* his aim is to trace the development of his own mind. In spite of the handicap that he had already described the most dramatic episode in his life, several of the chapters throw a good deal of fresh light on their creator, while others illuminate the changes that had taken place in England during his lifetime, what he calls "the shifting scenery and moving forces of the age." The *London Reminiscences* (as David Masson, his editor, called them) describe De Quincey's association with the brilliant group of writers who contributed to the *London Magazine* in its heyday. The *Lake Reminiscences*, which gave deep offense to Wordsworth and his friends, remain of great interest, although they are (of necessity) highly subjective and unreliable in matters of detail. As De Quincey himself remarks, through the ruin of his own mind he "looked into and read the latter states of Coleridge."

As a literary critic De Quincey has been underestimated. Unlike Charles Lamb (for example) he was not a literary antiquarian. The writers who interested him were the classical authors of antiquity and the major writers of modern times. Of the 17th-century poets, Milton is the only one on whom he wrote at length, of the 18th, Pope; and on both men he has some valuable observations to make. His only essay on Shakespeare deals with the effect made by the knocking on the gate in *Macbeth* and stands out as a brilliant piece of psychological criticism. The nearest approach to a formal critique in his work deals with the *Lyrical Ballads*, the discovery of which he described as "the greatest event in the unfolding of his own mind." He points out that Wordsworth's theory of diction is historically untenable and goes on to write most penetratingly on the nature of his poetic imagination. His own criticism owes a good deal to Wordsworth and Coleridge, yet he has been given too little credit for the results of his own life-long meditation on the nature of poetry and the use of criticism. It is worth remembering his remark that "in the sense of absolute and philosophic criticism, we have little or none; for, before that can exist, we must have a good psychology, whereas, at present, we have none at all."

The aim of *Suspiria de Profundis* was to expound the philosophy of life which had formulated itself in his mind as a result of his sufferings. A key to the whole scheme may be found in *The Posthumous Works*. "The Daughter of Lebanon," printed at the end of the *Confessions* in 1856, is a splendid fragment of the work which brilliantly exemplifies his ideal of "impassioned prose." The theme of the *Suspiria* as a whole was to be that pain and grief are essential to the development of the soul, but that this truth becomes apparent only to exceptional people and to them only when the original experience has sloughed off its "accidents" and assumed a universal and perhaps symbolical form in the mind. in a dream or reverie years later. This was to be the final fruit of a lifetime's meditation and there are few unfinished works in the history of literature which one would give more to possess in completed form.

BIBLIOGRAPHY.—De Quincey himself was responsible for *Selections Grave and Gay, From Writings . . . of Thomas De Quincey*, 14 vol. (1853–60). The text is revised and contains the first ed. of the longer version of the *Confessions*. The standard collected edition (which is not wholly satisfactory) is *The Collected Writings*, ed. by David Masson, 14 vol. (1889–90). *See* also *The Posthumous Works*, ed. by A. H. Japp, 2 vol. (1891, 1893); *The Uncollected Writings*, ed. by James Hogg, 2 vol. (1890); *A Diary of T. De Quincey, 1803*, ed. by H. A. Eaton (1927); *De Quincey's Literary Criticism*, ed. by H. Darbishire (1909). The 1822 text of the *Confessions* has been reprinted several times. Malcolm Elwin's ed. (1956) gives both texts, with a long biographical introduction. The best biographies are A. H. Japp, *Thomas De Quincey: His Life and Writings*, rev. ed. (1890); H. A. Eaton, *Thomas De Quincey* (1936); E. Sackville West, *A Flame in Sunlight* (1936). *See* also *De Quincey Memorials*, ed. by A. H. Japp, 2 vol. (1891); *De Quincey and His Friends*, ed. by James Hogg (1895); Sir Leslie Stephen, "De Quincey," in *Hours in a Library*, 1st series, pp. 349–

392 (1874); M. H. Abrams, *The Milk of Paradise* (1934)—on the influence of opium on De Quincey, Coleridge and others; J. E. Jordan, *De Quincey: Literary Critic* (1952); Ian Jack, "De Quincey Revises His *Confessions*," *Publications of the Modern Language Association of America*, vol. lxxii, no. i, pp. 122–146 (March 1957). Baudelaire was keenly interested in De Quincey—"Un Mangeur d'Opium" (the second half of *Les Paradis Artificiels*, 1860) is a very free paraphrase of the *Confessions*. Fuller bibliographies may be found in the *Cambridge Bibliography of English Literature*, vol. iii (1940) and vol. v (1957) and in *The English Romantic Poets and Essayists*, ed. by Northrop Frye and others (1957). (I. J.)

DERA GHAZI KHAN, a municipality and district in the Multan division of West Pakistan. The town, headquarters of the district, was founded at the close of the 15th century and named after the son of a Baloch chieftain, a feudatory of the Langah sultans of Multan, who made himself independent about 1480. The greater part of the city was washed away by the Indus in 1908–09. The new town, built nearby, lies about 50 mi. W. of Multan where the road from Multan to Quetta crosses that from Jacobabad to Dera Ismail Khan. Pop. (1961) 47,105. It is connected by road over the Taunsa barrage (45 mi. N.) with Kot Adu on the Campbellpur-Multan line, and by a bridge of boats with Ghazi Ghat, on the opposite bank of the Indus and thence with Muzaffargarh (38 mi.). There is a government college affiliated with the University of the Punjab. The town's chief products are wooden toys.

Dera Ghazi Khan District, in the southern part of the tract known as Derajat, is a narrow strip of country, 198 mi. long (north to south), sloping gradually from its western boundary, the Sulaiman hills, to the Indus. Pop. (1961) 776,620. Area 9,359 sq.mi. The hill torrents deposit silt and are dammed at various points to provide water for irrigating a strip 30 to 40 mi. wide. The low-lying tract along the river is irrigated by inundation canals. The latter is known as Sind and the rest Pachhad. In 1958 the Taunsa barrage was completed and construction of new canals was begun. An area, including the Biloch tract and the Barkhan subdivision of Loralai, was added to the district in 1955; this is now known as the "excluded area." The Biloch tract, occupied by Baloch tribes, most of whom are Muslims, lies in the hills to the west. The principal products of the district are wheat and millets. (K. S. Ad.)

DERAIN, ANDRÉ (1880–1954), French painter, whose works embody several of the most influential art movements of the early 20th century, was born at Chatou, Seine-et-Oise, June 10, 1880. He studied at the Académie Julian (1898) and Académie Carrière. Between 1899–1902 he worked with Vlaminck at Chatou. He then painted in the south of France with Matisse (1905) and became identified with the Fauve movement. In 1910 he worked with Picasso in Spain, and painted a few cubist pictures. Cézanne's style absorbed Derain next, and he traveled in France painting landscapes. About 1912 his interest in the primitives developed, and he began to paint more still lifes. After his release from military service (1919) he traveled in Italy (1921). In his maturity Derain became more concerned with the French tradition of Courbet, Corot, Delacroix and Renoir, and he painted many classical landscapes, still lifes, portraits and nudes. Derain illustrated numerous books and created designs for S. Diaghilev's ballets. He died at Garches, Seine-et-Oise, Sept. 10, 1954.

DERA ISMAIL KHAN, a district headquarters, district and division of West Pakistan. The town is situated near the right bank of the Indus, which during half the year is crossed by a bridge of boats to Darya Khan (12 mi.), a railway station (Peshawar-Multan line) on the left bank of the river. Pop. (1961) 46,140. The name is taken from Ismail Khan, a son of Malik Sohrab Khan Hot, a Baloch chief whose tribe, toward the end of the 15th century, occupied the northern part of the land between the Sulaiman hills and the Indus as a fiefdom of the Langah Sultan Husain of Multan. The old town was situated about 4 mi. E. of the present town and was washed away by the Indus in 1823. The new town was laid out at the present site by Durrani chiefs. The town has a 2½-mi. circular road around it. There are four main gates which are connected with metaled roads crossing each other at right angles, along which lie the four main bazaars. The town hall, government college, civil hospital, Circuit house and government offices are outside the circular road. There is an airstrip to the northeast. The town has no modern amenities. Most of the property left by the non-Muslims who emigrated on the partition of the subcontinent lies in ruins, adding to the untidy appearance of the place. There are two public parks. The town is famous for its lacquered woodwork, glasswork, mat and ivory work and lungis (sarongs).

Dera Ismail Khan District (area 4,723 sq.mi.; pop. [1961] 382,746) forms an irregular triangle with its base in the north marked by the Bhittanni and Marwat ranges, its eastern border by the Indus and its western by the Shirani and Sulaiman hills. Its southern extremity, barely 20 mi. broad, adjoins the district of Dera Ghazi Khan. It is mostly alluvial plain divided into the *kachi* or Indus riverain and the *daman* or area lying between the *kachi* and the hills. The *kachi* is a narrow strip of alluvial land beneath the old bank of the Indus, partly overgrown with jungle and tall grasses. It is cultivated by means of wells or with the aid of floodwater. The Paharpur canal, which takes off from the Indus near Bilot, passes through the town of Dera Ismail Khan and falls back into the river below it, after irrigating the adjoining area of the *daman*. The *daman* ("skirt of the hills") is strictly only the tract immediately beneath the hills but the term is used for the whole area from the hills to the *kachi*. It is intersected by numerous torrents which form deep valleys in its level expanse. The soil is hard clay and the embanked fields are cultivated with the help of water from streams, hill torrents and surface drainage. Outside the irrigated and cultivated area the plain is without trees and grass, except for a few scattered bushes. Wheat and bajra (*Pennisetum typhoideum*) are the staple crops, with gram and jowar (*Sorghum vulgare*) occupying smaller areas. Camels are extensively bred in the *daman* and many sheep are grazed. The climate is dry and fairly healthy. Temperatures rise to over 100° F. in summer, but the winters are cold with severe frosts. The district is the junction of Pathan and Balochi tribes, the Pathan element predominating. The chief frontier tribes are the Sheranis, Ustaranas and Bhittannis. Administratively the district is divided into Dera Ismail Khan, Kulachi and Tank tehsils and the special area under the deputy commissioner.

Dera Ismail Khan Division, formed in 1955 when West Pakistan became a single province, now consists of Dera Ismail Khan and Bannu districts, including the special areas attached to them. Wheat, millets, gram, rape and mustard are the chief crops. About 21.6% of the cropped area is irrigated. The area is 11,130 sq.mi. and the population was 1,205,719 in 1961. (K. S. Ad.)

DERBENT (Derbend), a town in the Dagestan Autonomous Soviet Socialist Republic of the U.S.S.R., is situated on the southwestern shore of the Caspian sea at the foot of the eastern hills of the Greater Caucasus, on the Baku-Makhachkala railway. Pop. (1959) 42,300. It is a wool and silk spinning centre, and there are fruit and fish canning factories and a wire factory. There are agricultural, medical and teachers' training institutes, a Lezgian national theatre and a museum. It was founded in the 6th century A.D. by the Persians as a defense post against northern invaders guarding a pass known as the Caspian or Iron Gates. Derbent was captured by the Arabs in 728 and by the Mongols in 1220, and was incorporated in the Russian empire in 1813. There are many ancient monuments, including remains of the ancient Caucasian or Alexander wall and gates dating back to the 6th century, a congregational mosque (8th century) and some ancient caravansaries, cisterns and baths. (G. E. Wr.)

DERBY, EARLS OF. The 1st earl of Derby was probably Robert de Ferrers (d. 1139), son of one of the Domesday commissioners, who owned lands in Normandy, Derbyshire and Staffordshire. Robert is said to have been made an earl by King Stephen after the battle of the Standard in 1138. He and his descendants retained the earldom until 1266, when Robert (*c.* 1239–79), the 6th earl, having taken a prominent part in the baronial rising against Henry III, was deprived of his lands and practically of his title. These earlier earls of Derby were also known as Earls Ferrers or de Ferrers from their surname; as earls of Tutbury from their residence; and as earls of Nottingham because this county was a lordship under their rule.

The large estates which were taken from Earl Robert in 1266 were given by Henry III to his son Edmund, earl of Lancaster, and Edmund's son Thomas, earl of Lancaster, called himself Earl Ferrers. Thomas was beheaded in 1322, however, and all his honours were forfeited. In 1337 Edmund's grandson Henry (*c.* 1299–1361), afterward duke of Lancaster, was created earl of Derby and this title was taken by Edward III's son, John of Gaunt, who had married Henry's daughter Blanche. John of Gaunt's son and successor was Henry, earl of Derby, who became king as Henry IV in 1399, all his honours being merged in the crown.

In Oct. 1485 Thomas, Lord Stanley, was created earl of Derby, and the title was thenceforth retained by the Stanleys. Thomas also inherited the sovereign lordship of the Isle of Man, granted by the crown in 1406 to his great-grandfather Sir John Stanley, and this sovereignty remained in possession of the earls of Derby till 1736, when it passed to the duke of Atholl.

The earl of Derby is one of the four "catskin earls," the others being the earls of Shrewsbury, Huntingdon and Pembroke. The term "catskin" is possibly a corruption of *quatre-skin*, derived from the fact that in ancient times the robes of an earl (as depicted in some early representations) were decorated with four rows of ermine, as in the robes of a modern duke, instead of the three rows to which they were restricted in later centuries. The "catskin" earldoms are the only earldoms in existence which date from creations prior to the 17th century, except those which are merged in higher titles.

THOMAS STANLEY, 1st earl of Derby (*c.* 1435–1504), was the son of Thomas Stanley, who was created Baron Stanley in 1456 and died in 1459. His grandfather Sir John Stanley (d. 1414) had founded the fortunes of his family by marrying Isabel Lathom, the heiress of a great estate in the hundred of West Derby in Lancashire, from whom was also derived the well-known Stanley crest of the eagle and child. The future earl of Derby was a squire to Henry VI in 1454, and not long afterward married Eleanor, daughter of the Yorkist leader Richard Neville, earl of Salisbury, and sister of "Warwick the kingmaker." At the battle of Blore Heath in Aug. 1459 Stanley, though close at hand with a large force, did not join the royal army, while his brother William fought openly for York. In 1461 Stanley was made chief justice of Cheshire by Edward IV, but ten years later he sided with his brother-in-law Warwick in the Lancastrian restoration. Nevertheless, after Warwick's fall, Edward made Stanley steward of his household. Stanley served with the king in the French expedition of 1475 and with Richard of Gloucester in Scotland in 1482. About the latter date he married, as his second wife, Margaret Beaufort, mother of the exiled Henry Tudor.

Stanley was one of the executors of Edward IV and was at first loyal to the young king Edward V. However, he acquiesced in Richard's accession and retained his office as steward, avoiding entanglement in the duke of Buckingham's rebellion on behalf of Henry Tudor (1483) in which his wife was deeply involved. He was made constable of England in succession to Buckingham and was granted possession of his wife's estates with a charge to keep her safe in some secret place at home. Richard could not well afford to quarrel with so powerful a noble, but he became suspicious when, early in 1485, Stanley asked leave to retire to his estates in Lancashire, and in the summer Richard asked Stanley to send his son Lord Strange to court as a hostage. After Henry Tudor had landed, Stanley made excuses for not joining the king; for his son's sake he was obliged to temporize. Both Thomas and William Stanley took the field, but while William was in treaty with Henry, Thomas professed to support Richard. On the morning of Bosworth (Aug. 22), however, when Richard summoned Thomas to join him he received an evasive reply and thereupon ordered Lord Strange to be executed, although his order was neglected and Strange escaped. In the battle it was William who turned the scale in Henry's favour, but Thomas, who had taken no part in the fighting, placed the crown on Henry's head. Henry VII confirmed him in all his offices and created him earl of Derby. As husband of the king's mother Derby held a great position, which was not affected by the treason and execution of his brother William in Feb. 1495. He died at Lathom on July 29, 1504. Lord Strange had died in 1503, and his son Thomas succeeded as 2nd earl.

EDWARD STANLEY, 3rd earl of Derby (1509–72), second son of the 2nd earl, succeeded to the earldom on his father's death in May 1521. During his minority Cardinal Wolsey was his guardian, and as soon as he came of age he began to take part in public life. He helped to quell the rising known as the Pilgrimage of Grace in 1536 but, remaining true to the Roman Catholic faith, he disliked and opposed the religious changes made under Edward VI. Under Elizabeth his younger sons, Sir Thomas (d. 1576) and Sir Edward Stanley (d. 1609), were concerned in a plot to free Mary, queen of Scots, and he himself was suspected of disloyalty. He died at Lathom house, near Ormskirk, on Oct. 24, 1572.

Derby's first wife was a daughter of Thomas Howard, duke of Norfolk, by whom he had a son HENRY, the 4th earl (*c.* 1531–93), who was a member of the Council of the North and, like his father, was lord lieutenant of Lancashire and Cheshire. Henry was one of the commissioners who tried Mary, queen of Scots, and was employed by Elizabeth on other high undertakings both at home and abroad. He died on Sept. 25, 1593, at Lathom. His wife Margaret (d. 1596), daughter of Henry Clifford, 2nd earl of Cumberland, was descended through the Brandons from King Henry VII. Two of his sons, FERDINANDO (*c.* 1559–94) and WILLIAM (*c.* 1561–1642), became in turn 5th and 6th earls of Derby. Ferdinando wrote verses and is eulogized by Edmund Spenser under the name of Amyntas.

JAMES STANLEY, 7th earl of Derby (1607–51), sometimes styled the Great Earl of Derby, eldest son of William, 6th earl, and Elizabeth de Vere, daughter of Edward, 17th earl of Oxford, was born at Knowsley, Lancashire, on Jan. 31, 1607. During his father's life he was known as Lord Strange. He was returned to parliament for Liverpool in 1625, received high offices in the north of England and on March 7, 1628, entered the house of lords as Baron Strange. When the Civil War broke out in 1642, Lord Strange devoted himself to the king's cause. His plan of securing Lancashire at the beginning and raising troops there, which promised success, was, however, discouraged by Charles, who was said to be jealous of his power and royal lineage and who commanded his presence at Nottingham. His subsequent attempts to recover the county were unsuccessful. After several defeats he left for the Isle of Man in June 1643 to deal with the disturbances which had broken out there, and in the summer of 1644 he took part in Prince Rupert's successful campaign in the north, when Lathom house, where Lady Derby had heroically resisted the attacks of the besiegers, was relieved and Bolton castle taken. He followed Rupert to Marston moor and after the complete defeat of Charles's cause in the north withdrew to the Isle of Man, where he held out for the king and offered an asylum to royalist fugitives. His administration of the island was strong rather than just. In July 1649 he refused scornfully terms offered to him by Henry Ireton. By the death of his father on Sept. 29, 1642, he had succeeded to the earldom, and on Jan. 12, 1650, he was nominated knight of the Garter and was chosen by Charles II to command the forces of Cheshire and Lancashire in the proposed royalist rising. On Aug. 15, 1651, he landed at Wyre Water in Lancashire and met Charles on the 17th. Proceeding to Warrington, he failed to obtain the support of the Presbyterians through his refusal to take the Covenant, and on the 25th was totally defeated at Wigan, being severely wounded and escaping with difficulty. He joined Charles at Worcester; after the battle he accompanied him to Boscobel and, while on his way north alone, was captured near Nantwich and given quarter. He was tried by court-martial at Chester on Sept. 29, his quarter was disallowed and he was condemned to death. When his appeal for pardon to parliament was rejected, though supported by Cromwell, he endeavoured to escape, but was recaptured and executed at Bolton on Oct. 15, 1651. He was buried in Ormskirk church. According to Clarendon, Derby was "a man of great honour and clear courage," and his defects the result of too little knowledge of the world. His political usefulness was handicapped by his dislike of the Scots. He was the author of several volumes of historical collections, observations and devotions and a commonplace book, as well as of a discourse on the government of the Isle of Man.

Some of these were later published in the *Stanley Papers*. He married in 1626 Charlotte de la Trémoille (1599–1664), daughter of Claude, duc de Thouars, and granddaughter of William the Silent, prince of Orange, by whom he had five sons and four daughters. The eldest son, CHARLES (1628–72), succeeded him as 8th earl.

Charles's two sons, WILLIAM, the 9th earl (*c.* 1655–1702), and JAMES, the 10th earl (1664–1736), both died without sons, and consequently, when James died in Feb. 1736, his titles and estates passed to SIR EDWARD STANLEY (1689–1776), a descendant of a brother of the 3rd earl. From him the later earls were descended. The 12th earl (1752–1834), who in 1780 founded the race called, after him, the Derby stakes, was his grandson. His son, EDWARD SMITH (1775–1851), the 13th earl, sat in parliament as a Whig from 1796 until 1832, when he was called into the house of lords as Baron Stanley of Bickerstaffe to support Lord Grey. He took little part in politics but was keenly interested in zoology and set up a private menagerie at Knowsley. He was president of the Linnean and Zoological societies. He died at Knowsley on June 30, 1851, and was succeeded by his eldest son, the 14th earl (*see* DERBY, EDWARD GEORGE GEOFFREY SMITH STANLEY).

EDWARD HENRY STANLEY, 15th earl of Derby (1826–93), eldest son of the 14th earl, was educated at Rugby and Trinity college, Cambridge, where he took a first in classics and became a member of the society known as the Apostles. In March 1848 he unsuccessfully contested the borough of Lancaster and then made a long tour in the West Indies, Canada and the United States. During his absence he was elected member for King's Lynn, which he represented till Oct. 1869, when he succeeded to the peerage. In 1852, while traveling in India, he was appointed undersecretary for foreign affairs in his father's first administration. From the outset of his career he was known to be a most liberal Conservative, and in 1855 Lord Palmerston offered him the post of colonial secretary. He was tempted by the proposal and hurried down to Knowsley to consult his father, who called out when he entered the room, "Hallo, Stanley! what brings you here? Has Dizzy cut his throat, or are you going to be married?" The offer was declined. In his father's second administration Lord Stanley first held the office of secretary for the colonies and then became president of the board of control on the resignation of Lord Ellenborough. He had charge of the India bill of 1858 in the house of commons, became the first secretary of state for India and left behind him in the India office an excellent reputation. When the Greeks were looking for a king after the death of King Otho and the crown was refused by Queen Victoria for her son Alfred, there was some idea of inviting Stanley to take the vacant throne but the offer was never formally made. After the fall of the Russell government in 1866 he became foreign secretary in his father's third administration. He compared his conduct in that great post to that of a man floating down a river and fending off from his vessel, as well as he could, the various obstacles it encountered. He thought that that should be the normal attitude of an English foreign minister.

Under Prussian pressure, he arranged the collective guarantee of the neutrality of Luxembourg in 1867; he also negotiated a convention about the "Alabama," which, however, was not ratified by the U.S. senate. In 1874 he again became foreign secretary in Disraeli's government. He acquiesced in the purchase of the Suez canal shares; he accepted the Andrassy note urging reforms upon the Turkish sultan, but declined to accede to the Berlin memorandum which called upon him to expedite them. His part in the later phases of the Russo-Turkish struggle has never been fully explained, but it is clear that both the queen and Lord Beaconsfield (as Disraeli had now become) had lost confidence in him by Aug. 1877; indeed Beaconsfield pursued that autumn a foreign policy of his own, without Derby's knowledge. Derby resigned at the end of March 1878. By Oct. 1879 it was clear that he had thrown in his lot with the Liberal party, but it was not till March 1880 that he publicly announced this change of allegiance. He did not at first take office in the second Gladstone government, but became secretary for the colonies in Dec. 1882, holding this position till the fall of that government in the summer of 1885. In 1884 he was created knight of the Garter. In 1886 Derby joined the Liberal Unionists and took an active part in the general management of that party, leading it in the house of lords till 1891. He died at Knowsley on April 21, 1893.

During a great part of Derby's life he was deflected from his natural course by the accident of his position as the son of the leading Conservative statesman of the day. From first to last he was at heart a moderate Liberal. His chief defect as a statesman was that in his anxiety to arrive at the right conclusions he too often turned a subject over till the time for action had passed. He also disliked foreigners, and this dislike combined with his characteristic indecision made him an unfortunate choice as foreign secretary.

Although he cared but little for what is commonly known as society—the society of crowded rooms and fragments of sentences—he very much liked conversation. His talk was generally grave, but every now and then was lit up by dry humour. A friend once said to him, after he had been buying some property in southern England: "So you still believe in land, Lord Derby." "Hang it," he replied, "a fellow must believe in something!" He did much work outside politics. He was lord rector of the University of Glasgow from 1868 to 1871 and of Edinburgh from 1874 to 1877. He succeeded Lord Granville as chancellor of the University of London in 1891. From 1876 to 1893 he was president of the Royal Literary fund and attended closely to his duties there. He lived much in Lancashire, managed his enormous estates with considerable skill and did a great amount of work as a local magnate. He married in 1870 Maria Catharine, daughter of the 5th earl de la Warr and widow of the 2nd marquess of Salisbury.

The earl left no children and he was succeeded as 16th earl by his brother FREDERICK ARTHUR STANLEY (1841–1908), who had been made a peer as Baron Stanley of Preston in 1886. He sat in the commons for various seats in Lancashire (1865–86), and after useful work as undersecretary became secretary for war (1878–80) and for the colonies (1885–86). He was governor general of Canada from 1888 to 1893, and was made knight of the Garter in 1897. By his wife, Lady Constance Villiers, eldest daughter of the 4th earl of Clarendon, he had seven sons and a daughter. He died on June 14, 1908, worth nearly £4,000,000.

His eldest son, EDWARD GEORGE VILLIERS STANLEY, 17th earl of Derby (1865–1948), born in London on April 4, 1865, was M.P. for the West Houghton division of Lancashire from 1892 to 1906. He was a junior lord of the treasury (1895–1900) and financial secretary to the war office (1900–03), though absent for a year at the South African War in 1899–1900, first as chief press censor and then as private secretary to Lord Roberts. In 1903 he became postmaster general, resigning in Dec. 1905 with the rest of the Conservatives. In 1914 he was made knight of the Garter, the 15th member of his line to join that order.

In Oct. 1915 he became director of recruiting and introduced the "Derby scheme," the last attempt to create a large volunteer army. In July 1916 he was made undersecretary and in December secretary of state for war. He was trusted by his friend King George V and strongly supported Lord Haig and Sir W. R. Robertson; this support made him unpopular with some of his colleagues, especially with Lord Milner and with the prime minister, Lloyd George. In April 1918 he was transferred to be ambassador in Paris, a post he held till Nov. 1920. From Oct. 1922 to Jan. 1924 he was once more war secretary, under Andrew Bonar Law and Stanley Baldwin. Though he never held office again—perhaps because he was thought too indecisive by close colleagues—he retained extraordinary influence in Lancashire. This influence rested partly on the tradition of his family and partly on his great wealth, but mainly on his personal character as an upright, shrewd and kindly man. He died at Knowsley on Feb. 4, 1948.

His grandson EDWARD JOHN STANLEY, M.C. (b. 1918) succeeded him as 18th earl. (M. R. D. F.; X.)

DERBY, EDWARD GEORGE GEOFFREY SMITH STANLEY, 14TH EARL OF (1799–1869), English statesman, leader of the Conservative party from 1846 to 1868, three times prime minister and one of England's greatest parliamentary orators, was born at Knowsley, Lancashire, on March 29, 1799, grand-

son of the 12th earl and eldest son of Lord Stanley (afterward 13th earl). After 1834, when his father succeeded to the earldom, he himself was styled by courtesy Lord Stanley; he was called up to the house of lords with that title in 1844, and succeeded to the earldom in 1851. Educated at Eton and at Christ Church, Oxford, he was elected to parliament as a Whig in 1820. His first office was the undersecretaryship of state for war and the colonies, which he held under Lord Goderich in 1827–28. He became chief secretary for Ireland in Lord Grey's government in 1830, and entered the cabinet the following year.

Stanley was a vigorous defender of the Protestant ascendancy in church and state. His family had large estates in Ireland, and he was responsible for much important Irish legislation. In 1832 he promoted an act for the compulsory composition of tithes, a parliamentary reform act and a remarkably ambitious act establishing a national system of state-aided education. There followed in 1833 a stringent coercion act and the Irish Church Temporalities act. In carrying through these measures, all highly controversial, Stanley showed himself "a masterful and drastic administrator" and a brilliant speaker. It was generally felt that Daniel O'Connell, powerful as he was, had fairly met his match in Stanley, who, with invective scarcely inferior to his own, evaded no challenge, ignored no argument, and left no taunt unanswered. This was in some ways the peak of his political career, and the moment when Sir Edward Bulwer (after Lord) Lytton's famous lines about him in *The New Timon* were most applicable:

> The brilliant chief, irregularly great,
> Frank, haughty, rash—the Rupert of debate.

In 1833 he became secretary of state for war and the colonies, and introduced and carried the act abolishing slavery in the British empire.

At the height of his parliamentary success, in May 1834, Stanley resigned from the cabinet, in company with the duke of Richmond, the earl of Ripon (formerly Lord Goderich) and Sir James Graham. They disagreed with their colleagues over the Irish Church question, being entirely opposed to the appropriation of ecclesiastical revenues to secular purposes. They attracted to themselves a following of between 50 and 100 members of parliament. O'Connell, misquoting from George Canning's *The Loves of the Triangles*, gave the party a nickname which stuck:

> Down thy hill, romantic Ashbourne, glides
> The Derby dilly, with his six insides.

(The "six insides" seem to have been Stanley and Graham together with their four most important supporters in the commons: Lord George Bentinck, Sir Stratford Canning, Henry Gally Knight and Sir Matthew Ridley.) For a year the "Dilly" held the balance in the house. Stanley and Graham declined to join Sir Robert Peel's Tory government, formed after the fall of the Whigs in Nov. 1834. They probably hoped for an opportunity to form a ministry themselves. But, with the conclusion in May 1835 of the "Lichfield House compact" between Whigs, Radicals and the Irish, the Whigs under Lord Melbourne returned to power, and the third party's chances were gone. Stanley and his friends soon became indistinguishable from Tories.

When Peel came to power in 1841, Stanley again went to the colonial office. There his work was unremarkable, but he made an unsuccessful attempt to carry a measure of Irish land reform in 1845. At the end of 1845, when Peel finally declared in favour of repealing the corn laws, Stanley was the only member of the cabinet who refused to support him. He at once became the recognized leader of the protectionists, with Lord George Bentinck and Benjamin Disraeli as his lieutenants in the commons. The party was small, inexperienced, discontented and unpopular, but the state of parties in the house of commons was so confused that in Feb. 1851 Stanley found himself commissioned to form a government. He gave up the task when he discovered that none of Peel's old colleagues would join the cabinet. The opportunity recurred in Feb. 1852, and Derby, as he now was, decided to try the experiment of governing with a purely protectionist ministry. Disraeli became chancellor of the exchequer, and the earl of Malmesbury foreign secretary. The government at once appealed to the country, but the election did not materially alter the state of parties, and in December the cabinet resigned after a defeat on Disraeli's budget. Three years later, when Lord Aberdeen's coalition was brought down because of its mismanagement of the Crimean War, Derby did not persist in trying to construct a cabinet after Lord Palmerston and W. E. Gladstone had declined to join him.

Derby became prime minister for the second time in 1858. By then his party's policy was more generally Conservative and less distinctively protectionist. This government carried two important measures, one to remove Jewish disabilities, the other to transfer the administration of India from the East India company to the crown. The question of parliamentary reform was taken up in 1859, but the bill was rejected by the commons, and a general election left the Conservatives in a minority against reunited opponents. Derby resigned in June, and for the next six years scarcely attempted to displace Palmerston's ministry. The industrial crisis in Lancashire, caused by the stoppage of the cotton supply in consequence of the American Civil War, now absorbed much of Derby's time and thought. He worked unceasingly for its relief, and subscribed several thousand pounds himself. His relations with Lancashire had always been cordial; after the cotton famine the cordiality passed into a warmer and deeper feeling.

On the rejection of Earl Russell's reform bill in 1866, Derby formed his third cabinet. Disraeli returned to the exchequer, and Derby's son, Lord Stanley, went to the foreign office. This government lasted for more than two years, and managed to settle the parliamentary reform question. Disraeli's brilliant tactics in the commons during the session of 1867 enabled the ministry to retain control of its Reform bill's progress despite the passage of numerous important amendments. Derby's description of the measure as a "leap in the dark" was eagerly caught up, since it exactly expressed an attitude very common at the time; most experienced statesmen admitted that the grant of household suffrage was a political necessity, though they dared not predict its effect on the constitution and government of the country. Declining health compelled Derby to resign office in Feb. 1868, to be succeeded by Disraeli. His subsequent appearances in public were few and unimportant, though his last speech in the house of lords, denouncing Gladstone's Irish Church bill, was marked by much of his early fire and vehemence. He died at Knowsley on Oct. 23, 1869.

Derby has no great reputation as a statesman. His abilities are indisputable, but it is questionable whether he had vision and seriousness of purpose. Especially in his youth, he often acted on rash impulses. He could be an overbearing colleague and an unnecessarily bitter foe. He had no sooner left Grey's government in 1834 than he was comparing his late colleagues to "thimbleriggers at a country fair." He disliked the drudgery of office, and never again displayed the power of application he showed under Grey. As leader of the Conservatives he seemed to Disraeli weak and indolent. In fact he is remembered less for his achievements than as the type of the aristocratic amateur in politics. Whatever he did, he did extremely well: he was a large and successful racehorse-owner, a benevolent if autocratic landlord, and a considerable classical scholar. At Oxford he had won the chancellor's Latin verse prize; it was his reputation for scholarship as well as his social and political position that led to his own election as chancellor in 1852; and in 1864 he published his blank verse translation of the *Iliad*. Still, his political career was remarkable enough. As Disraeli said: "He abolished slavery, he educated Ireland, he reformed parliament." Moreover, the Conservative party owes him a great debt for his long period of leadership. He lacked, it is true, the narrow patriotism of party: though he was loyal to the unpopular Disraeli, he realized the inadequacies of the rest of his followers and was reluctant to take office unless it was absolutely essential in order to keep them together. But he deserves much of the credit for the survival of the Protectionists through difficult years, and for educating them to accept Disraeli as his successor and to fit themselves for ultimate electoral victory.

See G. Saintsbury, *The Earl of Derby* (1892); W. D. Jones, *Lord Derby and Victorian Conservatism* (1956). (D. E. D. B.)

DERBY, a municipal, county and parliamentary borough and the county town of Derbyshire, Eng., 15½ mi. W.S.W. of Nottingham by road. Pop. (1961) 132,325. Occupying a position almost in the centre of England, the town is situated on the Derwent, at the southern end of the Pennines. It has been the centre of an important network of routes since early times and more especially since the Industrial Revolution. A little to the northeast is Little Chester, which was the site of Derventio, a Roman fort or village. Under the Heptarchy (*q.v.*) Derby was known as Northworthige, receiving its present name from Deoraby as it was known to the Danes after the peace of Wedmore (878). The first charter was granted by Henry II about 1154–56; this charter confirmed the rights of a market and other privileges granted by Henry I and William I. A charter of John (1204) gave the burgesses the right to elect their own reeve. In 1745 Prince Charles marched as far south as Derby. In 1927 Derby became a separate bishopric, after being a bishopric suffragan of Southwell. The borough returns two members to parliament.

St. Peter's church is a fine building of Perpendicular date. All Saints', with a beautiful choir screen and good stained glass, was made a cathedral in 1927. Its tower (210 ft.), built in 1509–27, is one of the finest in the midland counties. Derby Grammar school, placed in 1160 under the administration of the chapter of Darley abbey, now occupies St. Helen's house. Derby possesses a county hall (1660), assembly rooms (1763–74), a municipal technical college, a museum and art gallery (1878), a training college (1850), large cattle markets and two theatres. A town planning scheme was adopted in 1929, and further improvements to the river were also carried out. Of the many parks, the Arboretum (1840) designed by John Claudius Loudon, is one of the earliest. At Allenton, a suburb south of the town, there is a war memorial village for the disabled. The municipal airport (1938) is at Burnaston, 4 mi. S.W. of the town. Derby is the birthplace of the philosopher Herbert Spencer and of the painter Joseph Wright (1734–97).

Derby is celebrated for its porcelain; its manufacture was begun there in 1750 by William Duesbury and Andrew Planche. George III in 1773 visited the factory and gave Duesbury a patent to mark his china with a crown; thereafter it was called Crown Derby until 1890 when Victoria appointed the company manufacturers to the crown and changed its name to Royal Crown Derby. Duesbury in 1784 amalgamated at Derby the Chelsea and Bow factories of London. The china industry declined for a time but was revived from 1877 onward. Silk "throwing," or spinning by machine, was introduced in 1719 from Piedmont, Italy, by Sir Thomas and John Lombe. The fine wrought-iron gates of Lombe's mill are now next to the public library. The manufacture of silk, hosiery (helped by the inventions of Jedediah Strutt in 1758), lace and cotton formerly employed large numbers, and there are still many mills and factories making rayon, yarns and various fabrics, shirts and underwear. Canals helped the early industrial growth of the town, and in the 19th century a principal centre of the Midland railway was established in Derby; there are still large works making rolling stock. Other industries include the manufacture of aircraft engines (Rolls-Royce); heavy and general engineering; and plastics, printing, paints and chemicals.

DERBY, a city of New Haven county, Conn., U.S.: *see* Ansonia.

DERBYSHIRE, a north midland county of England, is bounded on the northeast by Yorkshire, on the east by Nottinghamshire and Leicestershire and on the west by Staffordshire and Cheshire. The area of the geographical county is 1,005.9 sq.mi.

Physical Features.—The county may be divided into two sections: the northern upland region culminating in the High Peak district, of which about 325 sq.mi. lie within the Peak District National park; and the smaller southern lowland area around Derby. It is thus a county of strong contrasts.

The great anticlinal system of the Pennines reaches its southern termination in the Derbyshire dome, which has been unroofed by erosion and now displays at its centre a large expanse of Carboniferous Limestone. It is in essence plateau country, falling slightly from the Castleton area in the north to Matlock and Wirksworth in the southeast, where it lies at about 1,000 ft. The limestone is deeply gashed by the valleys of the Wye and Dove, and in places the uniformity of its surface is broken by outcrops of volcanic rock. Parts of its margin are scarped and elsewhere it plunges steeply below the Edale Shales, the lowest member of the overlying Millstone Grit which consists of a thick series of alternating sandstones and shales. The shales, though accounting for more than half the total thickness, are easily eroded, leaving the gritstone as bold escarpments, sweeping in a great horseshoe from Axe edge near Buxton, northward by Black edge, then eastward by Rushup edge to Lose hill and Win hill. There the outcrop swings south, its lower members describing a series of zigzags where they are brought forward in subsidiary synclines, as at Bradwell and Eyam, at Bakewell and at Stanton. The higher members of the series outcrop east of the river Derwent. In the north they build fine escarpments, such as Derwent edge. Farther south they underlie Eastmoor, beveled at about 1,000 ft. South again they are sharply folded and the little anticlines of Ashover and Crich have both had their crests eroded away, the former giving rise to a charming little scarp-rimmed vale.

Beyond the horseshoe of scarps the grit builds in the north the moorlands of Kinder Scout and Bleaklow hill, more than 2,000 ft. high and clothed in heather and peat. To the west it passes below the Coal Measure rocks of the Goyt basin and to the east dips under a more extensive outcrop of the same series. Between the coal seams, which, for all their economic importance, account for only a small part of the total thickness, the Coal Measures consist of an alternating series of sandstones and shales. In the Chesterfield area they appear to have been beveled at about 650–700 ft. and then eroded into a succession of sandstone scarps and shale valleys. As the sandstones are much less thick than those of the Millstone Grit, the scarps are smaller-scale features and, on account of the complicated folding of the coal field, they follow sinuous courses. East of the valleys of the Rother and its tributary the Doe Lea is the straight north-south scarp capped by Magnesian Limestone, which overlies the Coal Measures unconformably. Though nowhere more than 613 ft. high, it is a well-marked feature. Creswell caves are situated in one of several gorges cut into its dip slope.

None of these formations above the Carboniferous Limestone makes any appearance on the southern side of the Derbyshire dome, but the succeeding Triassic marls and pebble beds, which on the east lie beyond the county boundary, wrap round the south and underlie the Trent valley, where they are to a great extent masked by boulder clay. The higher northern region of the county bears few of the marks of glaciation and much of it was probably untouched, at least by the later ice sheets. However, this section of the Trent valley formed a contact zone between ice from the north and west and ice from the east, and heavy deposits were laid down, first of boulder clay and then of fluvioglacial gravels which form marked terrace features.

The Trent lowland occupies a relatively small part of the county's total area. By far the largest portion is drained by the Derwent, virtually the whole of whose basin falls in Derbyshire. The course of this strikingly direct stream begins in the extreme north. In the area west of Sheffield it receives a sheaf of tributaries from Bleaklow hill, Kinder Scout and the northern fringe of the limestone dome. Continuing southward in a fine and always deeply cut valley, it receives the Wye at Great Rowsley, traverses the very much narrower stretch from Matlock to Ambergate and joins the Trent to the southeast of Derby. The Dove, which for most of its course coincides with the Staffordshire boundary, rises south of Buxton and joins the Trent several miles above the Derwent confluence. The Erewash drains a small area in the southeast and joins the Trent between Derby and Nottingham. A considerable area around Chesterfield falls in the basin of the Rother which flows north to join the Don, and the Goyt gathers the streams from the western side of Black edge and Kinder Scout, carrying their waters westward to the Mersey.

The winters in the uplands are generally severe and the rainfall

J. ALLAN CASH

DERWENT VALLEY NEAR AMBERGATE, DERBYSHIRE, ENG.

heavy. Mean annual rainfall ranges from 52.03 in. at Woodhead in the north to 25.59 in. at Derby in the south. At Buxton the mean January temperature is 36.1° F. compared with 39.4° at Derby and the respective July figures are 57.6° and 60°.

(A. M. F.)

History.—Important traces of the cultures of the Late Paleolithic Age were discovered at the Pinhole in the ravine of Creswell crags. The early settlement of Derbyshire was confined almost entirely to the well-drained Carboniferous Limestone lands of the Peak. The marked Derbyshire group of Beaker pots indicates an important settlement at the dawn of the age of metals around the Peak district. It is thought that the Beaker folk came from the European continent via the east coast, and groups apparently from the East Riding of Yorkshire reached the Derbyshire Peak district; others penetrated from the East Anglian coasts inland over the English plain. There are numerous megalithic remains in the same area, the largest stone circles being those of Arbor Low near Hartington, which retains most of its stones, and the "Bull Ring" at Dove Holes near Chapel-en-le-Frith. Finds of Bronze Age weapons and implements are not so numerous as in the neighbouring counties. Many defensible sites, especially in the north of the county, are capped by ancient camps which were probably in use over a great length of time. Mam tor near Castleton and Carl's Wark near Hathersage are good examples. Structures of this type were important in Romano-British and post-Roman times. The Romans were the first to utilize the lowlands to any great extent. At this period Littlechester, a camp to the northeast of Derby, became a focus of ways, receiving Ryknield street in particular. Aquae Arnemetiae (Buxton), Anavio (near Castleton) and Melandra (west of Glossop) were sites in the north.

The post-Roman centuries revived interest in the north until the conquests of the West Angles in the 6th century brought them up the valleys of the Derwent and the Dove. Later the district formed the northern division of Mercia, and in 848 the Mercian witan assembled at Repton. In the 9th century the district suffered frequently from the ravages of the Danes, who in 874 wintered at Repton and destroyed its famous monastery. Derby under Guthrum was one of the five Danish burghs, but in 918 was recovered by Aethelflaed. In 924 Edward the Elder fortified Bakewell and during 941–942 Edmund regained Derby from the Danes once more. Saxon barrows are numerous in Wirksworth hundred and the Bakewell district, among them being White-Low near Winster and Boar-Low near Tissington. There are Saxon cemeteries at Stapenhill and Foremark hall.

Derbyshire probably originated as a shire in the time of Aethelstan, but for long it maintained a close connection with Nottinghamshire and Domesday Book gives a list of customs affecting the two counties alike. The two shire courts sat together for the Domesday inquest, and the counties were under one sheriff until the time of Elizabeth I. Early divisions of the county were known as wapentakes, five being mentioned in Domesday Book, while 13th-century documents mention seven, corresponding with the six present hundreds except that Repton and Gresley were then reckoned as separate divisions. In the 14th century the divisions were described as hundreds; Wirksworth alone retained the designation wapentake until modern times. The miners of Derbyshire formed an independent community under the jurisdiction of a steward and barmasters, who held two barmote courts (*q.v.*) every year. The forests of Peak and Duffield had their separate courts and officers.

At the time of Domesday Henry de Ferrers owned almost the whole of the modern hundred of Appletree. The Ferrers estates were forfeited by Robert, earl of Derby, in the reign of Henry III. Another Domesday landholder was William Peveril, the founder of Peak castle, whose possessions were known as the honour of Peveril. In 1155 the estates were forfeited to the crown. During the reigns of John and Henry III discontent was rife in Derbyshire, and attacks were made on the central power. Riots occurred in 1443. In the 17th century the county first supported the king, but by 1643 Sir John Gell of Hopton had secured almost the whole county for the parliament. Derby, however, was always royalist and Roman Catholic in sympathy, and in 1745 entertained the young pretender, Prince Charles Edward.

Population and Administration.—The area of the administrative county (excluding Derby county borough), which contains six hundreds, is 993.2 sq.mi., with a population of 745,223 in 1961. Derby (*q.v.*; pop. 132,325) is the county town. The municipal boroughs are Buxton (19,236), Chesterfield (67,833), Glossop (17,490) and Ilkeston (34,672) (*qq.v.*). There are 16 urban districts, of which the largest are Belper (15,563), Long Eaton (30,464), Matlock (18,486) (*qq.v.*), Alfreton (22,998), Heanor (23,867), Ripley (17,601), Staveley (18,071) and Swadlincote (19,222), and there are 9 rural districts. The total number of civil parishes is 256. Ecclesiastically the county originally constituted an archdeaconry in the diocese of Lichfield. In 1884 it was transferred to the newly formed diocese of Southwell, but in 1927 was created a separate diocese of Derby, which includes the whole county except three parishes in the diocese of Peterborough.

The assizes for Nottinghamshire and Derbyshire were held at Nottingham until the reign of Henry III. Then they were held alternately at Nottingham and Derby until 1566; thereafter the Derbyshire assizes were held at Derby. The county is in the midland circuit. It has one court of quarter sessions and is divided into 17 petty sessional divisions. The boroughs of Derby and Chesterfield have separate commissions of the peace, and that of Derby has also a separate court of quarter sessions. The county returned two members to parliament from 1295 until 1832, after which it returned four members in two divisions until 1868, when six members were returned for three divisions. After 1955 the county returned ten members, one each for the following constituencies: Belper, Bolsover, Chesterfield, High Peak, Ilkeston, North-East Derbyshire, South-East Derbyshire and West Derbyshire; and two members for the county borough of Derby.

Industries and Communications.—Nearly 500,000 ac. are devoted to agriculture, but of this area not much more than one-quarter is arable land. Among the higher parts of northern Derbyshire, where the soil is poor and the climate harsh, grain will not flourish, while even in the more sheltered parts of this region the harvest is usually late. Such districts have heath pasture on which sheep are grazed, there being about 180,000 sheep in the county. Wheat and oats are the most important crops. A large part of the Trent valley is under permanent pasture, being devoted to cattle feeding and dairy farming. Cattle number about 180,000, of which roughly half are cows and heifers in milk and in calf.

Derbyshire has always been a mining and manufacturing county. The lead mines were worked by the Romans and Domesday Book mentions lead mines at Wirksworth, Matlock, Bakewell, Ashford and Crich. Iron has also been produced in Derbyshire from an early date, and coal mines were worked at Alfreton in the beginning of the 14th century. The woolen industry flourished in the county before the reign of John, when an exclusive privilege of

dyeing cloth was conceded to the burgesses of Derby. Thomas Fuller in 1662 mentions lead, malt and ale as the chief products of the county, and the Buxton waters were already famous in his day. The 18th century saw the rise of numerous manufactures. In 1719 Sir Thomas and John Lombe set up an improved silk-throwing machine at Derby, and in 1758 Jedediah Strutt introduced a machine for making stockings. In 1771 Sir Richard Arkwright set up one of his first cotton mills in Cromford and by 1787 there were 22 cotton mills in the county. The Derby porcelain or china manufactory was started about 1750. The industrial districts, based on the coal field, are in the east and extreme south-west. Silk, cotton, iron, papermaking, woolens, lace, malting and brewing are important. Derby and Belper are the silk and rayon centres, while Derby has also its china, lace, braids, chemical and engineering (Rolls-Royce) manufactures. Belper, Glossop, Ilkeston and Cromford specialize in cotton spinning and hosiery. The iron and heavy industries focus on Alfreton, Chesterfield, Clay Cross, Derby, Dronfield, Eckington, Staveley and Stanton. Lead, gypsum, zinc, iron ore, manganese and barites are mined to some extent. The county is famous for its limestone and marble quarries, while the fluorspar of the limestone caverns is made into ornaments. The warm mineral springs at Buxton, Matlock and Bakewell (also famous for bakery products) are well known. Derby is one of the great railway centres of the country, and one of the chief railway works is located there.

The main London-Derby-Manchester railway line runs from south to north through Derbyshire, and the two Leicester-Sheffield lines pass through the east of the county. Derby is joined to Manchester and Sheffield by trunk roads, and these and other classified roads in the county total more than 1,500 mi. Derbyshire is also served by the Trent and Mersey canal, and Derby has its own airport at Burnaston, 4 mi. S.W.

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DERELICT, in law, property thrown away or abandoned by the owner in such a manner as to indicate that he intends to make no further claim to it. The word is used more particularly with respect to property abandoned at sea. Land gained gradually and slowly from the sea belongs to the owner of the adjoining land by dereliction, but in England, in the case of sudden or considerable recession, the land belongs to the crown. *See* SALVAGE.

DERG (DEARGH), **LOUGH,** the name of two lakes in the Republic of Ireland, one of which is on the river Shannon along the boundary of County Tipperary with Galway and Clare, and the other on the river Derg in County Donegal.

Lough Derg on the Shannon (109 ft. above sea level) is 24 mi. long and ½ to 8 mi. wide with a maximum depth of 119 ft.; it is studded with islands and has the small towns of Portumna at its northern end and Killaloe (*q.v.*) with Ballina at its southern end, where it enters a gorge several miles long. The drop of over 100 ft. at the gorge was used for the first modern power scheme in Ireland (1925–29), which tapped the lake waters into a headrace (watercourse) more than 7 mi. long above the power station at Ardnacrusha. Because of the porous nature of the limestones in the Lough Derg area, the general shallowness of the lake and the variable climate, supplies of water for the power station have fluctuated beyond original expectations (*see* SHANNON).

Lough Derg in Donegal on the river Derg, a tributary of the Foyle, is renowned as a centre for a Roman Catholic pilgrimage of great austerity. This three-day retreat at the scene of St. Patrick's vision of Purgatory, takes place annually (June–August) on Station Island, in the south part of the lake. The island has two churches, hostels and priests' quarters. W. M. Thackeray wrote of the pilgrimage in his *Irish Sketch Book* (1842). (T. W. FR.)

DERING, RICHARD (*c.* 1580–1630), English organist and composer remembered chiefly for his vocal music. He supplicated for the Oxford B.Mus. in 1610, stating that he had studied music for ten years. In 1612 he may have journeyed to Italy. By 1617 he was organist to the convent of English nuns in Brussels, having become a Roman Catholic. In 1625 he was appointed organist to Henrietta Maria, and in the same year he was "musician for the lute and voice" to Charles I. He died in London and was buried there on March 22, 1630.

Collections of his music, all vocal and with *basso continuo*, were published at Antwerp between 1617 and 1620. His works remained popular after his death: Cromwell admired them and John Playford published some. Dering's compositions include motets, instrumental music, madrigals, English church music and two pieces based on London and country cries. (A. D. F.)

DERMAPTERA, an order of insects (*q.v.*), which includes the earwigs (*q.v.*).

DERMATOLOGY: *see* SKIN DISEASES.

DERMOPTERA, the name for the order of mammals comprising only the flying lemurs (*Cynocephalus* species), which were formerly included in the order Insectivora. *See* CYNOCEPHALUS.

DERMOT MAC MURROUGH (d. 1171), the Irish king of Leinster whose appeal for help first brought the Anglo-Normans to Ireland, was born *c.* 1110. His father Donnchad died as lord of Uí Cinsellaig and king of Leinster (1115). Dermot succeeded his brother Enna (1126), but had to face many rivals in his fight for recognition as king of Leinster. He attained his aim (1141) when he slew or blinded 17 of his chief rivals. To secure control of the abbey of Kildare (1132) he caused the abbess to be violated by one of his soldiers. Dermot abducted (1152) Dervorgilla, wife of Tiernan O'Rourke, king of Breifne (Leitrim and Cavan); she returned to Tiernan soon afterward. Later Tiernan allied with Roderic (Rory) O'Connor, king of Connaught (Connacht) and high king (árdrí) of Ireland and drove (1166) Dermot from Ireland. With the permission of Henry II Dermot enlisted the aid of some Welsh marcher lords, notably Richard de Clare, earl of Pembroke (Strongbow) who married Dermot's daughter Eva and succeeded him as ruler of Leinster when Dermot died at Ferns on May 1, 1171. Though guilty of grave misdeeds Dermot was a patron of the monasteries in his kingdom. The abbot of Terryglass who compiled the *Book of Leinster* during his reign laments his expulsion (1166) as a great loss to Ireland.

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DERNA (anc. DARNIS), a town on the northeast coast of Libya, Africa, 224 mi. E. of Benghazi by road and one of the six administrative centres of Cyrenaica province. Pop. (1964) 21,432. Lying under the barren eastern ridges of the Jebel Akhdar on the small but rich delta of the Wadi Derna, a deep dry ravine which becomes a torrent after winter rain, the town presents a pleasant appearance with its white houses, vine-trellised streets and luxuriant palm gardens, which are watered by fine perennial springs and produce bananas, grapes and other fruit and vegetables. It has secondary schools for boys and girls and a government hospital. The bay is unprotected from northwest to southeast and is inaccessible in rough weather. The harbour is small, taking vessels up to 200 ft. length and 11 ft. draught, but there is good offport anchorage. The port is not busy except as a seasonal sponge-fishing base. Mutilated rock-tombs above the town are almost the only remains of the Darnis of the ancient Greek settlers. The ruins overlooking the town are of a fort built by the Americans who landed there under William Eaton (*q.v.*) in 1805, as a result of piracies on American shipping. (D. G. W.)

DÉROULÈDE, PAUL (1846–1914), French author, patriot and politician who promoted the Franco-Russian alliance. He was

born in Paris on Sept. 2, 1846. On the outbreak of the Franco-German War he enlisted as a private but, after attaining the rank of lieutenant, he was forced by an accident to retire from the army. His patriotic poems, *Chants du soldat* (1872), enjoyed great popularity and were followed by the *Nouveaux Chants du soldat* (1875). In 1882 he founded the *Ligue des patriotes,* inspired by the ideas of the French *"revanche"* (revenge), and was one of the first advocates of a Franco-Russian alliance. A supporter of General Boulanger, he was exiled in 1900 for having plotted against the republic. He received an amnesty in Nov. 1905 and died near Nice on Jan. 30, 1914. Apart from his patriotic poems, he published several plays including *Messire Du Guesclin* (1895).

See J. and J. Tharaud, *La Vie et la mort de Paul Déroulède* (1925). (A. Pe.)

DERRICK, a type of crane; the name is derived from that of a famous early 17th-century Tyburn hangman, and was originally applied as a synonym (*see* Crane). The derrick of the petroleum industry is a skeleton framework or tower of wood or steel for hoisting or lowering from a fixed point; the term also is applied to similar smaller structures mounted on motor trucks. Oil-field derricks are used to raise and lower the drilling tools in the well and also to insert and remove the well casing or pipe. *See* also Petroleum.

DERVISH in the middle east is a member of a Muslim religious fraternity, whether mendicant or not, resembling in some respects a Christian monastic order. The fraternities arose within Sufism (*q.v.*), which is in origin religion at an individual level, the single soul seeking its own salvation; occasionally such an individual would gather round himself a band of devotees under instruction, who shared his life and religious practices. Such groups were at first ephemeral, becoming in the 12th century continuous organized corporations, with established leadership, prescribed discipline and a "chain" (*silsila*) of reputed spiritual descent from God through Gabriel and Mohammed. Each initiant dervish (*murid*) must know the *silsila* of his fraternity, to which he is bound through his initiating teacher, with whom he is often in rapport through hypnotic control. The main devotional exercise of the dervish is the *Dhikr* (*zikr*), "remembering" (*i.e.,* of God), to emphasize to the worshiper his dependence on the unseen world; the ritual always stresses the emotional aspect of religion, and tends toward hypnotic phenomena and ecstatic trance, engendering physical states which have earned for the dervishes the names "howling," "whirling," "dancing," etc. Besides the few dervishes resident in community there are many lay members (including women), both classes now being largely drawn from the lower levels of society. The greatest expansion of dervish communities was in the central lands of Islam, where they played a vital role in the religious, social and political life of the Muslim community in the middle ages. Their monasteries are now often under governmental control, and their theological standing is discounted by orthodox theologians.

DERWENT, the name of several English rivers. The word is derived from the Celtic *Dwrgent,* meaning "clear water."

1. The Yorkshire Derwent rises 875 ft. above the sea on the heather-covered Fylingdales moor only 6 mi. inland to the north of Scarborough, yet it runs 57 mi. to its junction with the Ouse at Barmby on the Marsh. It drains an area of 787 sq.mi., flows through alternating gorges and vales and presents difficult drainage problems. These peculiarities result from the past blockage of its former easterly course, north of Scarborough, by a glacier in the North sea. Gorges were cut through the Tabular hills around Hackness at Langdale and Forge Valley, and also through the Howardian hills at Kirkham Abbey. The course through the vales of Pickering and York (south of Stamford Bridge) is strikingly flat and is underlain by thick glacial outwash, lacustrine deposits and, nearer the sea, by marine warp. Land drainage in the Vale of Pickering dates notably from the period of enclosures, but the artificial Hertford river in the east of the vale (which cuts the Mesolithic settlement site at Starr Carr) was the result of the Muston and Yedingham Drainage act of 1801. Water was also led along the wide preglacial course of the Derwent from a point north of the Forge valley out to sea at Scalby ness, a fall of 145 ft. in five miles over eight weirs. Mills at Malton, which interfered with drainage, were the subject of an act in 1846, and improvements are continuous. Hardly any part of the course is natural and there are weirs between Kirkham and Sutton, the tidal limit.

2. The Derbyshire Derwent rises on Bleaklow hill, 2,060 ft. above the sea, in bleak gritstone Pennine moorlands. Its upper valley has three reservoirs, Howden and Derwent (filled 1911) and Ladybower (filled 1943). This last holds 6,300,000,000 gal. and when built was the largest British reservoir contained by an earth embankment. Together they supply the county boroughs of Derby, Leicester, Nottingham and Sheffield and the county council of Derbyshire. The river flows south through Chatsworth park, overlooked by impressive west-facing gritstone scarps, until at Matlock it runs on limestone for a short time. At Belper the beauty of the valley fades as a corner of the Derby coal field is crossed, and a little farther south the river enters the midland plain, runs through Derby and joins the Trent 100 ft. above sea level. Its tributaries are mostly right-bank ones, notably the Noe, a muddy river from Kinder Scout, and the clear Wye draining a limestone area.

3. The Cumberland Derwent rises 2,400 ft. above the sea on Great End in the Lake district in a rugged glaciated upland of Ordovician volcanic rocks. It drains Styhead and Sprinkling tarns, descends rapidly to Seathwaite, traverses the silted-up lake bed around Rosthwaite, where the Stonethwaite beck enters, through the Jaws of Borrowdale (truncated spurs) and into Derwentwater (*q.v.*). The remaining course is over the coal field past Cockermouth to the sea at Workington after a total unnavigable flow of 34 mi.

4. A river Derwent 30 mi. long flows northeast to the Tyne near Newcastle. (Jn. P.)

DERWENT, the principal river of Tasmania, rises in Lake St. Clair, in the main highland massif, and flows 107 mi. southeastward to enter Storm bay near Hobart by a magnificent estuary 3½ mi. wide. Near its mouth is a remarkable floating bridge (1938–43) with a total length of 3,807 ft., of which 3,156 ft. are formed by 12 floating sections arranged in an arc convex to the flood tide and prevailing winds. The principal tributaries of the Derwent are the Jordan, Clyde, Ouse and Dee. (O. H. K. S.)

DERWENTWATER, EARLS OF, an English title borne by the family of Radclyffe or Radcliffe from 1688 to 1716, when the 3rd earl was attainted and beheaded, and claimed by his descendants, adherents of the exiled house of Stuart, from that date until the death of the last male heir in 1814.

Sir Francis Radclyffe (1625–96), 3rd baronet, and 1st earl of Derwentwater, was the lineal descendant of Sir Nicholas Radclyffe, who acquired the extensive Derwentwater estates in 1417 through his marriage with the heiress of John de Derwentwater. Sir Francis was created Viscount Radclyffe and earl of Derwentwater by James II in 1688. He died in April 1696 and was succeeded by his eldest son Edward (1655–1705), 2nd earl, who had married Lady Mary Tudor, a natural daughter of Charles II. The 2nd earl died on April 29, 1705, and was succeeded by his eldest son James (1689–1716), 3rd earl, who was born in London on June 28, 1689, and was brought up at the court of the Stuarts in France as companion to Prince James Edward, the Old Pretender. He returned to England in 1710 and joined the Jacobite rising of 1715. He surrendered after the defeat at Preston and was then conveyed to London and impeached. Pleading guilty at his trial, he was attainted, and was beheaded on Tower hill on Feb. 24, 1716, declaring on the scaffold his devotion to the Roman Catholic religion and to "King James III."

The 3rd earl's estates were inherited by his only son, John (d. 1731) who, despite the attainder, styled himself earl of Derwentwater. After his death on Dec. 31, 1731, his uncle Charles (1693–1746), son of the 2nd earl, inherited his estates and continued to use the title. Charles Radclyffe had fought at Preston in 1715 and was condemned to death for high treason, but, more fortunate than his brother, he escaped from prison and went to live in Rome. He was captured by an English ship in 1745 while proceeding probably to join Charles Edward, the Young Pretender,

in Scotland, and was beheaded for his former treason on Dec. 8, 1746. His grandson ANTHONY JAMES (1757–1814) died without issue in 1814, when the title became extinct *de facto* as well as *de jure*.

DERWENTWATER, a lake of Cumberland, Eng., in the Lake District (*q.v.*). It is approximately oval in shape, about 3 mi. long and from ½ mi. to 1¼ mi. wide. The greatest depth is 72 ft. The lake, if seen from above, rests in an amphitheatre of mountains of varied outline, overlooked by others of greater height. Several elevations near the lake are famous viewpoints; *e.g.*, Castle Head, Walla Crag, Ladder Brow and Cat Bells. The shores are well wooded, and the lake is studded with several islands, of which Lord's Island, Derwent Isle and St. Herbert's are the principal. Lord's Island was the residence of the earls of Derwentwater. St. Herbert's Isle is so called because there lived St. Herbert, mentioned by Bede, in the 7th century. Derwent Isle (six acres) contains a handsome residence surrounded by lawns, gardens and timber of large growth. The Falls of Lodore, at the upper end of the lake, consist of a series of cascades in the small Watendlath Beck, which falls over crags from a height of nearly 200 ft. The "Floating Island" appears at intervals on the southern end of the lake near the mouth of the beck, and is formed by the accumulation of decayed vegetable matter floating on the water. The river Derwent (*q.v.*) enters the lake from the south and leaves it on the north, draining it through Bassenthwaite lake, which is separated from Derwentwater by a lacustrine delta, to the Irish sea. To the northeast of the lake lies the town of Keswick (*q.v.*).

DERZHAVIN, GAVRILA ROMANOVICH (1743–1816), notable Russian poet of the 18th century, was born at Kazan on July 14 (new style; old style, 3), 1743. He joined the army in 1762 and was made an officer in 1772. In 1777 he entered the civil service in St. Petersburg and during the next 26 years his posts included those of provincial governor at Olonets and Tambov, senator and minister of justice. His ode *Felitsa* (1783), addressed to Catherine the Great, gained her favour and he was for a time her private secretary. In 1803 he retired to his estate at Zvanka, where he died on July 20, 1816. He published an interesting book of memoirs (*Zapiski*, 1812). His main achievement lies in his lyrics and odes, among which are *Na smert knyazya Meshcherskogo* (1783, "On the Death of Prince Meshchersky"), *Bog* (1784; Eng. trans. *Ode to the Deity*, 1861) and *Vodopad* (1791–94, "The Waterfall"). His style was varied, often alternating between the sonorous and the humorous, and though it is uneven he remains Russia's greatest and most original 18th-century poet.

See D. D. Blagoi, *Derzhavin* (1944); A. V. Zapadov, *Derzhavin* (1958). (R. F. Hl.)

DESAIX DE VEYGOUX, LOUIS CHARLES ANTOINE (1768–1800), French military officer, was born in Auvergne on Aug. 17, 1768, the son of Gilbert Antoine Desaix, seigneur de Veygoux. Known at first as the chevalier de Veygoux, a regular officer, compromised and imprisoned after Louis XVI's deposition, he had the remarkable fortune in 1793–94 of being retained and promoted general by the deputies with the army of the Rhine, in spite of orders from revolutionary Paris. He showed his worth in the retreat to Strasbourg (1793), in the slow advance to Mainz (1794), in C. Pichegru's battle at Mannheim (1795), in his command of J. V. Moreau's centre corps in Bavaria (1796) and in the retreat through the Black forest. After being wounded at the passage of the Rhine in 1797 he went to Italy to see Napoleon and in his *Journal de voyage* (ed. by A. Chuquet, 1907) admirably described the army and its chiefs. Desaix took a division to Egypt in 1798 and after the battle of the Pyramids occupied upper Egypt against tough opposition from the mameluke Murad Bey. Napoleon did not take him back to France but called for him when he was conducting J. B. Kléber's negotiation for evacuating Egypt. He was captured at sea and could not reach Napoleon until June 11, 1800, in Piedmont. Sent at once with two divisions toward Genoa, he had not gone far (because of floods) when he was called to the battlefield of Marengo (June 14). He was beginning the counterattack which turned the battle to victory when he was shot through the heart. Napoleon paid him the highest honours. (I. D. E.)

DE SANCTIS, FRANCESCO (1817–1883), the foremost Italian 19th-century literary critic, was born at Morra Irpina, Campania, March 28, 1817. A liberal patriot, he took part in the Neapolitan revolution of 1848 and was for some years a prisoner of the Bourbons. He then lived in exile in Turin and Zürich, where he became known as a teacher and lecturer. He returned to Italy in 1860, and took up the work of educational reform, becoming minister of education (1861–62) and, in 1871, professor of comparative literature in the University of Naples. He died in Naples, Dec. 29, 1883.

A scholar of literature and history, De Sanctis brought to his criticism also a knowledge of philosophy, particularly Hegelian aesthetics. His essays on the Italian poets (*Saggi critici*, 1866; *Nuovi saggi critici*, 1873), especially on Dante, Petrarch, Leopardi and Manzoni, relate these poets to the society of their times and show acute sensibility and unfailing critical judgment. His masterpiece, *Storia della letteratura italiana* (1870; Eng. trans. by J. Redfern, 1931) is not only a history of Italian literature but an illuminating account of the development of Italian society. Although his ideas on poetry and his belief that art is form have become dated, his work remains invaluable for the understanding of Italian literature and civilization. Much of Benedetto Croce's thought was inspired by De Sanctis.

De Sanctis' *Opere complete* were ed. by A. Morano (1947). *See* also L. A. Breglio, *Life and Criticism of F. De Sanctis* (1941). (F. Dt.)

DESARGUES, GÉRARD (1591–1661), French mathematician, best known for his work in geometry, was born at Lyons on March 2, 1591. By profession he was an engineer and probably technical advisor to Richelieu and the government. Little is known about his earlier years; in 1636 he belonged to the scientific group in Paris centred around Marin Mersenne. He was fond of music and wrote a little manual on musical composition published by Mersenne. At the same time his *Traité de la section perspective* (1636) appeared. His main work, *Brouillon project* (1639), deals principally with conics and embodies most of his mathematical results of importance; it influenced the studies of Pascal, one of Desargues' disciples. In 1640 he published the manual, *La coupe des pierres en l'architecture* in *Leçons sur tenèbres*, which brought him into violent controversy with contemporary architects.

Desargues died at Lyons in 1661.

See R. Taton: *L'Oeuvre mathématique de G. Desargues* (1951). (O. Oe.)

DESBORDES-VALMORE, MARCELINE (1786–1859), among the greatest of French women poets, standing in the foremost ranks of the minor writers of the Romantic period, was born at Douai on June 20, 1786, and as a girl earned a living on the stage. After desertion by a lover whose identity has not been established, she married the actor Prosper Lanchantin (Valmore), with whom her life was happy, despite poverty and bereavements. Passionate love, her children, Douai, religion and death were the main themes of her poetry, which is elegiac and characterized by spontaneity, sincerity and exceptional musicality. One of her prose works, *L'Atelier d'un peintre* (1833) is autobiographical. Her correspondence reveals her noble character. She was admired by contemporary poets and encouraged by Dumas the elder and by Sainte-Beuve; Verlaine and Baudelaire esteemed her highly. Her success was considerable from 1819 (*Élégies et romances*) until 1843 (*Bouquets et prières*), but she died in Paris, July 23, 1859, in comparative obscurity. Some of her best work was published posthumously (*Poésies inédites*, 1860).

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DESBOROUGH, JOHN (1608–1680), English soldier, was Oliver Cromwell's brother-in-law and played a prominent part in Commonwealth politics. He was born at Eltisley, Cambridgeshire, and baptized on Nov. 13, 1608. He married Jane, Crom-

well's sister, in June 1636. He was a member of Cromwell's cavalry regiment at the beginning of the Civil War and distinguished himself in succeeding campaigns, but he carefully avoided all participation in the trial of the king in Jan. 1649. He fought at the battle of Worcester (Sept. 1651) as major general and almost captured Charles II near Salisbury. During the Commonwealth he held many high offices and was a member of the parliaments of 1653, 1654 and 1656. In spite of his near relationship to the lord protector, he violently opposed the suggestion that Cromwell should assume the crown. After Cromwell's death he was, with Charles Fleetwood, the chief instigator and organizer of the hostility of the army toward Richard Cromwell's administration, and forced him to dissolve his parliament in April 1659. Desborough was chosen a member of the council of state by the restored Rump parliament, but presenting with other officers a seditious petition from the army council, on Oct. 5, was dismissed. He was ordered to quit London in Jan. 1660. After the Restoration he escaped to the Netherlands where he engaged in republican intrigues. He was ordered home, in April 1666, on pain of incurring the charge of treason, and was imprisoned in the Tower of London from July 1666 to Feb. 1667. Desborough died in London in 1680. His rough person and manners are the constant theme of ridicule in the royalist ballads, and he is caricatured in Samuel Butler's *Hudibras* and in the *Parable of the Lion and Fox*.

DESCANT, in 20th-century music, is generally a type of counterpoint composed above a hymn melody. The word is also applied to 16th- and 17th-century wind and string instruments, particularly the recorder and viol, in the treble range. In 16th-century vocal music, descant might refer to one of the high parts, although treble was probably commoner in this sense.

The word is derived from the Latin *discantus*, which in the middle ages described a musical improvisation on a plainsong. As usual at this period, definitions are not precise, but *discantus* always seems to refer to polyphonic music. In sources of the 12th and 13th centuries *discantus* is defined as note-against-note movement. This is in contrast with organum (*q.v.*), which combines a free voice made up of many notes with a tenor based on the plainsong, so that many notes of the free organal voice are set to each note of the plainsong. Another feature of *discantus*, according to Franco of Cologne (*c.* 1260), was that it was strictly measured in contrast with the organum, which was relatively free rhythmically as well as melodically. Improvised descant is really nothing more in the middle ages than the singing in parallel motion of a second part a fifth above the original plainsong, a third part a fourth above that and a fourth part a fifth above the third part if necessary. This procedure was described in the 9th-century treatise *Musica Enchiriadis*, and the only development in it seems to be a certain ornamentation of the highest voice. This type of improvisation was practised in England, particularly from the 14th to the 15th century, but instead of proceeding in fifths and fourths the singers employed thirds and sixths. The texture was generally three-part and a system of so-called "sights" was used to read the correct intervals above the plainsong. Since the plainsong was on a small four-line stave, the singer would read a small interval below the chant to gain the larger interval above; *e.g.*, a third below sung an octave higher gives a sixth above. Fifths and fourths were retained at the beginning and end of phrases. (G. Re.)

DESCARTES, RENÉ, otherwise René des Cartes or, in Latin, Renatus Cartesius (1596–1650), the greatest of French philosophers, whose astonishing analytical genius was displayed in the invention of co-ordinate geometry and in his contributions to theoretical physics, to methodology and to metaphysics, was born at La Haye in Touraine on March 31, 1596, the third child of Joachim Descartes, councilor of the *parlement* of Rennes in Brittany, and of his wife Jeanne Brochard, who died in the following year. At the age of eight he was sent to the Jesuit college at La Flèche, then "one of the most celebrated in Europe," where he devoted five years to grammatical and literary studies and three to the sciences, elementary philosophy and theology. The college's mathematical teaching was strong, and mathematics soon became his favourite study "because of the certainty of its proofs and the evidence of its reasonings"; but he then supposed it "only to serve the mechanical arts," so that its "true use" did not at first occur to him, though he was surprised, its foundations being "so firm and strong," that nothing "loftier" had been erected on them. He acquired also some notions of the new discoveries in optics, astronomy and the use of the optical instruments recently invented. His delicate health secured for him permission to pursue his studies abed until midday—a practice that he retained throughout life. Leaving La Flèche in 1612, he passed to the University of Poitiers, where he graduated in law in 1616 (he appears, however, never to have practised).

Weary of study and desiring to see the world, he then joined the army of Prince Maurice of Nassau, to whom his mathematical ability was useful in military engineering. At Breda (1618–19) he became acquainted with Isaac Beeckman, a mathematician and rector of the college at Dortmund, who brought his mind back "to science and worthier occupations." With mutual enthusiasm they discussed a new way of treating physical problems, designed to render them amenable to mathematics. Resuming his travels in April 1619, Descartes eventually reached a German town, probably Neuberg, where he shut himself up "*dans un poêle*" (*i.e.*, "in a well-heated room") for the winter. There "a wonderful discovery" and "a marvellous science" were revealed to him in a dream (St. Martin's eve, Nov. 10, 1619), which clarified his purpose and determined his future endeavours, showing him that physics should be reduced to geometry and all the sciences be interconnected "as by a chain." He was to pass the next nine years in applying this method to algebra. Returning to France in 1622, he sold his estate in Poitou "to be free from the obligation of making a living by science." Resuming his travels, now through Switzerland and Italy, he carried out meteorological observations, studied glaciers and computed the heights of mountains. Returning again to France in 1625, he spent the greater part of the next three years in Paris in the company of men of science—Claude Mydorge, Étienne de Villebressieu, Jean de Silhon, J. B. Morin and his former school-fellow, the obliging Marin Mersenne, "in whom was more than in all the universities together." Completely possessed of his method by 1629, he expounded it in the invaluable, though unfinished, *Rules for the Direction of the Mind* (*Regulae ad directionem ingenii*, posthumously published in 1701).

Leaving Paris, Descartes went to Holland; and for more than 20 years from the beginning of 1629 he was to remain almost permanently in that country, profiting from its tranquillity and greater intellectual freedom: he made only three visits to France in all this time. In 1633 he finished *Le Monde* (its two parts dealing with "Light" and "Man"), wherein he reaffirmed the Copernican hypothesis of the earth's movement around the sun. But before publishing this he learned through Mersenne of Galileo's severe censure by the Inquisition for having advanced the same hypothesis; and to avoid conflict with Rome, he immediately stopped publication. Within four years of his scare at Galileo's condemnation, after "suitably" modifying his cosmology, he published his epoch-making work, the *Discourse on the Method of properly Guiding the Reason in the Search for Truth in the Sciences; Also the Dioptric, the Meteors and the Geometry, which are Essays in this Method* (*Discours de la méthode de bien conduire sa raison et chercher la vérité dans les sciences; plus la Dioptrique, les Météores et la Géométrie, qui sont des essais de cette méthode*, Leyden, 1637), so presenting fully worked-out examples of his method's application. The six-part *Discourse*, which claimed "not to unfold the method but only to talk it over," at the time a highly revolutionary manifesto, was really an extended preface: it has remained a philosophical classic. It fomented controversies with Pierre de Fermat and several other mathematicians which were a long cause of irritation to Descartes. Five years later his principal metaphysical work appeared: the *Meditations on First Philosophy, in which the Existence of God and the Distinction between Mind and Body are Demonstrated* (*Meditationes de prima philosophia, in quibus Dei Existentia et animae humanae a corpore distinctio demonstrantur*, 2nd ed., Amsterdam, 1642, including "objections" contributed by Thomas Hobbes, by Pierre Gassendi and by Antoine Arnauld and the author's replies to them; the 1st ed., Paris, 1641, had a slightly different title). Meanwhile in

this land of toleration he was to meet with enmity, the bitterest coming from Gisbert Voet (Gysbertus Voetius), president of the University of Utrecht, who, insinuating atheism, was instrumental in securing Descartes' condemnation by the local magistrates. But he had many friends and admirers in Holland too, and among them the refugee Princess Elizabeth of the Palatinate, daughter of the titular king of Bohemia, whose "most thorough and comprehensive understanding" of the *Discourse* and of the *Meditations* he thought "incomparable." To her he dedicated the *Principles of Philosophy* (*Principia philosophiae*, Amsterdam, 1644), in which the entire system was resumed under separate articles.

Descartes had hardly completed the *Passions of the Soul* (*Traité des passions de l'âme*, Paris, 1649) when Queen Christina requested him to come to Sweden and instruct her. He contemplated wryly this invitation "to live in the land of bears among rocks and ice" and feared too for his habits and independence, but was eventually persuaded by Pierre Chanut, the French ambassador. He left Amsterdam on Sept. 1, 1649, and reached Stockholm about a month later. Five o'clock in the morning was the bleak hour that the queen fixed for her lessons. Descartes, returning one bitter morning, caught a severe chill; and within a fortnight he died, on Feb. 11, 1650, having passed about four months in Sweden. His remains were brought back to France and buried in the church of Ste. Geneviève du Mont in Paris.

THE PHILOSOPHY OF DESCARTES

Methodology.—Descartes' earliest activities were confined to the sciences; only later did he turn to metaphysics, and his reason for doing so is of the first importance for understanding the orientation and distinctive character of his whole philosophy. To compass his purpose of enabling men to become "masters and possessors of nature," by improving "medicine, mechanics and morals," he saw that it was insufficient merely to augment the sum of what then passed for scientific knowledge and to continue using the methods that produced it. Confirming Francis Bacon's opinion that "the entire work of the understanding must be begun afresh, and the mind itself be, from the start, not left to take its own course, but be guided step by step," he devised and applied a method of discovery and demonstration whose results should replace the unclear, tentative and ununified conclusions of current scholastic science, the defects of which he traced to two sources: the obscurity of the concepts that it used in formulating and resolving its problems; and the lack of a universally applicable method adequate to the diversity of scientific data. Rejecting both the faltering, hand-to-mouth procedures of medieval science, which produced only "a collection of curiosities" attesting their users' sagacity, and the "occult qualities" and "substantial forms" (*e.g.*, weight, hardness, lightness, heaviness) the obscurity of which contrasted so unfavourably with the lucidity of geometrical ultimates (*e.g.*, point, plane, straight, circle), he would substitute a truly scientific method by which, from applying its few highly general principles, conclusions would be seen to follow necessarily and be verifiable by all. Only when the results in every science were as clear, controllable and certain as those in mathematics would the claim to have attained knowledge be justified. Mathematics thus became the exemplar of science in every field, empirical no less than formal; and its excellence, Descartes saw, was due to the exactness of its data and lay in its power to explain very much by means of very little. Aristotle too had explained its certainty by its formal character and, thinking this peculiar to it, denied that like certainty was attainable in other sciences having nonformal, empirical facts for their subject matter. Medieval scientists confirmed Aristotle, maintaining that each science's method must vary with, and answer to, differences peculiar to the materials that it investigated. It is here that the originality of Descartes' reform in methodology is most easily seen. He denied that differences in the diverse data of the various sciences should dictate a difference of method appropriate to them severally, for, disparate though their data be, they all alike advance by reasoning which is of the same fundamental character whatever be the terms. Since it is one and the same reason that is operative in all men, it follows, he thought, that there can be but one universal method, applicable indifferently to every kind of datum and problem, which eventually would yield a unitary, comprehensive, internally interconnected body of results. It would furnish not a "collection of curiosities" nor a plurality of detached sciences but a single and universal science. This is Descartes' momentous and historically most influential conception of a revised method, whose purpose and directive character he excogitated in outline at the age of 23. By its means he would first unify the branches of mathematics, then reconstruct and interrelate the nonmathematical sciences as well—a project which he admitted to be "incredibly ambitious." For it is one thing to think out the requirements that such a method must fulfill, quite another to devise one that satisfies them. To the last task he next turned. The several sciences should be so transformed in their constitution as to be unified into one whole, much as are the branches of the trunk of a single tree. And this he thought should be possible because they all employ the same kinds of operation, so that the new method in its application would be but a projection, into the continuous process of conceiving and inferring, of the intrinsic, universal nature of reason itself. That being so, it was incumbent on Descartes to analyze exhaustively the nature of our reason and elicit from it the constitution of that single method which he was seeking. This analysis would perforce be restricted to results established with certainty and finality, ignoring those that were merely possible, probable or tentative—which meant for Descartes that he would limit himself to analyzing reason when employed in mathematics. Its forms there displayed should reveal its precise nature and therewith the conditions of its success in other fields. His analysis, comprising two interdependent doctrines, concerns (1) the intellectual operations together constituting what is meant by "reason"; (2) the character of the subject matter in relation to which alone those operations are possible and successful. These doctrines together define the new, single method to be substituted for the variety of *ad hoc* procedures of medieval science.

1. No more than three kinds of operations are employed in mathematical reasoning: *intuitus*, *deductio*, *enumeratio*. The most fundamental is *intuitus*, a noninferential act of direct prehension—single, momentary and infallible—by which we no more than conceive a certain term, complex or simple (*e.g.*, a sphere or straightness). *Deductio* is not syllogistic deduction but an operation consequential upon *intuitus*; it elicits which terms among a series successively intuited depend upon which, or else what are the relations obtaining of necessity between which terms. It proceeds analytically and synthetically; *i.e.*, it passes from more complex to less complex or even simple terms and conversely from simples or relatively less complex to more complex terms. Subsequently recourse is had to *enumeratio* to avoid error due to faulty memory in cases where the steps in a passage of *deductio* are too numerous for all to be comprehended at the same moment. It consists in going over these steps again and again, each time shortening the whole passage by colligating the contents of its several stages under ever fewer but more complex concepts until the whole be so marshaled within a single span of attention as to eliminate all dependence upon memory.

2. No term fitted to be the object of these operations may be a sensible quality of any kind, for these, being all confused, cannot be clearly conceived separately or in combination. Only terms clearly conceivable in themselves and whose differences and connections among themselves are distinctly discernible can be objects for *intuitus*, and these are natures either complex or simple. To understand a complex nature we must decompose it into its constituent simples, discern the special character of each, also the order or manner in which they combine to make up the original complex, such decomposition and recomposition exhibiting the method's analytic and synthetic functions. All the ultimate indefinables (other than those of sense) to which we refer and which we use in thinking are called by Descartes "simple natures"; *e.g.*, what is immediately conceived and named by the words unity, independency, universality, cause, existence, substance, motion, point, straight, equality, duration, shape, magnitude, know, doubt, will, like, diverse, etc. The number of these natures he believed

to be very small. Just as the letters of the alphabet, recurrent in ever new combinations, make up the profusion of words in a language, so the variety of natural objects should be reducible to differences of combination and differences of the natures combined; and as we decipher a book by knowing the words and the syntax of its language, so from a knowledge of simple natures and mathematics we may hope to decipher the natural world. Physics and chemistry would accordingly become "sciences of number, weight and measure." In this way, Descartes expected to reach a unitary and exhaustive system of laws applicable universally throughout nature which should replace the tentative explanations of isolated facts characteristic of medieval science. Now in order to be genuine science and not merely presumed such by convention, our conclusions, besides being clear and compatible, must also be, and be known to be, true of what exists independently of us and our thinking. This further requirement, however, the method cannot satisfy, for it relates only to the passage in thought from idea to idea: alone it can furnish no more than an ordered system of ideas, but one—for all that we may know—that lacks any save a supposed and unauthenticated reference to things existing independently of it. Consequently, if ever the hypothetical physics furnished by his method was to be transformed into a certain and final knowledge of nature, Descartes had to make good the inalienable claim of knowledge to be "of" what actually exists and not merely of what is conceivable. The step from representation in idea to affirmation of existence must be authenticated. Should these ideas really be true of what exists independently, the very fact that they are so must itself be established. But this fact neither mathematics nor methodology is empowered to guarantee. Yet science can be shown to be synonymous with strict knowledge only if Descartes establishes with certainty that certainty about what exists is attainable and, in particular, is obtainable about those very things which we suppose to exist and be the subject matter of physics. There are thus, for authentication, two conditions to be satisfied: first, that which authenticates must itself be something existent and discoverable to be so with certainty; secondly, that which authenticates must be such that from its existence we can deduce with certainty the necessary existence of the objects of physics. Consequently, Descartes' first step is one not of demonstration but of search. He must discover that of which it is impossible to doubt or to deny the existence, and to this end he adopts systematically the practice of "methodical doubt."

Metaphysics.—He begins by doubting the existence of things that are, and things that are not, commonly found dubious, in order to discover whether there be one that withstands his determination to doubt of it. This decision, however, does not imply the assertion that what is doubted must be either false or improbable; the injunction *de omnibus dubitandum* ("that all things must be doubted") is a predetermination by the will to suppose false whatever we can suppose so, in order to test thereby the possibility of its being false. If, among our convictions so tested, one be found that resists indubitably our most thoroughgoing attempt to suppose it false, we shall be assured thereby that it cannot be overturned in the future; for what destroys the strongest possible doubt must by that fact be absolutely certain—be so and not merely be assumed such. Now whatever cause of deception we choose to suppose, however regular we suppose its operation, there is one affirmation that we all can make about which it is impossible that we should be deceived: the affirmation of our own existence, at least at that time when we attempt to doubt it. It is impossible for any cause of deception to bring it about that on the occasion when I am being deceived I do not then exist. I, the doubter, must exist while doubting; "the proposition 'I exist' is necessarily true each time I assert or conceive it." Whether or no deception involves an existent deceiver, it necessarily involves someone existing and capable of being deceived, for it is only a person (not "an idea") that could be deceived. In this way Descartes reached his first certitude—*cogito ergo sum* ("I think therefore I am"; better reformulated by Spinoza: *ego sum cogitans*, "I, in being conscious, am existent")—showing thereby that certain knowledge is attainable by having attained it and reaching therewith the first (and only) instance in which the thinker is directly related to something actually existent and not to an idea. For my self's existence is disclosed to me by no intermediary, instrumental idea that represents me to myself: my self is known to me exactly as and for what it is at the moment of my apprehending it. The *cogito* thus expresses the fundamental situation from and within which Descartes claims to demonstrate with a like certainty the existence of other things. But these are not to be known in the same manner, by the thinker's direct apprehension of their existence, but by his inferring that they exist from certain ideas present to *intuitus*. Henceforward, the immediate objects of the thinker's awareness are always ideas.

By having made one's awareness of one's own existence the first certainty, that is, the primary fact and initial datum of metaphysics, Descartes introduced a new orientation of very far-reaching influence into his own and into subsequent European philosophy—one that differentiates it most characteristically from ancient and medieval metaphysics. For he raised from inferior rank and gave primary place to epistemology, by directing attention to the nature of ideas (their status and their relation to existence) and to the significance and implications of the peculiar fact of one's self-awareness. Passing to the second of the conditions to be satisfied for authentication (*see* above), Descartes has now to deduce the existence of things other than himself. A review of the ideas occurrent in the continuum of our thinking discloses (1) some that are of diversely characterized bodies that move, change and interact in various ways; and also (2) the idea that those bodies are all dependent upon a further existent that is independent of them—that commonly named God. The existence of bodies, since not entailed by our ideas of them, must be demonstrated indirectly; their existence must be shown to follow necessarily from something whose existence does follow directly from our idea of it. Now, the only other idea we have (besides our innumerable ideas of different bodies) is the idea of God. Hence, if an indirect demonstration of the actual existence of bodies be possible at all, it must be consequential to a prior demonstration of God's existence. It is thus the "existential reference" of our ideas—that in them which constrains us to assert actual existence of something, in independence of the idea's suggestion of it—which has to be justified from case to case. For merely to contemplate an idea does not expose us either to truth or to error, but we are committed to one or to the other if we go on to assert or to deny the existence of something to correspond to it. Now, among our ideas, the majority, being supplied by sensation, are confused; but a few, due to our powers of conceiving and inferring, are clear and distinct, hence suitable as sources of knowledge. Further, there are cases in which an idea of one kind claims to represent the same thing as that which one of the other kind claims to represent, and yet these two ideas are incompatible and almost wholly unlike each other; *e.g.*, on the one hand, a sensory idea of "the sun" as being a "flat red disk as large as a florin located over yonder hill" and, on the other, the astronomical concept of that "sun" as being "an uncoloured sphere larger than our earth and located some 90,000,000 miles from yonder hill." Both these ideas, despite their patent incompatibilities, "represent the sun." But the former gravely misrepresents its real nature, and neither alone warrants our assertion that the sun exists. The astronomical concept is a result of employing the method; but any existential affirmation is beyond its competence. Failure to authenticate the existential reference of ideas, however, would commit us irrevocably to the conclusion that never could we have knowledge, astronomical or other, of the universe and that solipsism must be the last word; for our egocentric starting point would be also our closing point, since, by hypothesis, all we could know to exist would be ourselves and our successive ideas. But failure to authenticate the independent existence of material objects certainly will ensue unless there be one idea such that of itself the existence of that of which it is the idea follows necessarily. Such an idea is that of God, and it is the only idea satisfying the condition. It is unique, peculiarly different from all other ideas in that it connotes certain perfections—omniscience, omnipotence, perfect veracity. This idea is incontestably thought by us at times; even

an atheist must think it, or his denial of God's existence would be nonsignifying. But, Descartes asks, how shall such an idea be thinkable, how should ideas of perfections be indeed thinkable? Not, certainly, from finding them in ourselves; we are notoriously imperfect. Nothing, he decides, could explain the very possibility of our thinking such a thought as that of the divine nature save an existent of a nature adequate to cause it. An existent actually possessed of those perfections, however, answers completely to our defining idea: therefore must be its cause, and hence exist. To this demonstration from the empirical fact of the idea's being found in men's minds, Descartes adds a second, adapted from St. Anselm, which, passing from the perfections composing the divine nature, infers the necessary existence of that which possesses them. Since "God" is defined as the most perfect being conceivable, for such a being not to exist would be for it to lack a perfection. But "the most perfect being conceivable" could not lack a perfection and certainly not that of existence. So, from this definition alone, Descartes thought it followed that denial of God's existence involves self-contradiction. From his double assurance of God's existence and essential nature, Descartes thinks, he sees a way by which to pass to demonstrating the necessary existence of an independent physical world, peopled with moving and interacting bodies, of which he formerly had only ideas. From his indubitable assurance of *ego sum cogitans* and *Deus est* ("God exists"), he may demonstrate his third and last assertion of existence: *corpora sunt* ("bodies exist").

The existence of an independent world of bodies is demonstrated from two divine attributes: omnipotence and perfect veracity. Error and deception, being due to what is imperfect, cannot derive from God, for they are incompatible with omnipotence and complete veracity, as with omnipotence and perfect goodness. Our numerous representations of natural bodies inanimate and animate, being mostly sensory ideas, are highly confused, so Descartes has first to replace them by a clear concept that defines the minimum and essential connotation of their common materiality. That which constitutes the materiality of any material thing must be that on account of which it remains the same thing after, as it was before, undergoing its alterations in time. A character that the body displays at one moment but lacks at another cannot be, or be part of, its essential nature, for we declare it to be the same thing when not possessing as when possessing it. Hence, no sensible quality nor single definite shape or determinate rate of motion that it temporarily displays belongs to it essentially, but only contingently. Throughout its course of alterations there are but two properties constantly conserved, its extensity and its mobility, each variously determinable under different causal conditions. These attributes are alone clearly conceived to characterize permanently all physical things and so define their "matter," while definite shapes and varying rates and directions of motion are but ephemeral specifications or limitations of these constant attributes and objects of special study by geometry and kinematics. Thus we have a clear conception of what bodies would essentially be, were they existent; it remains to demonstrate that they do exist, independently of our conception. But with this idea of matter, as with the idea of God, there must be a sufficient reason that accounts for its being thinkable. Having shown that this cannot lie in the thinker's powers of sensing, imagining and willing, Descartes affirms the remaining alternative: it must be an independently existing matter possessed of those defining attributes. And this third affirmation of existence is vouchsafed by the divine veracity previously established; for a God wholly veracious and omnipotent could not deceive us if we affirm no more than is clearly and distinctly deducible. It follows then that normal sense perception is trustworthy in inclining us to assert the existence of bodies, untrustworthy only in reporting their natures. For the characters that bodies appear to possess (colours, odours, temperatures, etc.), being not clearly conceivable but only vividly sensible, are at most "by-products," epiphenomena collaterally occurrent when our sense organs are acted upon by bodies external to our own.

Thus both demonstrations (of God and of matter) are of the same form. Proceeding under the injunction *de omnibus dubitandum*, Descartes nowhere asserts but everywhere supposes the thing thought in idea not to exist, precisely in order to demonstrate that it does exist; beginning in both cases from a clear idea that defines the nature of the thing whose existence is in question. The principle of divine veracity which guaranteed the affirmation that bodies exist independently of our conceiving them is next applied retrospectively to the *cogito*. At that juncture, one was assured of one's own existence only on occasions of self-awareness. But such momentary disclosures, being intermittent, do not suffice to attest either the continuity or the identity of our self through periods between their occurrences when we are unaware of our existence, as in dreamless sleep or unconsciousness. But that principle of divine veracity which was adequate to validate a belief in the continued existence of bodies unperceived serves with like legitimacy to assure us of our own persistence when unperceived—besides authenticating the further affirmation that minds other than one's own exist. Thus the solipsism, which earlier may have seemed insurmountable, is transcended at the close of the *Meditations*, where Descartes concludes that we are indubitably assured of the existence of God, of a plurality of selves that think, of innumerable extended bodies that move and of the complete disparity in nature of selves and bodies. The existence of an independent world whose status was originally only problematical—it being but a working hypothesis of physics—is now, he believes, finally established as veridical or factual. God alone is eternally existent: whatever exists in time, depending upon God for its continuance, is either a body or a self, having for its ultimate inalienable nature either *extensio* (three-dimensional extensity and potential mobility) or *cogitatio* (awareness, feeling and volition). The continuant body or self displays its attribute throughout its changing existence in a series of actions and states ("modes" of that attribute) all determinate and qualitatively very diverse. Descartes now turns from "questions of existence" to "questions of essence." He makes each disparate attribute in turn the subject of a protracted deduction that shall explicate the principles of connection between its determinate modes and the laws of their causation. These two deductions form his philosophy of nature and his philosophy of mind; they should not however be identified with what are now called physics and psychology, for these he would allow to be only groups of more or less coherent hypotheses whose knowledge-value was highly problematical.

Philosophy of Nature.—To exhibit his "concrete geometry" as a veridical philosophy of nature and not a mere physics of a possible world, Descartes was required to show that it follows necessarily, without break, from his metaphysics. This should be possible, he thought, for his metaphysical conclusions and the initial principles of his natural philosophy are both of universal import, therefore of a character to be deducible, the latter from the former. The transition once effected, the rest of the deduction consists in showing step by step that principles less universal follow from others more universal, all together being adequate to explain the constitution of the natural world and the main types of change occurrent in it. Its laws of the highest generality once ascertained, he thought that he could then apply them to explain facts more special, though still general, of physics, optics, astronomy and other sciences, respecting the varieties, differentiating properties and behaviour of bodies, inanimate and animate, using throughout laws of two kinds only: those of motion and of space. Now the identification of matter with space entails that matter is wholly passive. No property of space necessitates motion, so motion, though presupposing space, is not deducible from it. Further, an explication must be found for the actual division of this intrinsically passive matter, this infinitely divisible but undivided space, into innumerable figured parts—volumes or bodies—and then for their individual changes of condition and of place. Descartes thought to explain both the plurality and individuality of bodies and their changes by means of one "simple nature": motion. But since space cannot impart motion to itself, nor selves impart it, the only source from which motion could be imported into space is the sole existent remaining, namely God. And God is an adequate cause, for, being omnipotent, this source must be sufficiently empowered; and being immutable, it follows that the quantity of motion imparted to, and conserved throughout, space must be con-

stant, susceptible of being variously distributed from time to time, but not of increasing or diminishing its sum. All multiplicity and diversity are thus derivative and in origin extraneous to the natural world. The identity of each particular body is founded in the constancy of its magnitude, this alone being conserved throughout its altering shapes and movements. Its locomotions, however, are not from and into independent, fixed places that are "absolute," neutral as between their occupants and successively occupied by different bodies, as Aristotle had supposed. The place of a thing at a moment is not "absolute" but wholly relative to the place of another at the same time, which other thing we agree to regard as immovable. That a body has moved means that it is now related to some other body by a distance different from that which related them previously—it is simply a question of convenience which be declared to move and which to be at rest, for "nothing has a permanent place except so far as it is fixed by our thought." Thus, it is convenient to say of a man seated aboard ship that he is "at rest,"—as he is, relatively to the ship's deck; but he is nonetheless "in motion," relatively to the harbour. Though motion is real, place or position is "a distinction of reason." "Motion is the transporting of one body from the vicinity of those bodies then in immediate contact with it to the vicinity of other bodies not then in contact with it." Neither does movement take place through a space unoccupied by bodies, nor does any body expand or contract, for both suppositions assume the existence of space that is empty. "To move" means simply to be in different places at different times. And since the identity of a body consists wholly in a certain magnitude (a certain constant quantum of extension), to speak of its volume's being increased or diminished can mean only that parts of its divisible extension have become separated by greater or lesser distances than those which previously separated them; there being no alteration of the body's original extension but merely displacement of its constituent parts. So unless "empty space" means space not displaying its usual or expected content, it is a contradiction in terms. From space's being indefinitely divisible it further follows that there can be no atoms; for even bodies so small as to be imperceptible will still be extended and therefore composite bodies further divisible. "Atoms," "empty spaces," "rarefaction" and "condensation" are at best convenient fictions. Having explained, by assigning its "first cause," how there should be motion at all in the world, Descartes next deduces the "secondary causes" sufficient to explain particular motions occurrent in this or that body. The total quantity of imparted motion being constant, the law of inertia immediately follows: no body changes spontaneously; for the initiation, as for the cessation of its motion, a cause is required, since a body always continues in its present state; at rest, unless another move it, or in motion, when moved, until another retard or stop it. And all movement is in a straight line, curvilinear motion requiring the intervention of a cause additional to that which initiated the movement. (These two laws are approximately the same as Sir Isaac Newton's famous "first law," formulated 40 years later.) Descartes now turns to velocity—an intensive, not an extensive or geometrical property of motion—and, to explain it, falls back on mass: their product defining "quantity of movement." Since he identified matter with space, he is able to define mass as volume. But this device does not really serve him, for (as Leibnitz afterward showed) retardation of movement cannot be explained by volume or space alone. What Descartes in fact required was not a geometrical but a dynamical property, and he probably saw this but refused to introduce what he considered "occult" for fear of compromising the wholly geometrical character of his natural philosophy. A third law, that of impact, with these two laws of inertia, exhausts the conditions necessary and sufficient for the occurrence of particular movements: "If a moving body impinging on another has less force to continue moving in a straight line than the other has to resist it, it loses nothing of its movement though it changes its direction; but if the former body has greater force it moves the other with it, losing so much of its movement as it imparts to that other." From these most general laws, applicable to all motions of all bodies indifferently, he then deduced seven special laws, applicable to typically different cases of impact.

The same principles explanatory of the constitution and changes of inanimate bodies are extended to explain those of animate ones —Descartes' anatomy and physiology require no principle additional to those of his celestial and terrestrial mechanics. A mechanistic biology is but a corollary to his mechanistic physics, animate bodies being but natural machines. Though their actions are more complicated and various than those of machines artificially constructed, nevertheless, like these they presuppose no more than a certain disposition of the body's parts or organs. Thus the spider is a natural weaving machine; the mole, a digging and boring automaton.

But there is a subclass of animal bodies—it was forced on Descartes' attention—which are peculiar compounds, such that the body machine exists in a continuous and intimate union with a "thinking thing"—a union that cannot be deduced from the principles of the "concrete physics" but which can be known only from observation and inference: the union of an extended human body with an unextended conscious self. Though experience testifies continually to their association and to its pragmatical efficacy in preserving the body from hurt and destruction, it provides no distinct and adequate explication of how they are united. In Descartes' treatment of this still unsolved problem, the insufficiency of his first principles both in number and in kind becomes only too apparent. He denies causal interaction between body and self to be possible not only because of their utter diversity of nature but also because, if by their volitions selves initiated movements in their bodies, they would create and communicate an ever-increasing quantity of motion additional to the amount originally imparted and declared constant. The interaction commonly supposed is fallaciously inferred from our sensory and emotional experience; in its stead he substitutes a parallelism in which changes of definite kinds occurrent in the nerves and brain synchronize with certain mental states correlated with them. This proposal opens the way to occasionalism (*q.v.*). Descartes, however, does not advance so far, but stops short at the negative conclusion that the two series of changes, physical and mental, remain ever distinct; no change in either causing a change in the other. But this explanation is seriously compromised when he turns to such special "mixed" problems in psychophysics as those of sense perception and volition. Sensation is a wholly physico-physiological transaction terminating in a movement of the pineal gland. Here, however, the continuity is broken, for the perception—the ensuing awareness of what is sensed—cannot be an effect of that movement, for it is an action of the self, of the perceiver himself, not an action of a gland in his body. So a hiatus remains between the set of physiological movements and the act of perception, the former being not the cause but only the occasion upon which the latter occurs. Again the continuity is broken, in converse order, when a volition is said to "initiate" movements in one's body: the same hiatus is indeed apparent throughout Descartes' whole treatment of the mind-body relationship. Selecting the pineal gland as the central reservoir from which the "animal spirits" radiate, he speaks of the self's being "constantly present to" that gland and "inclining" it when it propagates changes along the nerve channels and bloodstream. But he fails completely to show how the nonphysical self can move a pineal gland that is physical when it cannot move an arm or a leg. And to speak of this gland as "the seat of the soul" and of the soul "being present to it" is to use misleading metaphor, for both phrases rest on a spatial analogy that is inapplicable to what is unextended. "Animal spirits" too, however volatile, rarefied or gaseous, are still extensive and mobile, hence certainly material. Interpolating such intermediaries to make physical functions seem more mental and mental functions more physical is mere procrastination. Descartes elsewhere declares, however, that the self's union with the body, though discoverable, is not understandable.

Philosophy of Mind.—Having deduced in his natural philosophy the determinate forms into which motion diversifies space, so explicating the universal nature of bodies, their states and connecting laws, it remained for Descartes to attempt a complementary account of the other essential attribute, *cogitatio* or *pensée* (consciousness), its forms and their relationships, so explicating the nature proper to selves. Mind he conceives to be analogously

diversified into a continuum of determinate actions and states occurrent from moment to moment and so forming the self's history. They are of three main kinds: acts of awareness (of concepts, sensible appearances, images), states of feeling and emotion ("passions") and acts of volition and affirmation. Knowing, the self's primary function, is independent of the knower's bodily organs and activities ("the soul can work independently of the brain"); and in thinking the pure ideas that constitute its knowledge the self is exhibiting in temporal succession the nontemporal, invariable and universal constitution of human reason. Sensory awareness, though sometimes instrumental, is often obstructive to the acquirement of knowledge. Never, indeed, is it even partly constitutive of that which is known; its value is utilitarian, enabling animate bodies to conserve themselves and to adapt themselves to changing physical situations. No clear concepts that alone constitute pure science can be abstracted from the confused qualitative deliverances of our senses. Such pure ideas as those of "simple natures," the divine perfections and axiomatic truths, also the operations by which we apprehend them, all are alike "innate" or unlearned. Despite their individual differences all minds are by nature predisposed to think and rethink such thoughts in ever varied contexts, without, in order to do so, receiving any aid from senses, brain or body; experience and training providing only the occasions on which they shall be thought. This power to produce and to pass to and from such concepts complex and simple as the method envisaged—this innate, unacquired cognitive disposition—gives us the radical sense in which our ultimate defining nature is *cogitatio* or *pensée*. Yet this capacity differs from certain others, such as memory, that also are innate. Memory reinstates only what has already been experienced, whereas by this disposition we originate concepts never before conceived and which cannot be extracted from what is given in experience, as well as subsequently reinstating them in the course of our thinking. By *intuitus* we apprehend pure ideas, by *deductio* we educe their connections but no more; neither operation affirms the existence, in the physical world, of independent correspondents to those ideas and connections. Such affirmation or "judgment" is an additional function, distinct from merely prehensive and contemplative acts, and not simple as they, but complex. For, in being affirmative, it is an act of will; but since it is existence that it affirms, it necessarily has reference to an idea—one respecting the character of that whose existence it affirms—and in this respect it is so far "contemplative." Judgment is thus a complex function of the self, a joint operation of its volition and cognition: it affirms the validity, of that which is contemplated and supposed, to be independent of that very contemplation and supposal and thereby asserts its existence. It is in this way that selves transcend themselves in their knowing: thus a relationship with an independent order of existences is established in true judgment, and the difference between existential affirmation and simple contemplation elucidated. But what is so affirmed valid and independently existent may in fact be so in one case and not in another, judgment being exposed to a risk of error that does not beset simple contemplation. Yet, though no man ever wills to err, it is by his will that he does so. In its forms of choice, decision and affirmation, our will is perfect; the range of assertions possible to it is unlimited. But our cognition is not analogously perfect, for much that we perceive is unclear and cannot be brought to lucidity by mere effort of will. Error must therefore be due not to volition alone, for it is perfect; nor to awareness alone, for it is not affirmative; but precisely to their combination in the same self: the compresence in it of imperfect enlightenment with an unrestricted power of affirmation. Consequently self-deception and error consist in an imperfect use of our perfect freedom, asserting and denying where we do not clearly understand; for we are not compelled or "determined" in our use of will, we can suspend judgment no less than affirm. This self, active in judging and willing, is passive in sensing and feeling. Its emotions and affective states of pleasure, displeasure and pain evince maximum confusedness in their intrinsic qualities and in the subtlety of their varieties: they defy definition and can be treated only in terms of those collateral bodily disturbances of which they are the epiphenomena. Their confusedness is a function, directly of the intensity, indirectly of the location, quantity and direction, of the bodily disturbance; the two former varying in direct concomitance with the last. Contrasted with these epiphenomena of its body's changes—these "passions" to which the self is subjected—are its volitions. It recognizes these to issue from and to be caused by itself, and itself to be competent to counteract the inclinations of its passions, thereupon being again incontrovertibly assured of its own identity and continuant existence. Descartes' philosophy of mind is thus compounded of a science of cognition and a psychophysics of affection and conation.

Our will "is so entirely free that never can it be constrained." Its acts are not physically determined as are the changes in our bodies nor interconnected necessarily as are the properties of geometrical figures, but are contingent. Their contingency, manifesting our freedom, is not however unconditional, for a "liberty of indifference" would entail a radical irrationality of the will. The clear perception that a contemplated action to which emotion inclines us is good is of itself sufficient to secure our assent to it and initiation of it: we no longer withhold assent from it. But action so following upon a clear perception of its goodness is not determined, for this clear cognition of its goodness is not vouchsafed to casual inspection but is a result of our purposive effort to discover an idea that is clear and of our freely refusing to decide prematurely; such efforts and refusals in the prefinal stages of a deliberative process being themselves acts of will on the part of a self that is equally free at the time to decide precipitantly as to refrain from doing so. In so refusing to decide prematurely the self is acting freely, for, by hypothesis, it has not yet attained a clear perception of that alternative which it will eventually adopt. And the fact that we are free to refrain from asserting what is unclear is known to us immediately, not by inference but by self-inspection—"without proof, and simply by the experience that we have of it." When the idea contemplated be one concerning a course of social conduct and we conform our action with a precipitous judgment, the ensuing action will probably be vicious or morally wrong. Right or wrong conduct is the expression and the consequence of affirmations of what has been, or has not been, clearly perceived to be good. Thus Descartes in company with Socrates regards rightness of action to depend upon certainty of knowledge, and wrong-doing upon ignorance.

The self's intrinsic nature is successively displayed diversely and determinately in its actions and passions. Accordingly, when asked whether the self's nature consists in its states collectively or in its capacity to have them, Descartes does not hesitate to answer that *"l'âme pense toujours"* ("the soul thinks always") means primarily that it is its inalienable nature to be *pensée* ("conscious"), but, this being intrinsically a capacity diversifiable in time, it means secondarily and derivatively that it will continue self-consciously active and undergo passions so long as it remain united with its body. Thus the self's mortality or immortality properly relates not to whether there will occur an action or passion that is "its last," but to whether it be possible for "the thing that thinks" to become inexistent. The self plainly cannot itself cause this, neither can it be caused by the death of its body, no interaction between them being possible because of their utterly disparate natures. Further, the self cannot die through partition as the body does, for the self has no parts. Bodies cease to be animate and decay because they are not independent substances but only dependent parts ("modes") of a substance; but selves are by nature incapable of annihilation precisely because they are substances, each independent of all others. No self is a part of any other self, but every body is a part of the single extensive whole called matter: there are innumerable thinking substances but only one material substance. So, should a self be mortal, the cause of its mortality, since it can be neither itself nor another self nor matter (of which it is independent), could only be God, upon which it depends in common with all created things. Being the cause of the soul's existence, God could also be the cause of its annihilation. Whether a given self eternally survive its body's death could be answered categorically only from a knowledge of God's future decisions, which we have not: so to the question *quid facti* ("what is in fact the case") we must reply *ignoramus et ignorabi-*

mus ("we are ignorant and shall remain ignorant"). But on the question of possibility it may be added that, if God does not decree its annihilation, since nothing else could cause it the self will continue in existence despite and after its body's death.

See also CARTESIANS; DUALISM; KNOWLEDGE, THEORY OF.

SPECIAL PROBLEMS OF THE SCIENCES

In *Le Monde* (first published posthumously, Paris, 1664), a celestial and terrestrial physics, Descartes treats of classes of particular bodies whose existence can be known only by experience but for a knowledge of whose specific characters deduction also is required. In this characteristically Cartesian research Descartes' progressive analysis of one "absolute nature," namely light, is shown to depend upon solutions to certain subordinate problems that compelled him to investigate the sun and fixed stars (its source), the heavens (its transmitter), the comets and our earth with its bodies opaque and transparent (its reflectors and transmitters) and "animal-machines" (its perceivers). Those investigations involved the use of normal observation and of experiment. In many concrete problems that he investigated, relating to the weight of air (1631), to the laws of light and sound (1633) and to magnetism, magnification, the properties of glass, the phenomena of tides, lightning, thunder and the rainbow, the differentia of oils, spirits, common waters and salts, Descartes made a large use of experiment; and, again, his use of observation is apparent in his dissections of the heads of various animals to discover the mechanism of memory and imagination. And this dependence on experiment was not inconsistent with his claim that his method was wholly deductive. For to discover laws is one thing; to apply laws discovered in explaining phenomena quite another. The office of experiment was to facilitate selecting from this deductive system of laws those that are relevant to the particular phenomenon requiring to be explained, for we ought "to explain effects by their causes, not causes by their effects." But, he adds, "since the power of nature is so ample and these principles so general, there was scarcely any effect which I did not straightway recognize to be deducible from them in several ways, and my greatest difficulty was usually to find out in which of these ways it is that the effect depends upon them. In such circumstance, I know of no other plan than to devise experiments of such a nature that their result is not the same if it has to be explained in one of these ways as it would be if explained in another." It seems from this that the function of experiment in Descartes' view is to enable us to decide between *a priori* equipossible explanations of an effect when all that we know is that one of them must truly explain it but we do not know which is that one. Descartes claimed certainty and finality for the universal principles of his natural philosophy, not, however, for his particular conclusions resulting from their applications in his various departmental researches. These conclusions he recognized to be provisional and modifiable with the advance of science, for "to demand geometrical demonstrations in matters depending on physics is to ask me to perform the impossible, and if you restrict the word 'demonstration' to the proofs of the geometers you will be compelled to say that Archimedes demonstrated nothing in mechanics, nor Vitellion in optics nor Ptolemy in astronomy." Explanation of the specific and particular is thus relative to the insight and evidence available at the time, therefore provisional in principle; but this does not entail that the laws that are utilized in explanation are themselves no more than problematical. For laws demonstrated *a priori*, though primarily objects of knowledge, are also instruments by which to explain phenomena, these being of themselves impotent to contribute to natural philosophy any law of even the meanest generality. All phenomena are thus investigated under the dual principle that they are simply constant quanta of three-dimensional, divisible space and that their changes, however various, are but motions referable to a few kinetic laws. By their means alone he explained the phenomena of magnetism and therefrom the constitution of our earth as a whole, comparing it with a vast magnet. Weight, discarded as an unclear notion, he replaced not by gravitation but by motion; viz., that of certain globular particles ("second matter") surrounding the earth which propel bodies toward it in calculable motions. Likewise the action of water pumps is to be explained not by nature's abhorrence of a vacuum but "by the weight of the water which counterbalances that of the air." His denial of a vacuum also led him to discard the supposition that the transmission of light was an emission of corpuscles and to conceive it as a propagation of pressures through a fluid ether, from which conception Huygens developed his undulatory theory. Rays of light were lines along which the pressures were transmitted; if they passed through a transparent medium they were straight; were the medium otherwise, they were deflected. If those rays impinged obliquely on certain surfaces they were reflected, the angle of reflection being equal to the angle of incidence. Were the medium such as to diminish the velocity of the rays passing through it, they were refracted. From discovering the law of their refraction—expressed in the trigonometrical function still named after him—he deduced the principles of the chief optical instruments; and by the reflection and refraction of light rays in drops of water he explained the formation of primary and secondary rainbows. It is to Descartes too that the inception of the mechanical theory of heat is due. Heat is no quality of bodies but a violent motion of corpuscles and, establishing its connection with light, he showed that rays of the one could be transformed into rays of the other. So, by investigating the different transformations of which motion is susceptible and by persisting in his resolve to geometrize all nature, Descartes contributed substantially to forming that substructure of modern mathematical physics which Galileo had initiated and Sir Isaac Newton and J. L. Lagrange later improved.

His influence on later physiology was less extensive and profound than that on physics. Using only the same ultimates—the properties of space and motion—he extended the application of his "concrete geometry" from the inanimate to the animate, but in doing so probably assumed too uncritically that all activities of organisms are mechanistic and that their development, in contrast with their mere alterations and locomotions, is but mechanical too. He conceives a fully developed animal, for instance, as simply a body that now has a greater number of other bodies lodged in the interstices between its parts than it had formerly. Both the number and the nature of the ultimates adequate to resolving biological problems seem to have been too severely restricted. He persists in regarding both the structure and the behaviour of all bodies, human and animal, as completely mechanistic—declaring "if all the constituents of the seed of a given animal species were completely known, from that alone and by wholly mathematical reasoning, the shape and the structure of each of its members could be deduced; and conversely, from knowing certain peculiarities of that structure we could deduce what is its seed." Heat, which he calls "the mainspring" of all movements occurring in the body machine and its members, is continually renewed by respiration, "the air, mixing with the blood before it enters the left concavity of the heart, causes its heat to increase." The blood in turn by its continuous circulation (for he corroborated and stoutly defended William Harvey) conveys its acquired heat to all the body's parts. A similar mechanical account is offered of the body's alimentation. Discarding the "faculties" with which parts of the body were then thought to be endowed and which enabled them to discriminate, select and attract each its appropriate aliment, Descartes accounts for alimentation by means of the location of the organ in relation to the path which the particles of nutriment follow and by the sizes and shapes of the pores into which they enter. Other internal activities of the animal body require little besides the system of nerves (imagined as tubes) and the animal spirits flowing within them. Impulsion from without causes pressure of those spirits, this pressure (envisaged as undulation) in turn causing actions and reactions, and motions of flexor and extensor muscles. The overt behaviour of the body as a whole likewise illustrates none but mechanical principles (*cf.* leverage in walking), and its inanimate condition after death is comparable with the difference between a watch wound and unwound.

Descartes' greatest service to the future of science lay in his attempted geometrization of all nature, and his contributions to pure mathematics far surpass in permanent value those which he

made to other sciences. The *Geometry* (1637) was his great and original work in this field; much then revolutionary in it has now been absorbed into standard textbooks of co-ordinate geometry. The originality of the reform by which he laid the foundations of analytic geometry consisted in his introducing into traditional geometry a procedure employing the notions of constant and variable and making it possible to express properties of curves by algebraic equations. Having established a correlation between a set of points and a set of numbers he demonstrated that certain relations between those points correspond with certain relations between the numbers. One may then proceed to treat the numbers algebraically without referring to their correlative points, or conversely deal with the points without reference to their correlative numbers. Each procedure has its advantage: the algebraic treatment greatly facilitates the resolution of complicated problems of geometry, the geometric representation of algebraic results exhibits their import more vividly (*cf.* the value of graphs). Descartes' great merit here was to have applied geometry to algebra; he was not the first to have applied algebra to geometry. In algebra, he systematically employed exponents, interpreted the notion of negative quantities and elaborated his "rule of signs" for determining the number of negative and positive roots in an equation (*see* EQUATIONS, THEORY OF). And to Descartes we owe the first systematic classification of curves. After dividing "geometric curves" which can be precisely expressed in equations from "mechanical curves" which cannot, he classified the former into three classes of increasing complexity according as their equation contains (1) no term of higher degree than the multiple of two unknown quantities, or the square of one (*i.e.*, the circle, the parabola, the hyperbola, the ellipse); or (2) one or more terms of the third or fourth degree in either or both of its unknowns; or (3) a term of the fifth or sixth degree in either or both of its unknowns. The straight line he regarded as the limit of a curve of the second degree; *i.e.*, of class 1. This new geometry (which illustrates some of the rules only announced in the unfinished part of the *Regulae*) is more than a general theory of quantity: it led to the concept of continuity, from which was developed the theory of function and, in turn, the theory of limits. Further, his resolution of the problems of doubling the cube and of trisecting an angle enabled him to contribute to the theory of equations. His general rule for resolving an equation was to express it in zero form and try to factorize the left hand side so as to reduce it to two or more equations of lower degree. If the equation were one of the third or fourth degree, the solution depended upon the intersection of a circle with a conic. For solving equations of still higher degree he proposed to use intersections of circles with the several classes of geometric curves—conics being used to generate curves of class 2, and these again to generate curves of class 3. But he was mistaken in believing that equations of any order could be so resolved.

See ANALYTIC GEOMETRY; CURVES, SPECIAL; *see* also references under "Descartes, René" in the Index.

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DESCENT, SYSTEMS OF. The societies covered in this discussion are chiefly confined to the civilizations of Europe and Asia. Additional material, including similar themes in primitive societies, is contained in the articles KINSHIP; KINSHIP TERMINOLOGY; MARRIAGE, PRIMITIVE; and SOCIAL ANTHROPOLOGY.

Introduction.—In its broader meaning, the word descent is used for the set of principles according to which individuals are placed in terms of their kinship connections. For example, when a man X is said to be descended from a man Y, the ascription of descent implies that X enjoys a certain status and has certain rights and duties by virtue of his relationship to Y. In the narrower meaning of the term, descent is the principle by which individuals are allocated to clearly defined kinship groups. In the simplest case, unilineal descent (which may be either patrilineal or matrilineal, *i.e.*, through a line of males or through a line of females), divides society up into a number of mutually exclusive clans or lineages.

The distinction between these two senses of descent may be seen by a comparison between the nonunilineal kinship system of most modern western countries and the unilineal (patrilineal) system of traditional China. In the former system an individual may say that he is descended from ancestors whom he traces through a variety of links, and on both sides the chains of descent pass indifferently through males and females. The practical significance of such descent may be either that a man establishes (or tries to establish) some kind of claim on other people descended from the same ancestor or that he enjoys some status or privilege by virtue of his descent. Both structurally and in terms of the rights and duties involved, this system is vague.

In the Chinese system the descendants of a man traced exclusively through males formed a distinct group vis-à-vis other groups similarly constituted. In some parts of China, especially in the central and southeastern regions, patrilineages tracing their origin to an ancestor 20 to 30 generations back and numbering several hundred people constituted local communities or definite segments of such communities. As a local group the patrilineage included the wives married to its men and excluded its own women, who by rule were married to men of other groups. These patrilineages were corporate bodies which had legal, political and economic rights and which formed distinct ritual communities through the worship of common ancestors. Any one lineage might be segmented into patrilineal groups which were in turn further segmented, so that the lineage as a whole consisted of lesser groups nesting within greater ones. Patrilineal descent did not rule out descent in its broader sense since, for certain purposes, a Chinese also traced descent through both mother and father to some nonpatrilineal forebear.

Naming Systems.—The English and Chinese systems resemble one another in that in both systems individuals bear surnames which they acquire from their fathers, but it is important to avoid reading too much into this resemblance. In England, a man's relationships with cousins who bear his surname and with cousins of a different surname are not normally different in principle. In China the surname is an index of patrilineal connection, and even if two men of the same surname are not members of one local patrilineage, the fact that they bear the same name gives rise to certain assumptions about ultimate patrilineal descent and furnishes the basis of a potentially active relationship. A Mr. Ch'en in China regards other Ch'ens as significantly different from people bearing other surnames; for a Mr. Brown in England most other Browns are, as it were, accidents of nomenclature.

It follows that naming systems by themselves must not be taken as simple indices of descent. In common Muslim practice the naming model "A ibn B" (A son of B) indicates each man's father (or each woman's father, on a similar model) but reveals no continuous thread through the generations. In the Spanish surnaming system, a man bears both the paternal element of his father's surname and the paternal element of his mother's; his children carry

forward the paternal element of his surname joined with that of their mother's. Such a system stresses the continuity between a man and both his grandfathers and passes on one name in the male line, but it is not the basis for clearly delineated descent groups. Neither is the Russian system of naming, in which a surname is transmitted through males and in which each individual is also linked by a patronymic, which precedes the surname, to his, or her, father; *e.g.*, Georgi Ivanovitch (son of Ivan) Koslov. In the Chinese patrilineal descent-group system, on the other hand, not only is the surname a basis for marking out groups but within each patrilineage all the males of one generation may bear a common element in their name, so that a Chinese name in the form A B–c indicates descent in the first element, generation status in the second and individual identity in the third.

In surnaming systems, it is common to find that a woman either adopts her husband's surname (as in English-speaking countries) or joins her husband's surname to her own (as in Spain). The significance of the change lies in the transformation of the married woman's legal status—some rights being transferred to her husband. In various European legal systems a married couple form a single personality in some respects, the husband standing as its representative. Therefore, the adoption of her husband's surname by a wife is best regarded as an aspect of the immediate marriage relationship and not necessarily as evidence of the incorporation of a married woman into some group symbolized by the husband's surname. Indeed, where incorporation of this kind does take place (as in China), the woman may well retain her own surname, for her new status is unambiguously indicated by her new residence and a myriad aspects of her everyday behaviour, while her own surname may serve to show the link between the group into which she was born and the group to which her children will belong.

Descent Systems in Europe.—The theme of descent has not been well explored in Europe, more exotic parts of the world having largely commanded the attention of anthropologists. The great majority of Europeans live within the framework of nonunilineal (often called bilateral or cognatic) kinship systems. In these systems kinship is reckoned symmetrically on the paternal and maternal sides, according to degrees of proximity. All four kinds of cousin (father's brother's child, father's sister's child, mother's brother's child, and mother's sister's child) are structurally equivalent. The systems of kinship terminology (relationship terms) bring out the symmetry; in English, for example, the terms grandfather and grandmother, uncle and aunt, cousin, nephew and niece, grandson and granddaughter fail to show whether they are on the maternal or paternal side. Terms for more remote relatives leave the particular linkage unspecified among a great number of possible connections. Thus (where F represents father; M, mother; B, brother; Z, sister; S, son; D, daughter), my male second cousin is any one of the following: FFBSS, FFBDS, FFZSS, FFZDS, FMBSS, FMBDS, FMZSS, FMZDS, MFBSS, MFBDS, MFZSS, MFZDS, MMBSS, MMBDS, MMZSS, MMZDS. In principle, there are no limits to the range of relatives recognized in such a system. No two individuals, unless they are full brothers or sisters, have exactly the same circle of relatives, and every individual stands at the centre of a circle of relatives who do not as a whole share common ancestors. A cousin on my father's side has no connection by descent with a cousin on my mother's side (unless some cross-marriage has taken place). In technical language the relatives in each circle are known collectively as a kindred.

The limits of the kindred are likely to be defined in formal terms only when quite specific obligations are laid upon kinsmen. In modern circumstances one would not expect to find clear definitions of the limits, but if one looks at the historical material on European kinship, examples are found of bounded units of this kind, the demarcation being made in order to take account of important reciprocal obligations among relatives. There are recorded rules of the degrees of cousinship defining the extent of the kindred among several Germanic peoples in northwestern Europe in the middle ages and later, especially in relation to wergild (the payment and receipt of compensation for slaying), although it is important to realize that the evidence is often fragmentary and that there was much variation according to place and time.

The modern systems which have grown out of the earlier kindred systems of Europe are extremely flexible. Kinship may well play an important part in governing the behaviour between members of a long-established farming community, laying down patterns of association and co-operation, but a kindred is not a corporate body which is perpetuated through the generations and it cannot in itself be a property-owning unit. On the other hand, members of a kindred may enjoy certain rights in relation to the property held by one of them. In Norway, for example, when a farmer sells land to a stranger, the law of *odelsrett* entitles his kin, in a fixed order among themselves and within a fixed period, to buy back the land at the market price. Studies of countrymen in Britain and Ireland have shown how kinship may be important without being the framework of community life.

It is often assumed that the wide ties of kinship found in rural communities contract, perhaps to insignificance, in the conditions of urban life. Studies in England, however, suggest that these ties may be widely recognized and utilized if there is a fair degree of stability in an urban population. The obligations assumed or expected may be few and seemingly unimportant in relation to the whole field of social life; yet they give rise to a number of utilitarian and symbolic "services" among relatives which make it rewarding to keep alive relationships which the general nature of legal, political and economic institutions does little to support and sanction.

Modern Europe is characteristically a continent of nonunilineal kinship systems. The precise nature of the patrilineal institutions of classical Greece and Rome is still a matter of debate, as is the unilineal character of other regional forms. By an ironical twist of etymology the word clan, as used in kinship studies, has very limited application to modern Europe. It is derived from the Gaelic *clann* ("offspring"), but the clans of the Scottish Highland system, which appears to have taken shape during the 11th century and which survived into the 18th, seem to have had more in common with nonunilineal descent groupings than with unilineal ones. They were nonexogamous political groups, subdivided into local segments, the members of which traced their descent to common ancestors but not exclusively through male links.

The only unambiguous evidence of patrilineal organization in 20th-century Europe seems to be in the Balkans. Until the 1930s, a patrilineal kinship system in which the largest units were exogamous clans, each bearing a surname formed from the name of the founding ancestor, persisted among the southern Slavs. A clan was composed of *zadruga,* which consisted of two or more nuclear families (*i.e.*, of two or more families of parents and unmarried children). A *zadruga* did not necessarily occupy the same homestead, but it formed a single unit with regard to the ownership and control of property. Nonpatrilineal kinsmen could be incorporated by adoption. The *zadruga* appears to have taken different forms in different areas of the Balkans: one form in the tribal society of Montenegro and northern Albania; another in central Albania, north and central Macedonia, and parts of Croatia and Bosnia and Hercegovina; and still another in southern Albania, southern Macedonia, western and central Bulgaria and parts of Croatia and Serbia. This type of organization has for the most part disappeared or been radically altered as a result of modern economic and political changes, but it is interesting to find, in a field study of a Serbian village by J. M. Halpern, that while *zadruga* and individual households had come to coincide in the majority of cases, the clan structure was still in evidence; the households of a clan were usually in the same neighbourhood and individuals were able to recite their genealogies. (*See* also CLAN.)

Descent Systems in Asia.—Something has already been said about the form taken by patrilineal descent in China. Despite the degree of political centralization, it was possible for localized lineages (*tsung-tsu*) to maintain control over a great many of the political, legal and economic aspects of the lives of their members. The threat to internal solidarity posed by the differences in the political and economic power of the members was counterbalanced by opposition between lineages (amounting to feuds in

some parts of the country) and between lineages on the one hand and the state on the other. Among all civilized peoples in modern times, perhaps the Chinese came closest to textbook examples of patriliny in the thoroughgoing nature of their patrilineal organization.

There are great similarities between the Chinese system of descent and systems found in Vietnam and Korea. In the latter country, however, the *jongjung* (lineage, corresponding to the *tsung-tsu* of China) is differentiated internally by the maintenance of a senior line of descent, special rights in property and ancestor worship passing through eldest sons. Japan, in contrast, presents an entirely different system; the *dozoku* is not a lineage, in the sense of a group made up of all the unilineal descendants of a focal ancestor, but a line running through a succession of main families (*honke*) to which branch families are attached. The head of the family is succeeded in his status and rights by one of his sons, his son-in-law or an adopted son. Sons who do not succeed in this way form branch families, but the main family may also attach to itself branch families which were not previously related. This flexible system of descent produces a genealogical form and a kind of ancestor worship different from those of the other far eastern systems discussed above. The differentiation in status between main and branch families in the *dozoku* appears to be more marked in the northwestern part of Japan, but the system as a whole is necessarily changing because of increasing industrialization and modifications in land tenure.

The kinship systems of the various countries of southeast Asia are diverse. While, generally, there is no unilineal principle of organization among the civilized communities, there are a few examples of matriliny and patriliny. In the Malay peninsula, the Malays are an interesting case of a culturally uniform people with different descent systems. Most Malays live in communities based on a territorial principle, the only effect of kinship being to construct a kindred around individuals; and no continuing group of kinsmen emerges, except possibly in the context of patrilineal royal houses. Apart from certain Islamic obligations in the field of marriage, rights and duties inherited through father and mother are symmetrical. In the area of Negri Sembilan, however, there is found a system of matrilineal kinship which is connected historically with immigration from Minangkabau in central Sumatra. In this system every individual is a member of a matrilineage which, grouped in relation to other matrilineages of both like and unlike political status, forms the basis of the traditional political organization of the area. Rights to the ancestral ricefields are transmitted within the matrilineal group, so that when a man goes to live in his wife's house after marriage he becomes concerned in day-to-day economic affairs with property over which he has no traditional right. In modern times, changes in political organization and agriculture (especially the advent of smallholder's rubber plantations) have modified the working of matriliny and have brought the contradictions between matrilineal and Islamic principles to the fore. The Islamic rules of inheritance (which favour sons) provide people with an argument against the matrilineal rules entailing property in the female line.

Contrasting examples of patriliny and matriliny are to be found in Sumatra among the Batak and the Minangkabau, respectively. Among the former the patrilineal principle governs the construction of hamlets (whose members ideally form a small lineage), the larger lineages within one village and nonlocalized clans consisting of many lineages. Within the Minangkabau village there are several matrilineages, each divided into a number of house groups; those bearing the same name may be said to form a clan. In the traditional system a man continued to live in his own house after marriage, visiting his wife in her house at night. Succession to the headship of matrilineages and house groups passed from a man to his "sister's son."

The most complex civilization in Indonesia has developed in Java. The kinship system of the largest cultural group, the Javanese, is a nonunilineal system in which the tracing of links is partly determined by the quest for special status and land rights. In neither of the two broad classes of prerepublican Javanese society, nobility and peasantry, did descent form the basis for clearly defined groups, but clusters of kinsmen were produced among the nobility by passing down titles and establishing recognized connections between officeholders, primarily through the father. Among the peasants a man's status in the village, which regulated his right to land, was again primarily but not exclusively transmitted paternally.

The analysis of kinship in the nonprimitive areas of Burma, Thailand and the Philippines has not progressed far enough to make detailed comment worthwhile, but in these areas we find nonunilineal systems. The flexibility of such systems allows individuals to align themselves with kinsmen traced in many different ways according to various needs and rights, though there is generally a narrow range of cousinship defining a circle of intimate relations. The Melanau of Sarawak illustrate this flexibility. Though they do not think of their villages as kinship units, most marriages take place between fellow villagers, preferably with a second cousin, so that the inhabitants of one village are linked together in a complicated network of kinship ties. Kinship linkages (*laian*) help to establish a man's status. There are five status groups (*bangsa*) which are endogamous in theory, but in practice approximately half of all marriages are outside their boundaries, so that in any man's field of kinship there are likely to be people of different *bangsa*. A man normally assumes the rank of his father, but if his mother's rank is higher he may take hers instead. If he is recognized as being of low rank but becomes rich and influential in village affairs (a cash-crop economy making for social mobility) and wishes to raise his status, he can do so by citing *laian* which attach him or his wife to higher *bangsa*. He validates his claim by demanding a bride payment appropriate to his new rank when his daughter marries.

The data on descent in India and Pakistan cannot be summarized satisfactorily, but if one starts with a model of a patrilineal extended family it is possible to gain some insight into the most general pattern. A residential property-owning unit on the framework of patrilineal kinship and spanning three or more generations may be taken as a model. Women marry out of one extended family into another. Units resulting from the partition of such a family may then belong to no formally constituted unit other than the localized subcaste group. They may, however, form localized lineages with rights and duties which give them a separate existence within the subcaste. Furthermore, larger, nonlocal units may be found which are constituted on the basis of like descent from a common patrilineal ancestor and which may be called clans. Generally, in northern India, marriage must take place with women from other villages, but in the south more than one exogamous group of the same subcaste may live in the same village and intermarry. However, it must be stressed that the interpretation of differences in kinship system between different parts of the subcontinent is beset by difficulties which are matters of professional debate. (*See* CASTE [INDIAN].)

While Indian kinship may usually be thought of as patrilineal, it is not universally so. Indeed, India has furnished us with an outstanding example of matriliny: the Nayars of the Malabar coast. The Nayars are a caste which was organized traditionally into localized matrilineages, each composed of residential property-owning units. These units consisted of several generations of brothers and sisters, the members of one generation being the children of women of the preceding one. The problem posed by the Nayars, or at least by those in central Kerala, is whether they practised marriage in any real sense. Before puberty, girls were ritually "married" to men from certain specified lineages and thereafter received other men as lovers. After the ritual of "marriage," the "bridegroom" did not necessarily have any relation with his "bride." Once a woman was pregnant it was necessary, for ceremonial reasons, for one or more men of the appropriate subcaste to acknowledge probable paternity. While it is possible to argue that the Nayars practised marriage (in which case they might perhaps be said to be both polyandrous and polygynous), the role of social fatherhood was pared down to a minimum, and a child had no kinship relations except through his mother. Of all descent systems, that of the Nayars comes closest to a system where descent in one line is not accompanied by de-

scent in the wider sense, *i.e.*, through the parent from whom descent-group membership is not obtained. It is this unusual aspect of the Nayar case which makes it of great interest. (*See* also NAYAR.)

It is only possible to refer very briefly to certain forms of patrilineal organization in the rest of Asia. Broadly, in the central and southwest regions, tribal organization was arranged on a patrilineal framework, so that smaller units within greater ones were referable to points of segmentation on genealogies. This type of organization has left its mark on many settled and highly developed communities, whose local organization is still affected to a greater or lesser degree by patrilineal alignments.

Conclusion.—The study of descent groups in civilized societies leads naturally to the question of their ability to survive. Will all kinship systems come to resemble the vaguely delineated "bilateral" systems of the industrialized west? In thinking about this problem we must distinguish between the effects of calculated political attacks on traditional institutions, on the one hand, and the unplanned changes brought about by shifts in the economic, political and legal aspects of life on the other. In China the eradication of the "feudal" family system has enjoyed a place of honour in the schedule for social revolution, so that the systems that flourished in many parts of China up to 1949 must now be called traditional lineage organization. In such areas as Malaya, India and Japan, descent-group systems are being worn down more gradually. New legal concepts of individual rights in family property may remove the economic basis of a descent-group corporation, and new concepts of citizenship and allegiance to the state may conflict with membership of lineages. It is interesting to note that matrilineal descent systems suffer from a special disadvantage in modern conditions because the assumption of new rights and duties between father and son is a direct threat to a man's being involved in the affairs and interests of his matrilineal group. New economic opportunities may encourage individuals to withhold the fruits of their enterprise from a common pool, and industrial society may break the ties between kinsmen who were at once neighbours, fellow workers, co-owners and members of the same ritual community. Besides being of practical interest, the study of descent groups in decline may throw light on the conditions in which they are able to emerge and persist.

See also FAMILY.

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DESCHAMPS (DE SAINT-AMAND), ÉMILE (1791–1871), French poet, prominent in the development of the romantic movement. Born at Bourges, Feb. 20, 1791, his literary *début* came in 1818 when, with Henri de Latouche, he produced two plays, *Selmours de Florian* and *Le Tour de faveur*. Five years later, with Victor Hugo, he founded the *Muse française*, the journal of the romanticists, and the preface to his *Études françaises et étrangères* (1828) formed a manifesto of the movement. His translations of *Romeo and Juliet* (1839) and *Macbeth* (1844), though never performed, were also important. He wrote several libretti, notably that for Berlioz' *Roméo et Juliette*, and his prose works include *Contes physiologiques* (1854) and *Réalités fantastiques* (1854). He died at Versailles, April 23, 1871.

His brother, ANTOINE (Antony) DESCHAMPS (1800–69), wrote romantic lyrics, revealing brilliance, but also the insanity which ended his career, and translated Dante's *Divina Commedia* (1829).

See Émile Deschamps, *Oeuvres complètes* (1872–74); H. Girard, *Un Bourgeois dilettante à l'époque romantique* (1921).

DESCHAMPS, EUSTACHE (1346?–1406?), prolific French poet famous for his *ballades*. Born about 1346 at Vertus in Champagne, he was educated at Reims by the poet and musician Guillaume de Machaut (whose nephew he may have been) and at Orléans, where he read law and the liberal arts. When about 20 he entered the service of King Charles V. As a squire and king's messenger, he had to ride all over Europe, sometimes under terrible conditions. In 1372 he was made gentleman usher (*huissier d'armes*) to the king, and in 1373 successively bailiff of Valois and master of waterways and forests for the region of Champagne and Brie. In the year of Charles V's death (1380) his house at Vertus was burned down by the English, but he received the castle of Fismes as compensation. In later years he accompanied Charles VI on his campaigns in Flanders, was sent on diplomatic missions, appointed bailiff of Senlis in 1389 and in 1390 entered the service of Valentine Visconti who, through her marriage to the duke of Touraine, had become countess of Vertus. But in 1388 his appointment as gentleman usher ceased; in 1404 he was forced to give up the post of bailiff of Senlis. The king appointed him to other offices, but these were of little use to him. He was unhappy: tired out by the life he had led and racked by arthritis, he thought himself old at 50. Besides, he had a surly disposition, which only grew worse with age. The events he had witnessed and the hardships he had undergone helped to embitter him: as a very young man he had seen French towns laid waste and pillaged by the English invaders; he had seen the signing of the disastrous treaty of Brétigny; and he had endured heat and cold, weariness, discomfort, colds and fevers in the course of his travels. He had married in 1373, had lost his wife three years later and been left with three young children to bring up; the English raiders had ransacked and burned his house. He suffered from baldness and had a pug-nose, a squint and a swarthy complexion (hence his nickname "*Morel*," *i.e.*, "the Moor"); he complained of his poverty, railed against women, hated the English and felt the woes of France deeply. He spent the last ten years of his life in this state of hypochondria, and died about 1406.

Since early childhood, Deschamps had had a passion for rhyming; he had learned the poet's craft from Guillaume de Machaut and until the day he died he devoted his leisure to poetry. He has

left a considerable body of work, the most interesting part of which is represented by the 1,500 pieces in M.S.840 (1,032 *ballades*, 142 *chants royaux*, 170 *rondeaux*, 84 *virelais* and 84 *lais*) in the Bibliothèque Nationale at Paris. His more considerable works include the *Fiction du Lion* (1382), which in an allegorical fashion explained the duties of a king to the young Charles VI; the *Miroir du Mariage*, a satire of over 12,000 lines against women; two comic plays, the *Farce de Maître Trubert et Antrongnard* and the *Dit des quatre offices de l'Ostel du Roy;* and a prose treatise, the *Art de dictier* (1392), the oldest work on poetics in French.

As a poet, Deschamps lacks breadth of conception; but he has wit and gusto and his originality lies not so much in his love poetry, pleasant though it is, as in the endless variety of his poetry and above all in the realistic way in which he describes the evils of his time and his personal misfortunes.

See his *Oeuvres complètes*, ed. by Queux de Saint-Hilaire and G. Raynaud, 11 vol. (1878–1903) including a life (vol. xi); E. Hoepffner, *E. Deschamps, Leben und Werke* (1904). (L.-F. F.)

DESCHANEL, PAUL EUGÈNE LOUIS (1856–1922), French statesman, the tenth president of the third republic, was born on Feb. 13, 1856, in Brussels, where his father, Émile Deschanel, a professor from the Collège de France, was living in exile for opposition to Napoleon III. After having studied law, Paul Deschanel began his political career as private secretary to the prime minister Jules Simon. In Oct. 1885 he was sent to the chamber of deputies by the *département* of Eure-et-Loir and joined the Progressive Republican group. He was constantly re-elected. Having been vice-president (1896) and then president of the chamber (1898–1902), he subsequently presided over the standing committee on foreign affairs, acted as *rapporteur* of the foreign office estimates and in 1912 again became president of the chamber, an office which he kept during World War I. Though never having been a minister, his knowledge of foreign affairs and his oratorical powers made him a prominent figure in French politics, while his affability won him friends in all parties. In Jan. 1920 he was elected president of the republic by 734 votes against 130, thus fulfilling the ambition of his life (the majority of senators and deputies preferred him to Georges Clemenceau as being "safer" and also because he was in favour of resuming diplomatic relations with the Vatican). However, on Sept. 21 of the same year neurotic trouble obliged him to resign. He was soon elected senator but died in Paris on April 28, 1922. He was a member of the Académie Française from 1899.

See R. Malliavin, *La Politique nationale de Deschanel* (1925); J. Chastenet, *Histoire de la IIIe République*, vol. iv and v (1957–60). (J. C. DE C.)

DESCRIPTIVE GEOMETRY, the study of the spatial relationships of points, lines and planes and other surfaces. It forms the theoretical basis for all architectural and engineering drawing, because it provides the means for solving graphically the problems involved in the representation of three-dimensional objects by two-dimensional drawings. The method employed is called orthographic projection, and its working concepts are based on the theorems and axioms of plane and solid geometry. (*See* also DRAWING, ENGINEERING.)

Orthographic Projection.—An orthographic projection is one made upon the assumption that the projecting lines from the object to the plane of projection are at right angles to that plane. One or more planes may be used. To obtain a clear understanding of orthographic projection, the relationship between four items must be comprehended; these are: (1) the object to be represented; (2) the planes upon which it is projected; (3) the point of sight from which the object is viewed; and (4) the lines of sight or projecting lines from the object to the planes of projection.

The object may be a point, line, plane or any real object, such as those encountered in engineering projects. In descriptive geometry the emphasis is upon the spatial relationships between the points, lines, planes and curved surfaces that comprise real objects rather than upon real objects themselves.

The plane of projection is that upon which the drawing is made. Three planes, mutually at right angles to each other, are normally

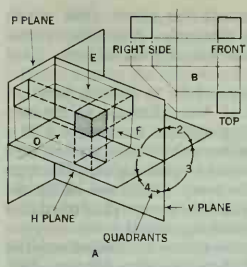

FIG. 1.—FIRST-QUADRANT PROJECTION OF CUBE: (A) POSITION OF PRINCIPAL PLANES, NUMBERING OF QUADRANTS AND THEORETICAL VIEWING DIRECTIONS D, E, F; (B) COMPLETED DRAWING, WITH P AND H PLANES ROTATED INTO COINCIDENCE WITH V PLANE

used and, when spoken of collectively, they are called the principal planes of projection. One plane is assumed to be horizontal and the second vertical; the third, called the profile plane, is at right angles to the other two, as shown in fig. 1.

The projecting line from the object to the three planes (fig. 1) are perpendicular to the respective planes. All lines perpendicular to any one plane are parallel to each other. By definition, parallel lines are said to meet at an infinite distance. Theoretically, therefore, the point of sight for any one view must be assumed to be at infinity.

The point of sight must be different for each view of the object. Thus in fig. 1(A) the arrow lettered D indicates the direction in which the observer theoretically looks to obtain the front view, arrow E indicates the direction for obtaining the top view and arrow F the direction for obtaining the right side view.

When the object is viewed from the front, the horizontal and profile planes are seen edgeways and can be represented by the two reference lines in fig. 1(B). When looking at the top view, of course, the vertical and profile planes appear edgeways, and in the profile view the horizontal and vertical planes appear edgeways.

Quadrants.—The horizontal and vertical planes divide space into four quadrants, customarily numbered as shown in fig. 1(A). The location of the profile plane does not affect the location or numbering of the quadrants in any way.

In first-quadrant projection the object is between the observer and the plane of projection, while in third-quadrant projection the plane of projection is between the object and the observer (fig. 1[A] and 2). In both quadrants the planes of projection are rotated away from the object to give the arrangement of views shown in fig. 1(B) and 3. All problems in this article are illustrated in third-quadrant orthographic projection.

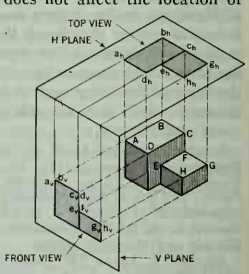

FIG. 2.—TWO-VIEW, THIRD-QUADRANT PROJECTION

Notation.—In the following discussion, standard notation will be used to designate points, lines and other elements.

The principal planes of projection—horizontal, vertical and profile—are called the H plane, V plane and P plane, respectively.

Upper-case letters (except for H, V and P) refer to points in space.

Lower-case letters with subscripts refer to projections of points on planes; thus, a_h, a_v are projections of the point A on the H and V planes, respectively.

H–V is the reference line that represents the edge view of either the H plane (when the observer is looking at the front view) or the V plane (when looking at the top view).

V–1 is the reference line that may represent the edge view of either the V plane or the first auxiliary plane.

The reference line that may represent the edge view of either

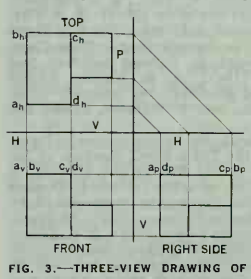

FIG. 3.—THREE-VIEW DRAWING OF OBJECT IN FIG. 2

the first or second auxiliary planes is designated 1–2.

Basic Considerations.—*Line Parallel to Principal Planes.*—Any line will appear in its true length in a projection on any plane to which the line is parallel. Thus, fig. 4(A) shows pictorially the line AB together with its projections on the H and V planes. The vertical projection or front view a_vb_v in fig. 4(B) shows the line parallel to the H plane. Therefore, the top view a_hb_h shows the true length (T.L.) of the line in the orthographic views. Fig. 4(C) shows a line parallel to the V plane. In both figs. 4(B) and 4(D), one view is parallel to the reference line H–V and the other view shows the true length of the line.

Plane Parallel to Principal Planes.—The true shape of a plane shows in its projection on any plane to which it is parallel. In fig. 2 and 3, since faces ABCD and EFGH are edgeways to the front view and parallel to the H plane, the top view, taken on the H plane, shows the true shape of these faces. Obviously the relationships between all lines in these planes will also appear accurately.

Auxiliary Projections.—In actual engineering drawings, lines and planes do not always occur parallel to one of the principal planes; in fact, a line may be inclined to all of the co-ordinate

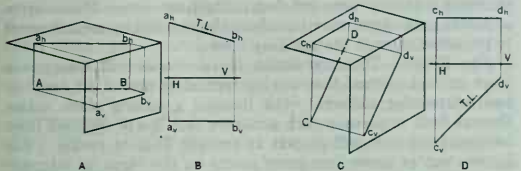

FIG. 4.—VISUALIZATIONS OF LINES PARALLEL (A) TO HORIZONTAL PLANE AND (C) TO VERTICAL PLANE; (B AND D) DRAFTSMAN'S CONSTRUCTION OF THE PROJECTIONS

planes, as shown pictorially in fig. 5(A). This line is shown in fig. 5(B) as it would appear in a three-view orthographic projection. It is obvious that none of the projections of the line is parallel to the reference lines, and hence the line does not appear in its true length in any view. In such a case an auxiliary plane may be set up to obtain the true length. Auxiliary planes may also be used to perform the four fundamental operations of descriptive geometry used in everyday drawing practice; these are: (1) finding the true length of any line; (2) finding the point projection or end view of any line; (3) finding the edge view of any plane; and (4) finding the true shape of any plane.

The use of auxiliary planes is governed by two simple rules: the first auxiliary plane used in any problem must always be perpendicular to one of the principal planes (*e.g.*, the auxiliary plane in fig. 6 is perpendicular to the H plane); and, to serve a useful purpose, the auxiliary plane must have a specific relationship to the object (*i.e.*, it must be parallel or perpendicular to it).

True Length of an Oblique Line.—The true length of the line AB in fig. 6(A) may be obtained by placing an auxiliary plane parallel to the line and projecting upon it. The orthographic solution is shown in fig. 6(B). Having the top and front views given, the true length is found as follows: (1) draw the H–1 ref-

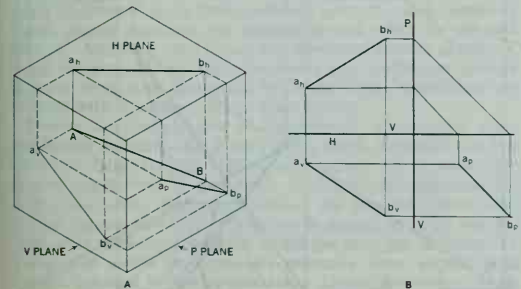

FIG. 5.—(A AND B) PROJECTIONS OF LINE OBLIQUE TO ALL THREE PLANES; NONE OF PROJECTIONS SHOWS TRUE LENGTH OF LINE

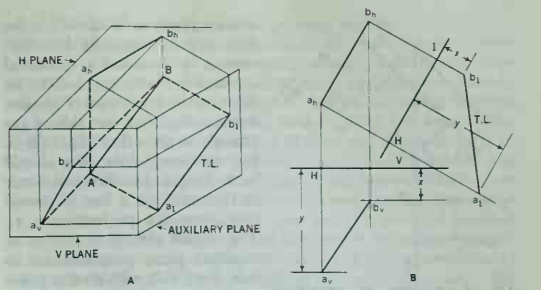

FIG. 6.—(A AND B) TRUE LENGTH (T.L.) OF OBLIQUE LINE OBTAINED BY USE OF AUXILIARY PLANE

erence line parallel to the top view a_hb_h; (2) erect projecting lines perpendicular to the reference line from a_hb_h; (3) measure the distances x and y obtained from the front view on the projecting lines in the auxiliary view, as shown in fig. 6(B). The auxiliary projection a_1b_1 gives the true length of the line.

Point Projection of a Line.—The point projection of a line may be obtained on a plane that is perpendicular to the line. Thus, in fig. 7(A) the line CD is perpendicular to the V plane, and therefore its projection on that plane is a point, c_vd_v. The line AB in the same figure, however, is parallel to the H plane and inclined to the V plane. Hence, its point projection can be obtained only on an auxiliary plane, which must be set up so that it is perpendicular both to the H plane and to the line AB. The orthographic construction (fig. 7[B]) can be made in three steps:

1. Draw the reference line H–1 perpendicular to a_hb_h at any convenient place.

2. Draw the projecting lines from a_h and b_h perpendicular to the reference line (these projecting lines will be coincident).

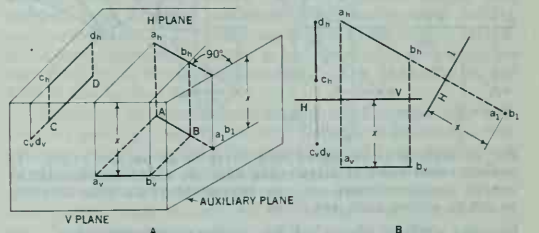

FIG. 7.—(A AND B) METHOD OF OBTAINING POINT PROJECTION OF LINE. LINE CD, PERPENDICULAR TO V PLANE, PROJECTS ON THAT PLANE AS POINT C_vD_v. LINE AB, NOT PERPENDICULAR, REQUIRES USE OF AUXILIARY PLANE TO OBTAIN POINT PROJECTION A_1B_1

3. On the resulting line measure off the distance x obtained from the front view, thus locating a_1b_1.

If the line AB had not been parallel to the H plane this construction would not have been possible, since a true-length view must first be available.

For an oblique line such as EF in fig. 8, the first step in obtaining an end view is to set up an auxiliary plane parallel to the line and obtain the true-length view on that plane as at e_1f_1. The next step is to set up a second auxiliary plane (2–1) perpendicular to the first auxiliary plane and to the line. The construction is now the same as before:

1. Draw the 2–1 reference line perpendicular to e_1f_1.

2. Draw the projecting line perpendicular to the reference line.

3. Measure on this line the distance r obtained from the first auxiliary view, thus locating the point e_2f_2.

Edge View and True-Shape View of a Plane.—The techniques are now at hand to complete the third and fourth operations, namely, to obtain the edge view and the true-shape view of any oblique plane. Oblique planes do not show edgeways in any of the three principal views. Given the top and front views of an

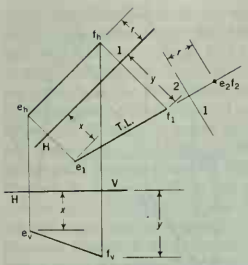

FIG. 8.—METHOD OF OBTAINING POINT PROJECTION OF LINE OBLIQUE TO PRINCIPAL PLANES. FIRST AUXILIARY PLANE (H-1) PRODUCES TRUE-LENGTH (T.L.) PROJECTION; SECOND AUXILIARY PLANE (1–2) GIVES POINT PROJECTION E_2F_2

oblique plane as in fig. 9(A), the first step in obtaining the edge view is to construct a horizontal line in this plane; this is done by drawing the front view of the line horizontally from one side of the triangle to the other (fig. 9[B]). For accuracy, this line should be as long as possible and hence in this example a line is chosen that gives the projection $m_v a_v$. The second step is to set up an auxiliary plane perpendicular to this line; this will give a point projection of the line and therefore an edge view of the plane in which it lies. Distances such as *y* are obtained from the front view.

Having an edge view of the plane, the last step is to set up a second auxiliary plane parallel to the plane by making the reference line 2–1 parallel to $m_1 n_1 o_1$, as in fig. 9(C). Projecting lines are erected perpendicular to the reference line 2–1. Distances such as *f* and *r*, obtained from the top view, are then measured off on the projecting lines, thus locating m_2, n_2 and o_2, which when connected give the true shape of the plane.

Other Problems.—Many other types of problems can be solved

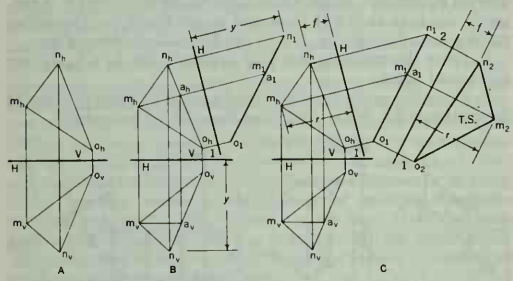

FIG. 9.—METHOD OF OBTAINING TRUE SHAPE OF AN OBLIQUE PLANE: (A) TOP AND FRONT VIEWS OF GIVEN PLANE MNO; (B) EDGE VIEW OBTAINED BY USE OF AUXILIARY PLANE H-1; (C) TRUE-SHAPE (T.S.) VIEW OBTAINED BY USE OF SECOND AUXILIARY PLANE 1–2

by using auxiliary planes. A few of these are listed below.

1. Find the angle between two lines. *Solution:* Obtain the true-shape view of the plane of the two lines.

2. Find the distance from a point to a line. *Solution:* Obtain an end view of the line or the true-shape view of the plane of the point and the line.

3. Find the distance from a point to a plane. *Solution:* Obtain an edge view of the plane, carrying the point along in the construction.

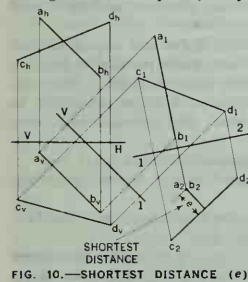

FIG. 10.—SHORTEST DISTANCE (*e*) BETWEEN TWO SKEW LINES (SHOWN IN FRONT VIEW AS $A_v B_v$ AND $C_v D_v$) OBTAINED BY PROJECTING THROUGH AUXILIARY PLANES V-1 AND 1–2

4. Find the angle between two planes. *Solution:* Obtain an end view of the line of intersection of the planes. Both planes are then seen edgeways, and the angle between them is shown at its true value.

5. Find the shortest distance between two nonparallel, nonintersecting lines. *Solution:* Obtain an end view of one of the lines, carrying the other line along in the construction, as shown in fig. 10 (the construction is similar to that in the preceding figures).

Intersections.—The problem of finding the intersections of surfaces falls within the province of descriptive geometry. Only a few simple illustrations can be given but the principles used can be applied in many situations. When one of the surfaces is a plane, the principle of finding the piercing point of a line and plane by the edge-view method is most convenient.

Plane and Cone.—In fig. 11 a cone and plane are shown, and the edge view of the plane, $a_1 b_1 c_1 d_1$, has been found. Twelve or more equally spaced elements of the cone may be drawn and the points where these elements pierce the plane can be seen by inspection in the auxiliary view. These points can be projected back to the corresponding elements in the top view and then to the front view. The location of points in the front view can always be checked by measurement to the same point in the auxiliary view.

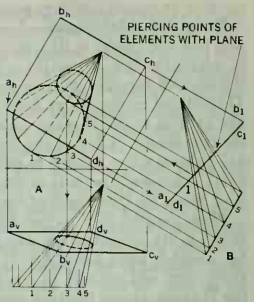

FIG. 11.—METHOD OF CONSTRUCTING INTERSECTION OF PLANE AND CONE BY OBTAINING EDGE VIEW OF PLANE, $A_1 B_1 C_1 D_1$, THROUGH AUXILIARY PROJECTION

Two Cones.—The intersection of two cones will illustrate a more general method that can be applied in almost all cases of two intersecting surfaces. (1) Imagine a cutting plane drawn through both surfaces in such a manner that it will cut lines from both surfaces that will project as straight lines or circles. The intersection of these lines gives points on the curve of intersection; (2) repeat this process a sufficient number of times to determine the curve. Thus, in fig. 12 it is necessary to pass the cutting plane through the vertices of both cones in order to cut a straight line from them. Therefore, a straight line is drawn through the vertices and extended until it pierces the plane of the base of both cones at the point P, shown in projections at p_v and p_h. From p_h a line can be drawn across the two bases locating the foot of the elements that lie in this cutting plane, numbered 2 in the top view. The crossing of these four lines gives four points on the curve of intersection. Enough additional cutting planes must be drawn to determine a smooth curve. In this case, because the first and last cutting planes are tangent to both cones, the intersection will be two separate curves, a circle and an ellipse.

The cutting plane method can be used to find the lines of intersection of such surfaces as two prisms, two pyramids, a pyramid and a prism, two cylinders, a cone and a cylinder, and a sphere

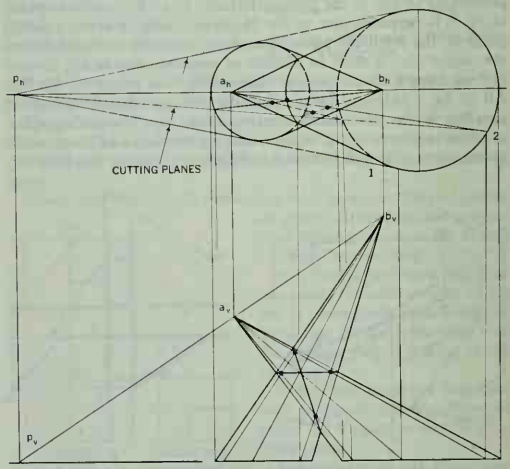

FIG. 12.—CONSTRUCTION OF INTERSECTION OF TWO CONES BY USE OF CUTTING PLANES THROUGH BOTH SURFACES

or spheroid and a cone or cylinder.

Developments.—Many engineering projects involve intersecting cones, cylinders and the like. Such objects often are made of sheet metal and their construction requires the development of flat patterns from which the metal can be prepared.

The fundamental principle that must be observed in the layout of flat patterns is that every line used in the layout must be shown at its true length.

Development of a Cone.—For the development of the cone in fig. 13 it is necessary to have the true length of each element as well as the true length of the chords of the base between elements. Only elements 1 and 7 appear in their true length in the front view. All the others (2 through 6) must be revolved to the left until they are parallel to the V plane, thus showing the true length in the front view (*e.g.*, element a_v2_r). Since the base is parallel to the H plane, the chords 1–2, 2–3, etc., show their true lengths in the top view. The symmetrical half-pattern results from the construction.

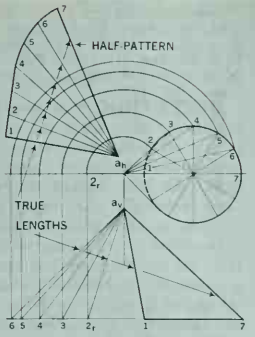

FIG. 13.—DEVELOPMENT OF OBLIQUE CONE PRODUCING HALF-PATTERN THAT CAN BE USED FOR CONSTRUCTION

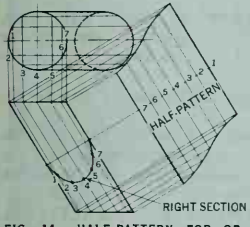

FIG. 14.—HALF-PATTERN FOR OBLIQUE CYLINDER PRODUCED BY DEVELOPMENT

Development of a Cylinder.—The development of an oblique cylinder requires the true length of a right section, since this line will roll out as a straight line in the pattern and will be perpendicular to the elements. In fig. 14 half of a right section is shown as a revolved section in the front view. The distances 1–2, 2–3, etc., can be laid out on the straight line that is the development of the right section. This gives the width of the pattern. All of the elements of the cylinder show in their true length in the front view, and they may therefore be projected direct to the pattern. All elements, of course, must be kept in their proper order relative to each other. This is true for all lines in any kind of development. *See* also PROJECTIVE GEOMETRY.

See R. P. Hoelscher and C. H. Springer, *Engineering Drawing and Geometry*, 2nd ed. (1961); B. L. Wellman, *Technical Descriptive Geometry*, 2nd ed. (1957). (R. P. Ho.)

DESERT, a term popularly applied to any environmentally extreme, deserted, desolate, uninhabitable, waste area. Technically a desert is any of the several biomes (communities of distinctive plant and animal life) occurring on all continents at the dry end of climatic gradients of decreasing water availability. Successively distributed along these gradients are such other biomes as forest, prairie grassland and steppes, beyond which lie the arid deserts. Aridity, a conspicuous and consistent feature of deserts, is but one aspect of a total environment which, although extreme in many ways, is as favourable to the biological assemblages associated with it as those of any other biome.

Deserts are concentrated in high-latitude, circumpolar areas and in two discontinuous, earth-girdling bands at middle and low latitudes. High-latitude cold deserts include the perennial ice deserts represented by Antarctica, Greenland and the polar ice packs, and tundra deserts of parts of the seasonally snow- and ice-free tundra (*q.v.*). Precipitation is meagre in polar regions, large areas receiving five inches or less per year, but deficiency of biologically usable water results primarily from physiological drought imposed by low temperature. Desertlike, rocky, barren lands within the tundra result from complex causes partially related to aridity, but most tundra areas are adequately supplied with water during the short, cool growing season.

Hot, arid regions furnish examples of the most familiar desert features, which exhibit considerable ecological similarity from one area to another but have little physical or biological relationship to cold polar deserts. Tropical deserts, occurring between approximately 15° and 30° north and south of the equator, include the Sonoran of northwestern Mexico and adjacent parts of California and Arizona, the Sahara (*q.v.*) of north Africa, the Arabian of the middle east, the Thar of northwestern India (*see* THAR DESERT), the Victoria of Australia and the Kalahari (*q.v.*) of southwestern Africa. These owe their origin and location largely to aridity resulting from the high moisture-holding capacity of air warmed by compression in descending from the high-pressure belt of the horse latitudes to the belt of tropical trade winds. Decreased precipitation and high evaporation rates combine to desiccate the land, especially on the west sides of continents.

Seasonally hot deserts at mid-latitudes, cool or topographic deserts result from complex and often obscure relationships between climate, geographic position and topography. The desert of Turkistan, east of the Caspian sea, and the Gobi and Takla Makan (*qq.v.*) of central Asia are deep within continental interiors distant from moisture-laden winds, while the Great Basin (*q.v.*) of the western United States and the deserts east of the Andes in southern Argentina exemplify the rain-shadow effect created by high mountains lying across the path of moist winds.

Deserts are highly varied in area, altitude, land forms, geology and other physical characteristics. Among hot deserts, the Sahara, with an area of about 3,500,000 sq.mi., is the largest and extends from 436 ft. below sea level to 11,204 ft. above. North American deserts are in part mountainous, but large areas vary from only a few feet above to well below sea level, the lowest point being reached at 282 ft. below sea level in Death valley (*q.v.*), California. Terrain may be of rugged mountains, high plateaus or plains, and many deserts occupy broad mountain-rimmed basins termed bolsons. Surface materials include bare bedrock, plains of gravel and boulders and vast tracts of shifting sand, respectively the hammada, reg and *erg* of the Sahara. Wind-blown sands, commonly thought to be typical of deserts, make up only about 2% of North American deserts, 11% of the Sahara and 30% of the Arabian desert.

Climates are characteristically extreme in all deserts, and variations are great from one to another. Differences in seasonal temperature regimes sharply differentiate tropical from mid-latitude deserts. Usually the environment is characterized by cloudless skies, intense sunshine, high percentage of possible hours of sunshine, extreme daily and seasonal temperature ranges, intense heating of surfaces, strong winds, rainfall quantitatively low and erratic in distribution and evaporation rates greatly exceeding precipitation. Rapid heat loss by radiation and convection to the clear sky results in chilly nights, frequently heavy dew and occasional frost even in tropical deserts.

Diurnal and seasonal temperature ranges are greatest in mid-latitude deserts. In the Gobi winter winds are violent and severe blizzards common, and in parts of this area as many as six months each year have mean temperatures below freezing. During the hottest seasons air temperature may average 85°–90° F., and averages of 105°–110° are not unusual. The highest air temperature recorded in the shade is 136.4°, measured in the Sahara, and a value of 134.1° has been recorded in Death valley. Precipitation is usually less than ten inches annually, and five inches or less is common. Several years may elapse without measurable rainfall, only to be followed by a deluge. At Iquique, Chile, in the Atacama desert (*q.v.*), 0.6 in. of rain fell in a single shower after four consecutive rainless years.

Desert landscapes are shaped by weathering processes and winds, but (paradoxically) mainly by erosion and deposition by running water. Chemical weathering and mechanical weathering by freezing are retarded in dry regions, and rock fragmentation results principally from expansion and contraction induced by wide temperature fluctuations. Winds transport great clouds of dust and impel large quantities of sand along the ground, all particles behaving as abrasive tools which blast vegetation and carve,

facet and polish rocks, mainly within two to three feet of the ground. Continued removal of fine materials produces deflation basins with surfaces of residual lag gravels and boulders, the desert pavement.

Infrequent rains of high intensity and short duration produce flash floods which rush from highlands as sheet floods or as torrents raging through the usually dry arroyos or wadies. Flowing with high velocity, and often without warning, streams transport large quantities of mud, sand and boulders short distances into the desert basins before the water is dissipated by penetration into the ground and evaporation. Centripetal drainage of bolsons produces gentle piedmont slopes or pediments consisting of upper eroded bedrock surfaces and lower, undulating slopes or bajadas of coalescing alluvial fans. Mineral salts leached from the highlands are carried to the centre of the basins, where they accumulate in usually ephemeral lakes which, lacking outlets to the sea, become increasingly saline. Exposed bottom sediments of dried-out lakes are termed playas and, when containing high concentrations of precipitated, dry, glistening salts, are called alkali flats.

Plant and animal populations differ qualitatively and quantitatively in various deserts, but all possess traits of structure, physiology and behaviour which favour obtaining and conserving a meagre water supply. Plants are mainly low-growing, thorny, small-leaved or leafless, grayish to light green in colour, with extensive and often deep roots, and are usually widely spaced. Reduced surfaces, daytime closure of stomata, water-impervious cuticle and waxy coatings, succulent organs which accumulate large quantities of water and physiological resistance to desiccation are genetic characteristics of significance to perennial species. Drought-evading, ephemeral annuals, dormant during dry periods, appear in profusion following rains. Vegetation is usually simple in composition, as in the Great Basin, where it is dominated by only a few species of low deciduous shrubs. A greater number of species and increased complexity of vegetation are often attained, as in the Sonoran desert, where there occurs a large variety of evergreen and deciduous shrubs, small trees, many succulents, including large columnar and other types of cacti, and annuals which constitute about 50% of the total flora. The dominant xerophytic (adapted to arid habitats) desert plants include agaves, cacti, composites, legumes and yuccas (*qq.v.*). Typical plants of American deserts include *Acacia* species, creosote bush, greasewood, mesquite, sagebrush and saguaro (*qq.v.*).

Desert animals include a few large mammals, many rodents, reptiles, birds and insects. Rapid, often leaping locomotion, burrowing and nocturnal habits are well-developed characteristics, although most birds and reptiles of the desert are diurnal. Most animals drink water when it is available, but in its absence depend upon water obtained by eating succulent plants or blood and other tissues of their prey. Many insects and some rodents (kangaroo rat, pocket mouse) utilize metabolic water, and even the camel, better known for its ability to store water in special stomach compartments, derives a significant water supply from oxidation of fats accumulated in its hump. Conservation of water is accomplished in diverse ways. Reptiles and some insects have water-impervious integuments, mammals concentrate urine by reabsorption of water before excretion and reptiles excrete nitrogenous waste as uric acid crystals without water loss. Nocturnal habits permit avoidance of water stress, and some animals (as the ground squirrel) estivate during periods of extreme heat and drought.

Large human populations are possible in deserts only where rivers (such as the Nile, Colorado, Tigris and Indus) make irrigation possible. Desert soils are often of high fertility when water is available, and many oases (*q.v.*) are agriculturally productive. The economy of scattered nomadic peoples is based upon subsistence agriculture in small part but depends principally upon grazing herds of sheep, goats, cattle and, less frequently, horses.

Deserts are a source of valuable mineral resources only in part related specifically to desert environment. Aridity and internal drainage are directly responsible for the wealth of evaporites, including borax, nitrates, potash and other inorganic salts, commercially exploited in many deserts, especially those of North America.

See also references under "Desert" in the Index volume.

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DESERTION, in marriage law, the act of leaving one's spouse against the latter's will and without legally justified cause. It is to be distinguished from separation, the situation in which spouses cease to live together by mutual agreement or in which one spouse leaves the other against the latter's will, but with legally just cause, especially when he or she has been authorized to do so by a decree of judicial separation.

Desertion is also committed by the spouse who expels the other from the marital home, and courts also tend to treat as a deserter a spouse who successfully engages in conduct toward the other calculated to induce the latter to leave the marital home. This last-named case is sometimes referred to as constructive desertion.

While ordinarily a husband is supposed to support his wife and children by providing them with a home, nourishment, clothing and recreation, a deserting husband will be compelled to provide maintenance for his wife and support for the dependent children living with her by making money payments to her. In England, maintenance orders for such payments can be made in speedy and inexpensive proceedings by the magistrates up to a maximum amount of £7 10*s.* a week for a wife and 50*s.* a week for a child. A decree of judicial separation providing for higher payments may be issued by the high court.

The amount of the alimony, as it will be called in such a case, depends on the circumstances of the situation, especially the parties' status in life, the extent of their respective property, income, earning power and needs.

In Scotland the reciprocal duties of the spouses may be enforced through a suit for aliment.

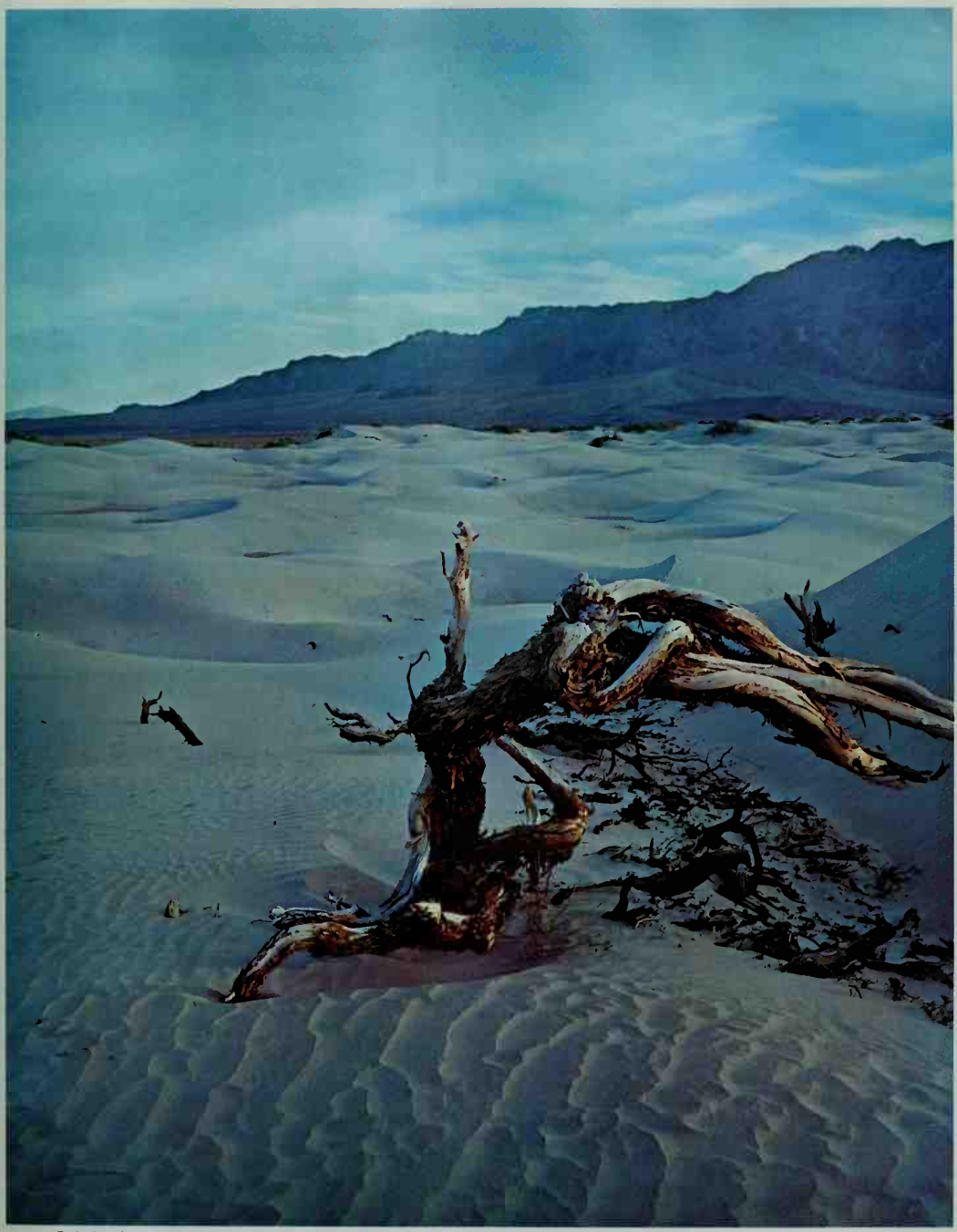
In the United States, too, speedy and inexpensive procedures are generally available to obtain money support at or near the subsistence level, and more formal proceedings exist to obtain separate maintenance at higher amounts.

In 1959 desertion constituted a ground for divorce in England, Scotland and all jurisdictions of the United States except New York, provided it had lasted for the minimum period prescribed by the statute in question, which is three years in England and Scotland, and in the United States from five years in Rhode Island to six months in Hawaii and no time limit in New Mexico.

See also DIVORCE; MARRIAGE, LAW OF. (M. RN.)

DESERT WARFARE. In terms of military operations, both topography and climate pose special problems that cause military men to look upon desert warfare as a special form of combat. The surface of a desert may vary from areas of flat, almost featureless terrain to steep ravines and dry river beds with precipitous banks or high rocky escarpments. Some areas have an almost rock-hard surface that presents no obstacle to movement; others are covered with fine drift sand and are, for all practical purposes, impassable. Until the advent of the motor vehicle there were no desert roads and very few tracks; most desert areas had not been surveyed or mapped. Limited supplies of water are to be found, but they are few and far between. Moreover, desert areas suffer from extremes of temperature.

Operationally, battles are won by the power to maneuver, but in desert areas maneuver is difficult. Administratively, the problem of supplying a desert force of any size with all its requirements, including water for men and animals, is tremendous. When armies consisted of marching men, accompanied by horses or other animals, this problem was considered almost insuperable. In the past, therefore, desert warfare was mainly confined to raids or punitive expeditions with a strictly limited scope, generally carried out by inhabitants of the desert who were used to its conditions. Their means of locomotion and transport was the camel, that "ship of the desert" which can be trained to exist without water for several days. (*See* CAMEL CORPS.) Forces organized on European standards were debarred from undertaking large-scale desert operations, though there were a few notable exceptions.



Early travelers named this hot, arid waste Death valley. Mountains of the Amargosa range form the eastern rim of the desert in eastern California

DEATH VALLEY

PHOTOGRAPH, SHOSTAL

DESERT

Bactrian camels feeding on spring grass in the Mongolian Gobi desert. One of the largest deserts in the world, the Gobi is about 300–600 mi. wide and over 1,000 mi. long

An Arab woman washing at Jahra oasis in the desert of Kuwait

Arabian (dromedary) camels in the Moroccan Sahara

The Negev, between Beersheba and Elath, a vast desert region occupying about 60% of Israel

DESERTS OF ASIA AND AFRICA

PHOTOGRAPHS, (TOP LEFT) LANDAU—RAPHO GUILLUMETTE, (TOP RIGHT) SHOSTAL, (CENTRE LEFT) SABINE WEISS—RAPHO GUILLUMETTE, (BOTTOM RIGHT) DOROTHY GABRIEL—PIX FROM PUBLIX

The great advances made in mechanization after World War I revolutionized the concept of desert warfare. Motor vehicles have attained standards of reliability and robustness which enable them to operate continuously under the severest conditions of strain and climate. There is practically no terrain, except precipices or the softest drift sand, which they cannot negotiate when suitably equipped. Thus large modern forces, which are all mechanically transported, can be moved about in the desert and supplied with all their requirements for protracted periods. The lack of roads capable of carrying a heavy volume of traffic has been overcome by modern methods of rapid road construction, so that a system of communication to the supply areas in the rear can be quickly built up in the wake of an advancing army. Water can be supplied in adequate quantities, even for large forces and for a considerable period, by means of special water-carrying transport units. Modern pipe-laying equipment can be used to build up a system of water-refilling points close behind an advancing force and water can then be pumped to these points from the rear areas.

Aircraft have also exerted a great influence on desert warfare. As deserts are devoid of vegetation, they offer virtually no natural concealment from air attack. To minimize the effect of such attacks, forces in the desert must always be widely dispersed; movement must be confined to the hours of darkness, using no lights. Even in easy desert terrain, however, movement in dispersed formation imposes a great strain upon vehicle drivers, and in difficult areas the strain is tremendous. Control of such movement is difficult, especially when an obstacle such as a river bed or an area of drift sand is encountered. Radiotelephony has done much to simplify this problem, but has not eliminated it.

Aircraft have still further simplified the supply in desert operations. It is now possible to maintain large forces at great distances from their base, either by dropping supplies from the air by parachute, or by landing aircraft at forward improvised airstrips. Air-borne operations may also have a decisive effect upon desert warfare if directed against the enemy's supply lines. In any large-scale campaign, supply will probably be restricted to one or two main routes, which will be vulnerable to attack. Their severance by air-borne attack at a focal point, even for a few days, may well give a decisive result for the whole campaign.

To summarize, it can be said that mechanical science has overcome most of the difficulties that previously beset desert warfare, and has made the conduct of large-scale operations in such areas possible. The operations of the Allied armies in north Africa in 1942 and 1943 during World War II are proof of this, and for a fuller study of the subject reference should be made to these campaigns. *See* World War II. (A. W. Le.)

DESERT WILLOW (*Chilopsis linearis*), a small North American tree of the bignonia family (Bignoniaceae), native to stream banks and the vicinity of springs in deserts from western Texas to southern California and southward to northern Mexico. It grows usually from 8 ft. to 25 ft. high, with stems from 2 in. to 10 in. in diameter, slender, ascending branches and narrow, willow-like leaves. During summer it bears a succession of showy, funnel-shaped, pink flowers, about 1½ in. long and 1½ in. across, in profuse terminal clusters, followed in autumn by narrow seedpods about 8 in. long.

It is a characteristic plant of southwestern deserts; because of its appearance, suggestive of a slender willow with catalpalike flowers, it is cultivated there as an ornament.

DESGARCINS, MAGDELEINE MARIE (originally Louise) (1769–1797), French actress, who during her short career was one of the greatest of French tragediennes, was born at Mont Dauphin (Hautes Alpes). She was the associate of François Talma, with whom she nearly always appeared.

Mlle Desgarcins made her debut at the Comédie Française on May 24, 1788, in Jean Racine's *Bajazet*, and was at once made a full member of the company. She left the Comédie Française in 1791 for the house in the Rue Richelieu, soon to become the Théâtre de la République, and there her triumphs were no less—in *King Lear*, *Othello*, La Harpe's *Mélanie et Virginie*, etc. She died insane, at Paris, on Oct. 27, 1797.

DESHOULIÈRES, ANTOINETTE (née du Ligier de la Garde) (1638–1694), French poet and, from 1672 until her death, a celebrated literary figure, was born at Paris on Jan. 1, 1638. She received an excellent education, which her marriage in 1651 does not appear to have interrupted, for her husband left soon afterward to support the prince of Condé in Flanders and she, living with her parents, applied herself to poetry and the philosophy of Pierre Gassendi. In 1655 she went to rejoin her husband in Flanders where her pertinacity in demanding from the Spanish authorities the pension which they had promised him led them to imprison her in the château de Vilvorde. Released after several months when her husband and a small band of French officers attacked the château, she returned with him to France, but their marriage was not successful and after 1659 they separated.

Antoinette Deshoulières became a prominent literary figure after the publication of some poems in 1672 in the *Mercure galante*. Voltaire called her the best of French poetesses and by other admirers she was styled the tenth muse. Her *salon* was a meeting place for all the prominent literary figures of her day. Despite a royal pension, obtained through Madame de Maintenon in 1688, her last years were clouded by poverty and painful ill-health. She died at Paris on Feb. 17, 1694. Complete editions of her works were published at Paris in 1695, 1747 and 1882.

DESICCATION: *see* Dehydration.

DESIDERIO DA SETTIGNANO (d. 1464), Italian sculptor, who created works unrivaled in the 15th century for subtlety and technical accomplishment, was born at Settignano near Florence between 1428 and 1431. He seems to have been trained in the studio of Bernardo Rossellino, and was deeply influenced by Donatello after the latter's return from Padua (1453). At this time he may have executed the so-called "Martelli Baptist" (Museo Nazionale, Florence), which since the time of Vasari has been ascribed to Donatello. After 1453 Desiderio designed and carved the monument of the Aretine humanist Carlo Marsuppini in Santa Croce in Florence. With its rich architectural detail and its admirable effigy, this tomb occupies a position of exceptional importance in the history of the Florentine wall monument. Between 1455 and 1460 Desiderio carved the frieze of *putto* heads for Filippo Brunelleschi's Pazzi chapel, and in 1461 completed the Altar of the Sacrament in S. Lorenzo. Stucco versions of the figure of the Child Christ which surmounts this altar seem to have been made in some quantity in the 15th century. Two celebrated busts of children, now in the National Gallery of Art, Washington, D.C., are infused with the same tender sentiment. As a sculptor in relief, Desiderio masterfully employed the technique of *rilievo stiacciato* (low or flattened relief) evolved by Donatello in Madonnas at Turin and Philadelphia and a "Child Christ and the Young St. John Baptist" in the Louvre. Like his contemporaries Antonio Rossellino and Mino da Fiesole, Desiderio executed portrait busts. The most notable of these are in the Museo Nazionale, Florence, the Louvre and the Kaiser Friedrich museum, Berlin.

Despite the strongly personal character of his work, Desiderio seems to have been the head of an extensive studio, and Filarete alludes to commissions for decorative carving carried out by the artist and his assistants. An example of this survives in a chimneypiece in gray sandstone (*pietra serena*) in the Victoria and Albert museum, London. He died in Florence on Jan. 16, 1464.

See Leo Planiscig, *Desiderio da Settignano* (1942).

(J. W. P.-H.)

DESIDERIUS (8th century A.D.) was the last Lombard king (*see* Lombards). Duke of Tuscany at King Aistulf's death in 756, he contended for the throne against Aistulf's brother Ratchis, after whose abdication in 757 he was generally recognized as king. Despite promises made to Pope Stephen III (II), he sought to recover territories ceded to the papacy by his predecessor. Probably in order to gain freedom of action against the pope, he pursued a policy of friendship toward the Franks, which culminated, in 770, in the marriage of a daughter of his to Charlemagne. After the death in 771 of Charlemagne's brother Carloman, however, Franco-Lombard relations deteriorated rapidly; Charlemagne hav-

ing seized Carloman's dominions, his widow sought refuge with her sons at the Lombard court, and about the same time Charlemagne repudiated his Lombard wife. In the same year 772, Desiderius resumed his offensive against the papacy, in order both to compel Adrian I to recognize Carloman's sons and to press his own territorial claims. Lombard troops advanced into the Roman duchy; threatened with a siege of Rome, the pope appealed for help to Charlemagne, who crossed the Alps in the summer of 773 and besieged Pavia, where Desiderius capitulated in June 774. Charlemagne assumed the title of king of the Lombards and probably took Desiderius back with him to France to die in captivity.

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DESIGN, from the Latin *designare*, "to mark out," is the process of developing plans or schemes of action; more particularly a design may be the developed plan or scheme, whether kept in mind or set forth as a drawing or model. Thus one can speak of Napoleon's designs on Europe and of the designs for next year's automobiles. The execution of a plan is not, properly, designing, except insofar as the plan may continue to develop in order to meet originally unanticipated requirements. Similarly the end result is not a design, but it is reasonable to speak of its design, that is, of the antecedent plan or scheme discoverable in it, as in the design of Dante's *Divine Comedy*.

A plan or scheme set forth in a drawing or model is an aspect of design close to its etymology and to its most usual specific meaning—design as the pattern for making a product. Design thus meant indicates primarily an interrelation of parts intended to produce a coherent and effective whole. The disposition and detailing of components is ordinarily planned with four limiting factors in mind: the capacities of the materials employed, the influence of methods adapting these materials to their work, the impingement of parts within the whole and the effect of the whole on those who may see it, use it or become involved in it. Design in the sense of a pattern for making a product has become a synonym for work in the applied arts, and a designer is one who practises them. Design in the fine arts is often considered to be the creative process per se, while in engineering, on the contrary, it may mean a concise record of the embodiment of appropriate concepts and experiences. In architecture and product design the artistic and engineering aspects of design tend to merge; that is, an architect, craftsman, graphic or industrial designer cannot design according to formulas alone as an engineer can, nor as freely as can a painter, poet or musician.

Design is a word used loosely in all the arts, and particularly in their instruction, to mean composition, style or decoration. Composition is the framework of relationships in a thing, considered analytically in isolation from the parts and from the whole; this is the meaning of phrases like "the design of Raphael's *Sistine Madonna.*" Neoclassic design means the neoclassic style of design. An all-over design is a regularly repeated decoration covering an expanse. Such loose, localized uses of the word are usually comprehensible in context but may confuse readers or listeners who correctly suspect that design in aeronautics, for example, is another thing. *See* Design, 19th-Century; Design, 20th-Century; Display Design; Industrial Design; Furniture Design; Packaging. *See* also references under "Design" in the Index. (Er. K.)

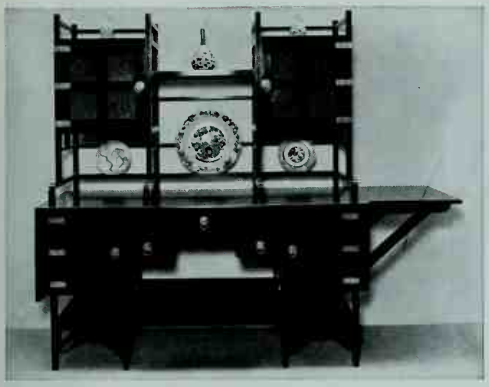
DESIGN, 19TH-CENTURY. In the west, 19th-century design was conditioned by three ideas that had grown strong at the end of the preceding century: human equality, popular education and scientific progress. Nineteenth-century products were thus conceived, made and used in a spirit and with means different from those of medieval or Renaissance crafts or academically controlled 18th-century design. Yet, imitation of those very eras characterized 19th-century design in the eyes of later generations. This view obscures the positive accomplishments of the period. Careful investigations have shown 19th-century design to be the matrix of new concepts suited to the modern world, preliminary in fact to 20th-century design.

Historicism and Science.—A return to past forms is regular in civilizations; unique, however, were the range, enthusiasm and thoroughness of the 19th-century designers' exploitation of history. The scientific method was being widely applied to the evidence of explorers, archivists and archaeologists; knowledge of every kind poured in almost faster than understanding could deal with it. Much that was derogatorily called eclecticism was an earnest attempt to make use of this spate of information. Designers were convinced that in the mass of documentation lay a key to the principles of their art. Like scientists they compared, experimented, deduced. Systematic analysis of natural forms and colours, it was believed, might provide another approach to fundamentals. This recurrent search for design principles in nature or history demonstrates that 19th-century designers were keenly aware of the need for a firm basis from which to deal with the vast problems presented by the Industrial Revolution.

For designers the Industrial Revolution meant unprecedented floods of goods, unprecedented popular markets and division of the once close-knit activities of designers, workers, manufacturers and distributors. The traditional significance of handwork and the individual craftsman vanished. Steam power, in Europe alone, increased a hundredfold between 1800 and 1900; after 1870 gasoline engines and electricity began to augment energy at a rate previously inconceivable. Transportation improved so that, in effect, distances were reduced by seven-eighths. The relationship of raw materials, fuels and labour supply was upset; production centres moved; transmittal of stylistic and technological information was greatly speeded. Lithography and, later, colour lithography profoundly influenced visual information; softer, fuller, more sensuous images became the rule. Mass production made its first strides in textiles, which were revolutionized again when synthetic dyes were perfected after 1850. Later, wallpapers became common, further changing the character of interiors. Synthetic materials made their appearance about 1840 with the vulcanization of rubber; gutta-percha, Celluloid, papier-mâché and artificial stone were quickly and widely accepted. Plywood (used by the ancient Egyptians) was mass-produced around mid-century; bent, solid wood furniture, invented around 1840 by Michael Thonet (1796–1871), became commonplace. In metals, mechanized stamping and spinning, improvements in casting and, above all, electroplating made great changes; improved alloys appeared, as well as new metals like chromium and aluminum. No previous period had such a record of continuous change and invention.

Neoclassicism.—As the century opened the style dominant in the arts was neoclassicism, in which elaborate Roman grandeur was revived, chastened by Greek precedent and authority. Neoclassicism had arisen 50 years earlier as a reform directed against the caprice of the rococo. The rediscovery and publication of Greek (as contrasted to well-known Roman and Renaissance) architecture and art relics had stimulated a pristine, earnest style theoretically favouring structural logic, expression of the natural qualities of a few chosen materials and chaste, symbolic ornamentation. Ancient and modern conquests of Egypt occasioned some use of Pharaonic motifs. From 1750 to 1850 one or more variations of neoclassicism flourished. Around 1800 neoclassicism lost its first impetus, though as the official style for Napoleon's empire it enjoyed great prestige. Empire style (*q.v.*) was generally dry, monotonous and cramped, though elegant and correct. In areas relatively free of Parisian influence neoclassicism was often agreeably unforced, as in some provincial Empire products and some works of the English regency, the Austrian and Russian empires and the United States before 1850.

Neoclassicism inherited many intellectual appetites of the Enlightenment but not that movement's fearless logic. Thus Empire ornament tended to reduce symbolism to association, prefiguring the sentimental, anecdotal language of later design. Such symbols as laurels for glory, wheat for plenty and sphinxes to guard the mysteries of royalty and of eternal life communicated to a humanistically educated happy few, but under the pressures of industry and democracy symbols often became mere malapropisms.

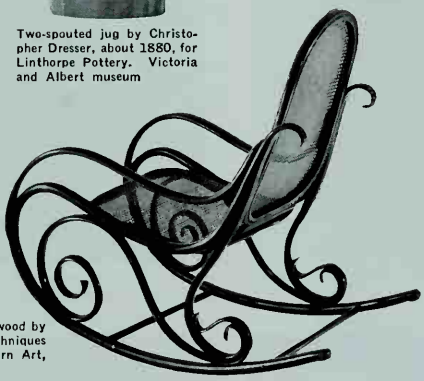


Sideboard of ebonized wood designed by E. W. Godwin about 1877; produced by W. Watt. Collection of Mrs. E. M. Hartree, Victoria and Albert museum

Breakfast room in John Soane's own house, 1812; later the Soane museum, London

"Morris chair" produced by Morris, Marshall, Faulkner and Co. about 1867. Collection of Mrs. A. J. Tozer, Victoria and Albert museum

Two-spouted jug by Christopher Dresser, about 1880, for Linthorpe Pottery. Victoria and Albert museum



Adjustable rocking chair of bent beechwood by Michael Thonet about 1876, using techniques developed in 1840. Museum of Modern Art, New York

Silver teapot designed about 1848 by A.W.N. Pugin. Produced 1861–62 by John Hardman and Company, Birmingham, Eng. Victoria and Albert museum

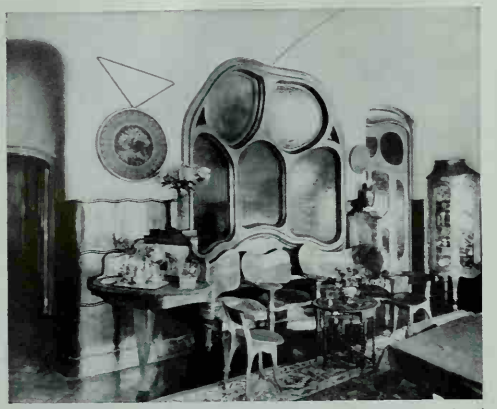
Dining room of the Waller house, River Forest, Ill., 1899, by Frank Lloyd Wright

Wardrobe by Philip Webb with paintings by Edward Burne-Jones, 1858, a wedding gift to William Morris. Victoria and Albert museum

FURNITURE, INTERIOR DECORATION AND OTHER EXAMPLES OF 19TH-CENTURY DESIGN

BY COURTESY OF (TOP LEFT, CENTRE RIGHT) VICTORIA AND ALBERT MUSEUM, (CENTRE LEFT) AMY J. TOZER, (CENTRE ABOVE) DORMAN MEMORIAL MUSEUM, (CENTRE BELOW) MUSEUM OF MODERN ART, NEW YORK, (BOTTOM LEFT) CHICAGO ARCHITECTURAL PHOTOGRAPHING COMPANY, (BOTTOM RIGHT) ASHMOLEAN MUSEUM; PHOTOGRAPH, (TOP RIGHT) A. F. KERSTING

DESIGN, 20TH-CENTURY



Dining room in the Casa Batlló, Barcelona, Spain, 1907, by Antonio Gaudí

Dining room designed by R. Quibel, presented by Mercier Frères at the International Exposition of Decorative Arts, Paris, 1925

Social rooms of an apartment hotel designed by Walter Gropius and exhibited by the *Werkbund* at Paris in 1930

Model dining room designed by Marcel Breuer (with F. R. S. Yorke) and exhibited at the Royal Agricultural show, Bristol, Eng., in 1936

Room designed by Finn Juhl for the Nordenfjeldske Kunstindustrimuseet, Trondheim, Norway, 1952

Lounge chair and corner of the living room, 1957, of designers Charles and Ray Eames, Santa Monica, Calif.

SIX 20TH-CENTURY INTERIORS

BY COURTESY OF (TOP LEFT, BOTTOM RIGHT) EDGAR KAUFMANN, JR., (TOP RIGHT) CH. MOREAU, PARIS, (CENTRE LEFT) MUSEUM OF MODERN ART, NEW YORK, (CENTRE RIGHT) MARCEL BREUER, (BOTTOM LEFT) FINN JUHL

Sir John Soane (1753–1837) was the most original master of structure, lighting and space in neoclassical architecture. Two other prominent architects, the amateur Thomas Jefferson (1743–1826) in the United States and the highly professional K. F. Schinkel (1781–1841) in Prussia, applied mechanical ingenuity and rational forms to the solution of problems of everyday comfort and convenience. From these men to creative engineers of the period such as Sir Samuel Bentham (1757–1831) and, in the U.S., Oliver Evans (1755–1819) was a short step, yet it led outside design.

Early in the century architects of the French Revolutionary era sought the sublime, so called, in forms severely plain, gigantic, visibly indeterminate though logically defined, and strongly contrasted one with another. Cylinders, spheres and circles, pyramids and triangles were preferred. Fluent transitions between parts, gradations mounting to a climax, were abandoned for abrupt juxtapositions.

A curious echo of these efforts reverberated in the Biedermeier, a name given to certain furnishings produced in German-speaking lands from 1810 to 1840. Yet Biedermeier design opposed sublimity; the very name was derived from a literary character of the period, a typically solid, humdrum 19th-century bourgeois.

Romanticism.—Like neoclassicism, medieval design was an inherited interest of the 19th century; many playful evocations of Gothic detail had slipped easily into irregular rococo design. A related 18th-century heritage was the concept of the picturesque, influenced by the wild landscapes with Gothic and other ruins depicted by Claude Lorrain and Salvator Rosa and their schools. In gardens, and then in decorating an infinitude of products, picturesque taste nostalgically evoked the decay of classicism with artificial ruins and contrived wildernesses. As nature seemingly resumed its sway over the works of man, the picturesque could approach the sublime, which was most effective in untouched and savage nature. Nature, raw material for scientific research, was also considered the very stuff of poetic insight. Samuel Taylor Coleridge, lecturing about Shakespeare in 1808, said, "Such as the life is, such is the form," recognizing organic form and process as prototypes for the creations of men. Before the century's end the U.S. architect Louis Sullivan (1856–1924) phrased the idea more familiarly: "Form follows function."

Napoleon's ventures in Syria and Spain turned the world's attention toward Islam. Early in the 19th century, Gothic, Romanesque and Islamic design were confused with each other, since none fitted the classicist codification that Europe accepted as its great tradition. The heritage of Greece and Rome was said to have been polluted by travel-stained crusaders, or by Moors and Goths probing deep into the continent during the dark ages. All this barbarism seemed alike.

Another romantic feature can be credited to Napoleon—his omnivorous ambitions aroused modern nationalism that naturally turned to history for its atmosphere and insignia. In Protestant lands the period of transition from Late Gothic to Renaissance most often provided the requisite glamour; in Catholic countries it was the period of the baroque. Thus romantic design revived that of the Elizabethans, the Bourbons, Frederick the Great and Barbarossa—the entire historic pageant, filtered to reinforce each separate national identity and pride.

Mid-Century Design.—The waning of neoclassical design was associated with decreasing confidence in the Enlightenment and its results. Until around 1825 the dislocation and brutalization of traditional ways of life seemed catastrophic; the French Revolution had produced misery and repression. But from 1825 to 1850 the working classes mustered strength; unions began to be legally recognized; Marx and Engels rewrote history from the viewpoint of productivity, discarding humanist values. A great gush of mechanical inventions appeared from 1800 to 1830; by 1850 processes were developed to utilize them. Confidence revived despite repeated economic crises and uprisings across Europe, culminating in the revolutions of 1848. In this situation romanticism flourished, nurtured by escapism that accompanied social chaos and, more significantly for the future, by the revival of ethical and religious standards in which design played an important role. Feeding romanticism, historicism was in its turn reinforced by abundant, increasingly informative, printed words and pictures, largely addressed to the masses.

In 1851 attention was focused on design by the first Great Exhibition of the Industry of All Nations, for which the Crystal palace was built in London. The sensational palace, designed by Joseph Paxton (1801–65), a self-educated gardener, was essentially a huge conservatory; demountable iron and glass members, interchangeable and mass produced, were organized in a building that ever since has been regarded as progressive, practical and inspiring. The fully illustrated catalogues of the 1851 exhibition became the principal records of Victorian design. Their value was challenged on the claim that mostly atypical showpieces were reproduced. Like the great international exhibitions that followed, however, the Crystal palace indicated the dominant design trends of its time. The historic masquerade, with all styles mixed together, was in full swing; heavy, bulging forms prevailed, covered with flat patterns and molded ornaments, often anecdotal and naturalistic. Craftsmanship had flown from the arts to engineering. World trade encouraged generally low standards of material quality, but a growing public demanded many amenities and mechanical ingenuity prospered.

Reform and Realism.—The Crystal palace revealed confusion, but the struggle for order had begun. Early in the century academic art instruction throughout the west formalized the applications of neoclassical art to industry, successfully initiated by Sir Josiah Wedgwood (1730–95). In a dynamic period these efforts were insufficient. An English parliamentary committee of 1835 began to hear expert witnesses on design as it affected the national economy. The dependence on importing and copying, especially of excellent handmade French wares, was to be countered by improving English design and design education. The experts favoured neither Greece nor any other historic precedent, but held that knowledge of nature was the best basis for design. As this idea was tested, a clear divergence developed: some wanted to copy natural forms as the most perfect ones, a new academic ideal; others wanted to analyze natural forms to extract their principles of structure and relationship, an approach modeled on scientific inquiry. As early as 1835 the influence of engineering on aesthetics was acknowledged; it was said that there was probably no example of a perfect machine which was not at the same time beautiful. Design, moreover, should be characteristic of its age and of its nation. Design piracy was decried. These ideas were introduced in instruction and practice with "complete and utter failure" reported in another parliamentary review of 1849.

While these attempts were being tested another approach was made by an eccentric, successful young English architect, A. W. N. Pugin (1812–52), whose greatest task was the creation of all the ornamental details of the new Houses of Parliament. Trained by his *émigré* father, an ardent gothicist, Pugin late in the 1830s established workshops for authentically designed furnishings to complete his churches and houses. Thrice married, he designed his homes, their furniture and even his wives' jewelry. Pugin became a Roman Catholic in 1835, and most of his private work was for wealthy patrons stimulated by the Catholic Emancipation act of 1829.

Pugin was the first in the 19th century to formulate a consistent design code, and it was influential for over a century. He believed design was primarily a moral act; the attitudes of designers were transmitted to others through their works. Therefore the higher the ideals, the greater the art. Pugin opposed the picturesque which valued effects regardless of means, saying "designs should be adapted to the material in which they are executed." He thought the designer's "skill consisted in embodying and expressing the structure," that is, the purpose of the structure even more than its constructive system. Deriving decorative arts from architecture, he saw the architect as the chief implementer of a good and noble life. Bygone ages offered examples of how good work could be done but not of how it should appear; even in Gothic Pugin sought "not a *style*, but a *principle*." Thus every age and nation should evolve spontaneously a style that expresses its life—a thought close to Coleridge's. To achieve fitness, repose

and unity, the tests of successful design, Pugin recommended "seeking *the most convenient form* and then *decorating* it" so that "the smallest detail should *have a meaning and serve a purpose.*" He wrote that naturalistic ornament should be conventionalized and disposed geometrically to enhance the underlying form. He hated all sham materials, fought against three-dimensional effects on plane surfaces and criticized the overabundance of draperies. These reformatory ideas, launched throughout the 1840s in books which Pugin wrote and illustrated, were widely accepted. The year before his death, when his products were featured at the Great exhibition, Pugin correctly claimed "my writings, much more than what I have been able to do, have revolutionized taste in England." Pugin anticipated later 19th-century design reformers; he differed, however, from many of them in important ideas and practices. "Any modern invention which conduces to comfort, cleanliness or durability should be adopted," he wrote. "We do not want to arrest the course of inventions, but to confine them to their legitimate uses." Thus he found steam engines, modern plumbing and gas lights "most valuable"; railroads he thought offered great architectural opportunities. Tiles, metalwares, furniture, stained glass, vestments and jewelry by Pugin were manufactured and sold in regular trade. Not fanatic about handwork, he believed it should be supplemented by labour-saving devices and itself used chiefly for significant embellishments.

England at mid-century developed an internationally influential school of Gothicizing church architects, associated with the Oxford movement, founded in 1833. The English Protestant religious revival naturally was more accepted than the similar Catholic activity Pugin served. The Oxford movement's most original architect, William Butterfield (1814–1900), introduced the concept of realism, meaning a clear expression of materials through colourful contrast of textures and patterns, and large, abrupt forms indicating structure and workmanship. Such masculine expression has remained important in design.

Another personality in mid-century England was Owen Jones (1809–74), a colour expert, author and designer of prefabricated metal buildings. In 1856 Jones published *The Grammar of Ornament* with large colour plates whose subjects ranged from "Ornament of Savage Tribes" through all history to "Leaves and Flowers From Nature," preceded by "General Principles in the Arrangement of Form and Colour, in Architecture and the Decorative Arts." Jones's *Grammar* was frequently reprinted.

An occasional associate of Jones and Pugin was Sir Henry Cole (1808–82), civil servant, author, editor, entrepreneur in design and other arts and an important figure in the Great exhibition, working closely with its patron, Prince Albert. Subsequently he headed the National School of Design and its collections that grew into the first great national museum of applied arts, the Victoria and Albert.

The school and museum were modeled on a plan suggested by Gottfried Semper (1803–79), who went to England, a revolutionist exiled from Dresden, just as the Great exhibition was taking form. With the gifted English sculptor Alfred Stevens (1817–75) and a French refugee, Léon Arnoux (1816–1902), technical and artistic leader of Minton's ceramic works, Semper helped introduce a neo-Renaissance mode into English design. In the mid-century confusion of styles this seemed livable and reasonable. The Renaissance, moreover, had played an important role in English architecture from the 1830s, and a subordinate one in neoclassicism from the beginning.

Neo-Renaissance design opposed neo-Gothic on the continent also, from the 1860s on. Leading the trends were Semper, active in Germany, Switzerland and Austria, and Eugène Emmanuel Viollet-le-Duc (1814–79) in France. Both gifted, rebellious architects wrote extensive analytic design histories, announcing principles from which a new design could arise, befitting modern man. Viollet-le-Duc the Gothicist and Semper the humanist each exerted great influence on behalf of his favourite style. However divergent their tastes, both believed that the best examples of past eras revealed utilitarian structure, logical expression of materials and distribution of colour and decoration to emphasize structure and materials. Thus Viollet-le-Duc and Semper upheld a rational design evaluation, linking the neoclassical reform of the 18th century to the functionalism of the 20th.

In the 1850s and 1860s the English art critic John Ruskin (1819–1900) won a phenomenally wide audience, American as well as British. His central themes were two: the study of nature, particularly botany and geology (an enthusiasm of Viollet-le-Duc's), to discover therein principles of form and organization; and the importance of the "human touch" that involuntarily but effectively gives character to the surface of an artifact. Ruskin felt that only happy, moral men could make truly beautiful products; skill was not a prime requisite, still less the mathematical perfection of the machine. The touch of the artist or workman was the true source of artistic value, not rationality of structure or rational use of materials. The preference for expressive character over inherent logic brought Ruskin close to the concept of architectural realism. In the importance he attached to the human being behind the product his ideas paralleled Pugin's, but he had shifted emphasis from the intent of the designer to the involuntary character of the handmade surface. Mid-19th century sensitivity to surface quality has been attributed to improvements in printing illustrations; tactile values were readily rendered and became widely appreciated. Ruskin in fact was much concerned with the illustrations in his books. As regards architecture Ruskin and his followers favoured Venetian Gothic.

William Morris (1834–96) adapted a Ruskinian version of Pugin's principles to the applied arts. A constant experimenter, he revived many vanished or dying crafts, and he was an unusually gifted designer of flat patterns. Morris, like Pugin, built and furnished several houses for himself. In Morris' early furnishings, heavy neo-Gothic forms were supplemented with Pre-Raphaelite paintings by himself and his friends. After Morris' example, the idea of design reform through handicraft, with Gothic forms and moral ideas dominant, spread throughout the west. There already was a lively interest in oriental handicrafts. In 1862, at a second international exhibition held in London, Japan exhibited fascinating crafts; Turkey, Arabia and India were challenged. Acceptance of these newly revealed crafts was helped by the vogue for Japanese woodcuts and, in the next decades, by the discovery of Japanese architecture.

Idealism and Innovation.—Following the Great exhibition, Pugin's successors in England divided into two camps: eloquent, reforming handicraft workers, who are remembered by posterity; and pioneering designers for industry who welcomed the machine and believed medieval methods could not satisfy the wants or express the character of their civilization. Three of these stand out. E. W. Godwin (1833–86) was trained as an architect. He became interested in the Japanese in 1862 and soon after became a friend and collaborator of the painter J. A. M. Whistler. Godwin's long association with the actress Ellen Terry led him to costume and scenery design, at which he excelled. His first table was produced in 1868 by William Watt, for whom he designed, over many years, strikingly simple, sensible and original furniture, light in construction, often dark in colour and occasionally ornamented by flat, bright hardware and inset panels. Godwin and Whistler together evolved a style of interior in pale tints, sparsely, asymmetrically furnished. This style and Godwin's "art furniture" launched the Aesthetic movement in design that became the butt of caricaturists (Gilbert and Sullivan, *Patience*, 1881). Christopher Dresser (1834–1904) was a design student who switched to botany; he drew an important page analyzing plant forms for Jones's *Grammar of Ornament*. In 1862 Dresser's first text on design was published; it was widely used, as were its sequels. In the next five years he built an extensive practice as a free-lance commercial designer, like Godwin, of furniture, textiles and wallpapers. Dresser also did much in metalwares, pottery and glass; surviving examples are notably above the general level of his times. In 1868 he founded a design office and in the 1870s traveled as official representative to international exhibitions at Vienna, Tokyo, Philadelphia and Paris. Dresser's designs in the Aesthetic style were forerunners of 20th-century work—functionally conceived, favouring geometric shapes, often severely plain. He was an ornamentalist, especially in textiles and wallpapers, where he

used a surprisingly abstract symbolic expressionism. Bruce J. Talbert (1838–81), after schooling as an architect, began to design furniture for manufacture in 1862. In three years he became the leading gothicist in his field, then within a decade he turned toward the Jacobean style, freely interpreted in furniture, carpets, wallpapers, textiles and metalwork, paralleling the Queen Anne revival in English architecture.

Charles Locke Eastlake (1836–1906) wrote *Hints on Household Taste,* published in 1868 from earlier magazine articles. It resumed Pugin's theories in homely form, showing neo-Gothic furniture rationally constructed and ornamented. These illustrations were copied and varied commercially, but Eastlake himself did little designing.

In 1866 William Morris' firm received its first commissions: rooms in St. James's palace and the Victoria and Albert museum. The 1870s and 1880s were busy years for this group which included the Pre-Raphaelite painter Edward Burne-Jones (1833–98), who designed tapestries, stained glass, tiles and embroideries; the "realist" residential architect Philip Webb (1831–1915), who designed metalwork and glass of particular excellence, furniture, embroideries and jewelry; and the American George Jack (1855–1932), who was chief furniture designer. Many textiles, wallpapers and rugs were designed by Morris himself, but the famous Morris chair with adjustable back, beloved in many variations in the U.S., was produced by the firm without specific authorship. The Morris chair was an elementary example of the "patent" furniture that grew popular in the 1870s and 1880s. Twentieth-century historians also appreciated the inventive engineering and common-sense functionalism of these designs, generally overlooking their ancient sources.

The arts and crafts movement (*q.v.*) flourished from 1882 to about 1910, spreading Ruskin's ideals and Morris' practices. Craftsmen's guilds—associations to spread information, maintain standards, exhibit and teach—were formed in England and, later, elsewhere. Less medievalizing than that of Morris, their work emphasized materials and workmanship, ornament was reduced and floral elements were more naturalistic than conventionalized. English guilds organized an Arts and Crafts Exhibition society in 1888 to demonstrate the unity of all the arts, fine and applied, as Ruskin and Morris taught. This idea, almost an axiom of design in later years, directly opposed the academic approach to the arts. Walter Crane (1845–1915), an admired illustrator, was leader of the movement, as was C. R. Ashbee (1863–1942), a distinguished teacher. Arthur H. Mackmurdo (1851–1942) was an early contributor; later, like Ruskin and Morris, he became concerned with social rather than artistic reform. C. F. A. Voysey (1857–1941) was the leading architect of the movement; his original, delightful, cottage-style houses were widely copied. Voysey rose to prominence in the 1890s; even earlier he was known as the best flat-pattern designer after Morris. Perhaps influenced by Whistler and Godwin, Voysey's designs were light-toned; here too his example was very widely followed. The arts and crafts movement began a successful reform of lettering, printing, binding, illustrating and related arts; William Morris' epochal Kelmscott Press was founded in 1890; two distinguished book designers, T. J. Cobden-Sanderson (1840–1922) and Sir Emery Walker (1851–1933), worked there. The arts and crafts movement recruited leading young architects and designers in the Netherlands, Belgium and Germany and in the United States, where the Mission style of furnishings and *The Craftsman* magazine lasted through 1916; Frank Lloyd Wright's (1869–1959) prairie house furnishings (1895–1910) were related.

The arts and crafts movement focused attention on humble, handmade things, leading to a revival of cottage crafts, the diversified crafts originally developed to keep a peasant household self-sufficient. This activity and Voysey's cottage architecture followed a century-old interest in peasant huts and hamlets, inaugurated by Queen Caroline of England and Queen Marie Antoinette of France in their garden retreats. The passage of time ensured a change from the picturesque approach to realism, but the attitude of escape from actuality remained.

Glasgow in the latter 1890s produced a vigorous design group centred on the architect C. R. Mackintosh (1868–1928). For a few years this highly romantic, symbolizing version of the arts and crafts movement led insurgent design. Liège, Vienna, Turin, Budapest, Dresden, Munich, Berlin, Venice and Moscow admiringly exhibited works of the group. To the process-bound forms of the movement, Glasgow designers added a feminizing, lyrical complexity and curvilinearity that was the very opposite of realism and led straight to *art nouveau* (*q.v.*), the last flower of 19th-century design.

Art nouveau had three reciprocal but distinct characteristics, all evident before 1900. Reformatory like British work, but centred in Brussels, Nancy and Paris, it fed directly on the rational, progressive ideas of Viollet-le-Duc. It looked to train sheds and viaducts rather than to cottages for inspiration, becoming a style of metal and glass. Second, continental designers were close to the *Symboliste* writers, musicians and painters of the 1880s and 1890s and brought to design the symbolists' love of linearity, undulating rhythms, glowing colours and richly encrusted accentuation, as well as their penchant for mysticism, allusion and psychological tension. Third, the need was strong for a new style, not assembled in bits from historic revivals (by then as stifling as academic classicism had been) but totally modern.

Many *art nouveau* designers, however, took their points of departure from previous nonimitative styles such as rococo, baroque or even Biedermeier, hoping to re-establish the broken chain of western creativity. Despite this tribute to history a fresh spirit was supported by insurgent art periodicals. In London *The Studio* began in 1893; similar magazines followed in New York, Chicago, Vienna, Brussels, Paris, Berlin, Munich, Dresden, Darmstadt, Stuttgart, Amsterdam, Rome and Milan. *Art nouveau* typography and ornament spread far into commercial graphic arts. When not abstractly expressive, *art nouveau* ornament in all fields was often floral. The first and best master of this vein was Émile Gallé (1846–1904) of Nancy, who designed widely influential glass and furniture. An American, Louis C. Tiffany (1848–1933), was the one glass designer and decorator of the 1890s comparably original. Parisian modern designers were the most elegant; three exhibition centres served them, the earliest, founded in 1895, was S. Bing's shop, l'Art Nouveau, which gave the style its name. Bing's first designer was Henry van de Velde (1863–1957), a Belgian who soon thereafter pioneered modern design in Germany. Van de Velde's impetus was derived from the Brussels architect who initiated *art nouveau,* developing it with sudden, peerless genius, Baron Victor Horta (1861–1947). In 1892 Horta designed a residence for Émile Tassel, first of a series of town houses large and small that in fittings, furnishings and structure were rational and unprecedented; they were unified by sinuous linear networks and warm, rich colours. Nothing in France or Germany, where the style took root almost at once, or in Spain before 1900, surpassed the Brussels originals.

The speed and vitality with which *art nouveau* spread demonstrated that the 20th century would be ushered in with what had not been seen for a century—modern design intrinsically free of retrospection. Its principles were those formulated in the 1840s by Pugin; now they found shapes unmistakably independent and apposite.

See also MODERN ARCHITECTURE; INDUSTRIAL DESIGN; DESIGN, 20TH-CENTURY.

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DESIGN, 20TH-CENTURY. Design in the west during the 20th century has been subject to the social trends that dominated the 19th century: democratization, industrialization and governmental responsibility for education and social security. The year 1900 was the apogee of *art nouveau* (*q.v.*), an original style of design that lately had succeeded, for the first time since the rococo, in uniting progressive efforts in all the applied visual arts. The Exposition Universelle, Paris, 1900, revealed a new growth of modernism arising amid the mass of decadent historic-revival styles. In Barcelona Antonio Gaudí (1852–1926) created buildings and furnishings of unparalleled inventive freedom. Yet, before World War I, *art nouveau* flowered and wilted, weakened by its attachment to the fine arts, then deep in emotional *symbolisme*. The arts and crafts movement (*q.v.*), an older design trend, survived better, purified of medievalisms, invigorated by an augmented interest in folk arts of all eras and areas.

Unlike *art nouveau*, the arts and crafts movement repudiated industrialization; yet the first systematic program of design in industry was initiated in 1907 in Germany by men whose ideals and plans were directly derived from those of the English arts and crafts guilds. Peter Behrens (1868–1940), self-taught artist-designer-architect, was a principal figure in two enterprises begun that year: the entire design program of the German electrical trust—products, advertising, buildings—was placed under his guidance; simultaneously he helped found the Deutscher Werkbund, an association of designers, manufacturers, educators and government officials dedicated to raising design standards especially in low-cost consumer goods. The Werkbund also upheld professional ethics and education. Both these enterprises flourished, becoming models for similar efforts all over the world in succeeding decades. Before World War I the failure of *art nouveau* invited a resurgence of classically correct revival styles. The conditions of modern design, furthermore, were profoundly altered by scientific management, mass production and the revolution in psychiatry.

World War I and After.—The decade of World War I saw two tendencies rise in design: functionalism, that borrowed forms and materials from machine shop and scientific laboratory, and expressionism, that attempted to exteriorize the new insights into subconscious and emotive depths. In the postwar chaos and economic stringencies of Europe, functionalism offered hope of broad improvements in everyday life. Expressionism gradually receded from industrial design and architecture to handicrafts, fine arts and theatre. In design, expressionism and functionalism started as equals, repeating the earlier polarity of *art nouveau* and the arts and crafts movement; as before, rival modern trends had to fight shoulder to shoulder against established historic-revival styles.

The Bauhaus (*q.v.*), a German school for all the arts founded in 1919 by Walter Gropius (1883–), became the symbol of functionalist design, despite the presence of important expressionist talents on its faculty. Its curriculums—notably a preliminary course evolved from kindergarten practices and the use of handicrafts as training grounds for industrial designing—exerted wide, lasting influence on design education, particularly in the United States where several Bauhaus members, migrating under Nazi pressure, established schools or found posts at Harvard, Yale, the Massachusetts Institute of Technology and the Illinois Institute of Technology. Bauhaus graduates spread its ideas widely and designers trained at its American daughter-schools influenced design education and industry.

International decorative arts were exhibited in 1925 at Paris; there was a spate of expressionism, overornamented, trivially neo-Cubist, but well received commercially, particularly in the United States, where a classical-colonial revival had dominated since the 1890s. Progressive observers everywhere were alarmed; at the exposition itself a pavilion of protest was built and furnished by the architect Le Corbusier (Charles Édouard Jeanneret, 1887–) and his colleagues. The furnishings were either architectural miniatures (cabinets and tables) or plain, artless chairs and small articles, modern industrial "folk" art. The lack of forceful modern product design was clear. Two years later a very different international exposition opened in Stuttgart. Under the direction of Ludwig Mies van der Rohe (1886–), a new residential section was laid out on a hill crest, with modern houses and flats fully furnished, designed by leading European modern architects. Furniture had advanced well beyond the Paris showing: expressionism and ornament hardly appeared; an image of modern living began to emerge. Interiors by Mies, Le Corbusier, Gropius, Marcel Breuer (1902–) and their associates in 1929–30 mark the fulfillment of functionalist design. The Netherlands, Scandinavia, England, Italy, Spain and the United States soon followed the lead. Expressionism was subdued, and some earlier modern mannerisms were eliminated. As Adolf Loos (1870–1933), Viennese critic-architect, had predicted for 30 years, ornament became taboo. Handmade surfaces, admired since Ruskin's day, looked artificial. The artiness of *art nouveau* was put aside. Art historians wrote about the influence of 20th-century painters and sculptors over designers, but more significantly there were common enthusiasms—structural engineering, primitive and folk arts —that influenced artists and designers simultaneously.

In the United States, industry, in search of new ways to reach consumers during the Great Depression of the 1930s, turned to modern designers at hand; they were unexpectedly successful. In a few years a new, often crudely handled, but sometimes effective style was born, "streamlining."

Based on engineering studies to reduce friction on bodies moving in liquids or in air, the admired forms were bulbous, sleek, tapered, with easy transitions between parts. Such forms were used frequently for quite static objects, particularly protective shells over machinery. Ornament appeared as bright striping, often grouped in threes. Streamlining existed without benefit of the ethical ideals inherited by functionalist design from the arts and crafts movement, and many thoughtful people deplored it. Yet the popular image of an age of speed had found its embodiment, and with inevitable adaptations streamlining survived and grew, bringing big-business practices and sleek, impersonal design, initiated by Behrens, into wide use. Kitchens, bathrooms and motor vehicles were most affected. Streamlining pioneers included Walter Dorwin Teague (1883–1960), Norman Bel Geddes (1893–1958), Raymond Loewy (1893–) and Henry Dreyfuss (1904–), men whose later works have often been acclaimed.

In Europe of the 1930s other challenges to functionalist design arose. In richly forested Scandinavia, wood was emphasized. Simple country-house furnishings of the early 19th century were restyled without ornament, scaled for modern rooms and modified to suit modern ideas of comfort; light furniture was made of birch, beech, ash and oak rather than conventional mahogany, walnut or maple. As "Swedish modern" this mild effort was widely accepted in the United States. The Finnish Alvar Aalto (1898–) produced rational furniture in bent plywood, and Bruno Mathsson (1907–) in Sweden, a manufacturer-designer, used Michael Thonet's century-old techniques for bent-frame, strap-seated chairs, forthrightly modern. The chief Bauhaus furniture designer, Breuer, and Le Corbusier's furniture assistant, Charlotte Perriand (1903–), both designed for wood in pliable and solid forms. Functionalist metal furniture continued, a special rather than a leading style; most dinette and porch furniture, commercially important in the United States, was made of metal.

Influenced by the Bauhaus and the Werkbund, Germany in the 1930s produced clear, logical examples of modern design in metalwares, china, lighting fixtures and wallpapers. Later, Scandinavian sources enriched the repertory with excellent decorative and table glassware, textiles of all kinds and peasant basketry. Particularly for homes, the emphasis on machine-finished and technologically sophisticated materials—chromed tubes, Bakelite, etc.

—was relaxed; many craft effects reappeared before the end of the 1930s.

World War II and After.—World War II effectively terminated the design of the 1930s. The creative designers of earlier decades were conspicuously inactive, though some continued with brilliant success as architects. The tone of design changed. Functionalism seemed inadequate; feelings as well as reason demanded expression. Curvilinear, richly detailed, interestingly textured design gradually returned; even *art nouveau,* once spurned, could again be enjoyed and studied.

Just before the war Eero Saarinen (1910–1961) and Charles Eames (1907–), young American architects, had jointly experimented with molded plywood shells for seating. In 1946 the Museum of Modern Art in New York city exhibited Eames's much refined furniture. His plywood chair became a classic, followed soon after (1948) by Saarinen's spacious armchair, upholstered over sheet plastic, which long remained the best modern comfortable chair. Eames produced other brilliant and influential chairs and toys; Saarinen too continued as a furniture designer. In both, a strong technological interest indicated the heritage of functionalism, but the forms and taste were fresh. These two men changed the basic elements of chair design; with a few others they placed the United States, for the first time, in the forefront of progressive design. American industrial designers shared in this international recognition. American automobile design, challenged from all sides, continued the streamlined trend; alone in modern design at mid-century it featured heavy ornamentation, though by the 1960s it, too, was beginning to reflect the contemporary taste for purity. Industrial design merged into architecture as more building elements were factory finished, like curtain-wall panels and illuminated ceilings. Technological progress affected design directly, as in foam cushioning, 1936; plastic films, filaments and forms, *e.g.,* polyethylene containers, 1945; melamine dinnerware, 1947, and chair shells, perfected by Eames, 1949; and, in 1959, Pyroceram and fluorescent lamp improvements.

Three European countries led design after World War II. Italy was prodigal with effective specialties and displays, particularly at the Milan triennial exhibitions, which consistently presented advanced European designs. Finland began to export glass, earthenware and other products of remarkable subtlety and perfection by a host of designers, chief among them Kaj Franck (1911–) and Tapio Wirkkala (1915–). Denmark, noted early in the century for handmade silver and underglaze-painted porcelain, in the later 1940s spurted into exceptional design activity that won world recognition. In furniture, Finn Juhl (1912–), Hans Wegner (1914–) and Arne Jacobsen (1902–) were but three of a long, distinguished roster of designers; Juhl in particular led an antifunctionalist reaction. Typical Danish innovations in modern furniture were teakwood and matte finishes (shiny varnishes had been standard). The Danes were as profuse and skilled in silver, steel, ceramics, textiles and plastics as in wood; outstanding metal designers were Kay Bojesen (1886–1958) and Magnus Stephensen (1903–).

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DESK: *see* Cabinet Furniture.

DESLANDRES, HENRI ALEXANDRE (1853–1948), French physicist and astrophysicist, noted for his contributions to spectroscopy and solar physics, was born in Paris on July 24, 1853. Deslandres' research on band spectra (1886–91) proved the structural identity of the various bands emitted by a molecule under given conditions and showed that the wave numbers of individual band heads are—like those of individual lines in a band—nearly in arithmetical progression; he derived a general formula for the wave numbers and inferred the presence of harmonic oscillations.

In 1891 Deslandres and G. E. Hale independently discovered the reversal of the calcium H and K lines on the solar disk and Deslandres invented the *spectro-enregistreur des vitesses* or velocity recorder, an instrument related to the spectroheliograph (*q.v.*). In 1908 he became director of Meudon observatory, where he obtained a long series of excellent spectroheliograms and velocity records. These were used to study the *plages faculaires* and dark filaments, which Deslandres identified as prominences projected on the solar disk, and led to a general picture of the circulation of material at various levels through the sunspot cycle.

Deslandres was elected to the French Académie des Sciences in 1902 and received the gold medal of the Royal Astronomical society in 1913. He was appointed director of the Paris observatory in 1927. He died in Paris on Jan. 15, 1948. (B. E. J. P.)

DESMAN, a common name for two species of aquatic insectivores related to the moles: *Desmana moschata* (16 in. overall) from southeastern Russia and western Siberia; and *Galemys pyrenaicus* (11 in. over-all) from the Iberian peninsula and the Pyrenees. They have a long snout, no external ears, webbed hind feet and a scaly tail that is flattened at the sides in the larger species. The dense fur is dark brown above, light below. *See* also Insectivore. (L. H. M.)

DESMAREST, NICOLAS (1725–1815), French geologist who presented the first clear proofs that valleys have been eroded by the streams that flow through them, was born at Soulaines, in the *département* of Aube, on Sept. 16, 1725. He was educated at Oratorian colleges in Troyes and Paris. In 1788 he was appointed inspector general and director of manufactures for France; in 1792 he was imprisoned but later was recalled to government service. In 1775 he had presented a memoir on the effects of weathering and stream erosion on volcanoes and lava flows, but delayed publication until 1806. Desmarest also prepared a work on physical geography, including much geology, as part of the *Encyclopédie Méthodique.* Although it filled four large volumes, this work had progressed only to the letter *N* at the time of his death, in Paris, on Sept. 28, 1815. (M. A. F.; C. L. Fe.)

DESMARETS, NICOLAS, Sieur de Maillebois (1648–1721), French minister of finance at the end of Louis XIV's reign, was born in Paris on Sept. 10, 1648. A nephew of J. B. Colbert (*q.v.*), he rose rapidly in the financial administration but fell into disgrace on Colbert's death in connection with a scandal over the illicit fabrication of four-sol pieces. Allowed to return to Paris, in 1686, he provided the controllers-general of finance over the next ten years with a remarkable series of memoranda exposing the desperate economic situation of France. Having worked under Michel Chamillart (*q.v.*) from 1699, he succeeded him as controller-general in Feb. 1708, during a critical phase of the War of the Spanish Succession. The financial situation was grave; expenses to be met in that year were far in excess of the normal revenue, most of which in any case, together with a large part of that for following years, had already been assigned in advance to secure loans. Desmarets began canceling the assignments on the revenue for 1708 and postponing redemption of the loans till a later date. This bold step, which might have been taken for defaulting, paradoxically inspired confidence, and he was able to raise new loans (at heavy interest). In 1709, when famine still further reduced the ordinary revenue from taxation, he suspended all payments from the Caisse des Emprunts (which had originally attracted investors by offering very high rates of interest on deposits that could be withdrawn at will); and subsequently he converted the deposits into bonds redeemable at various dates and with a lower rate of interest, which in turn he finally changed into perpetual annuities at 1%. He was careful to treat the obligations sponsored by himself more punctiliously than he did those undertaken by his predecessors. Other expedients were a royal lottery; devaluation and then recall of the metal currency (this was too extreme, and foreign powers profited by offering better prices than the French treasury for coin); state borrowing of precious metals to restore the circulation of coin (as opposed to the note currency of assignments on public funds); and, in Oct. 1710, an income tax of one-tenth (based on Vauban's proposals in his *Dime royale* of 1707), which however the privileged classes contrived to avoid. His efforts saw France through the war, though in 1715 he had to recommend that the state should declare itself bankrupt. After

Louis XIV's death, Desmarets was dismissed by the regent duc d'Orléans, though he had proved himself France's greatest finance minister since Colbert. He died in Paris on May 4, 1721.

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DESMARETS DE SAINT-SORLIN, JEAN (1595–1676), French writer and first chancellor of the Académie Française, who opened the long literary battle against the ancients on behalf of the moderns with *La Comparaison de la langue et de la poésie française avec la grecque et la latine* (1670). He was born in Paris in 1595. A romance, *Ariane* (1632), gained him admission to fashionable literary circles, and under the patronage of Richelieu he wrote numerous plays, the best being *Les Visionaires* (1637), and received political preferment. After 1645 his growing religious intolerance was directed particularly against the Jansenists. The long heroic poem *Clovis* (1657) and *Les Délices de l'esprit* (1658) both emphasize the Christian basis of his opposition to the ancients. He died in Paris, Oct. 28, 1676.

See R. Kerviler, *Desmarets de Saint-Sorlin* (1879); P. A. Brun, *Autour du XVIIe siècle. Les Libertins . . . Desmarets* (1901).

DES MOINES, the capital of Iowa, U.S., and seat of Polk county, is located in the south-central part of the state along both banks of the Des Moines river in the heart of the corn belt and surrounded by coal fields.

The first settlement in the area was the establishment of a military garrison (Ft. Des Moines) in 1843 at the strategic juncture of the Raccoon and Des Moines rivers to protect the rights of the Sauk and Fox Indians. In the same year, however, the area was opened to white settlers, and by 1851, with nearly 500 inhabitants, Des Moines was incorporated as a town.

There is much controversy over the origin of the name of the Des Moines river for which the city is named. One explanation is that the original French name, *la rivière des moines*, meant the river of the monks, who lived along its banks. Another theory is that it is a derivation of the French *de moyen* ("middle"), inasmuch as the river is midway between the Mississippi and Missouri rivers. Probably the best explanation, however, is that it is a French corruption of the name of an Indian tribe, the *Moingona* or *Moingwena* (a name of uncertain origin), whose village, located on the river, was shown on Jacques Marquette's map of the region.

When the state capital was moved there from Iowa City in 1857, Des Moines was chartered as a city and its growth was assured. In 1884, the state capitol building was completed in a park of 80 ac. in east Des Moines. With its gold-gilded central dome, the capitol is an imposing example of the revived classical Roman style of 19th century architecture. Nearby are located the State Historical, Memorial and Art building, and state library. Des Moines was one of the first cities in the U.S. to plan a city development program that took advantage of its natural setting. Along the river front, a civic centre was created in 1924 with the city hall, municipal courthouse, federal building, post office and city library. Along Grand avenue, a wide tree-lined street, great mansions were built in the late 19th century. Of particular interest is Terrace Hill, the Hubbell family home, one of the finest examples of the French mansard roof style of architecture still extant in the U.S.

In the first 50 years after its founding, Des Moines grew to be first in size of Iowa cities. Its most rapid period of growth was in the ten-year period from 1910 to 1920, due in part to the development of the rich coal areas nearby. Pop. (1960) 208,982; standard metropolitan statistical area (Polk county), 266,315. (For comparative population figures *see* table in IOWA: *Population.*) Des Moines, an important communication centre, also has major commercial, wholesale and manufacturing importance. Products include meats, clothing, brick and tile, aircraft parts and farm machinery. Many insurance companies established their home offices in the city. Des Moines is also an important publication centre for periodicals, especially farm journals.

In 1907 Des Moines pioneered in the reform of municipal government with the adoption of the commission form of government. This was superseded in 1950 by the council-manager plan.

In the field of higher education, there are Grand View Junior college (Lutheran, founded 1896) and Drake university, a privately endowed institution founded in 1881 and related to the Disciples of Christ. The university, which has eight colleges and a graduate division, co-operates with the city in the operation of an observatory and a symphony orchestra. The Drake Relays, founded in 1910, is one of the major U.S. track and field meets. The Des Moines Art centre, designed by Gottlieb Eliel Saarinen, located in Greenwood park, was opened in 1948; in addition to providing a gallery, it conducts a school for training in art and crafts.

Other recreation and educational centres are the Veterans auditorium, KRNT theatre, the largest legitimate theatre in the U.S., and the Iowa State Fair grounds. The Des Moines park system, comprising over 1,400 ac., was one of the first to provide a municipally owned golf course (begun in 1894, the course was opened to the public in 1901). Ft. Des Moines, adjoining the city on the south, was re-established as a cavalry post in 1900. In World War II it became the first training centre for the women's army corps, and later was converted into a veterans' housing centre. Walnut Woods State park is nearby. (J. F. WA.)

DES MOINES RIVER, the longest stream in Iowa, U.S., and an important western tributary of the Mississippi, rises in the southwestern part of Minnesota, near the town of Pipestone. From its source the river flows 535 mi. in a southeasterly direction until it eventually joins the Mississippi two miles south of Keokuk, Ia. Above Humboldt, in central Iowa, the river is known as the West Fork. The East Fork and the Raccoon river are the two principal tributaries. For a distance of 25 mi. above its mouth the river serves as the boundary between Iowa and Missouri.

From its source to its mouth the river falls a total of 1,375 ft., or about 2.6 ft. per mi.; this rate is nearly constant throughout its entire course. The Des Moines drains an area of 15,807 sq.mi. of rich, glaciated farm land. Floods are common and the damage inflicted upon the cities and countryside of the lower valley is often widespread. At Keosauqua, Ia., 45 mi. above the mouth of the Des Moines, the average discharge is 5,359 cu.ft. per second. During June a maximum of 42,900 cu.ft. per second is reached; in the latter part of September the river ceases to flow for a short time. For the origin of its name, *see* DES MOINES.

The first attempt to use the Des Moines river for navigation came in 1837, and from that time until the close of the American Civil War the river was the main artery of commerce for central Iowa. The city of Des Moines was the main upper terminus for river steamers, although some boats regularly navigated as far north as Fort Dodge. A complete decline in river traffic came with the widespread development of railroads. The river was early utilized for power. Although none survive, a total of 80 mills for grinding grain were built along its banks between 1840 and 1890.

The major cities along the banks of the Des Moines river include Des Moines, Fort Dodge, Ottumwa and Estherville. The river is an important source of water for these cities. (R. R. D.)

DESMOND, GERALD FITZGERALD, 14TH EARL OF (*c.* 1538–1583), Irish leader, known sometimes as the "rebel earl" because of his opposition to the government of Elizabeth I, was the son of James FitzJohn, 13th earl, by his second wife Mor O'Carroll. In 1550 Gerald married Joan, heiress of James (d. 1529), 10th earl. She had previously married James Butler (d. 1546), 9th earl of Ormonde, and Sir Francis Bryan (d. 1550), lord justice, and was mother of Thomas, 10th earl of Ormonde, who in consequence was a claimant to the Desmond inheritance. Gerald succeeded his father as earl of Desmond in Oct. 1558. His neutral attitude toward the reformation legislation in the Dublin parliament of 1560 led to suspicion of hostility toward the government and he was believed to have been involved in an offer of the kingdom of Ireland to Philip II of Spain. Ormonde's return to Ireland in 1554 revived the rivalry between Butlers and FitzGeralds, particularly over the border areas of east Waterford and southwest

Tipperary. Both earls were summoned to London, where Desmond's manner provoked the queen, and he was briefly imprisoned. He was allowed to return to Ireland in 1562 and undertook to enforce the reformation legislation in Munster. The death of his wife (Jan. 1565) who had failed to give him an heir, was followed by an open conflict with Ormonde in which Desmond was wounded and captured at Affane early in 1565. Ormonde's representation of this as an action on behalf of the government was not admitted by the queen, but her partiality for Ormonde and prejudice against Desmond caused anxiety to Sir Henry Sidney, the lord deputy.

After a further imprisonment in London, Desmond, fearing charges of treason, surrendered his estates to the queen and was conditionally restored after substantial damages had been awarded to Ormonde. Early in 1566, Desmond married Eleanor Butler, daughter of Lord Dunboyne. After attempting to exercise jurisdiction over lands possessed by Ormonde in southwest Tipperary, he was arrested (1567) and remained in custody for six years. North Kerry, County Limerick and east Cork were experimentally entrusted to a commission including Desmond's more capable brother Sir John FitzGerald, but later Sir John too was arrested and sent with Desmond to the Tower of London. During Desmond's imprisonment, his cousin James (Fitzmaurice) FitzGerald (*q.v.*) launched a rebellion against the English, but came to terms (Feb. 1573) shortly before the earl's release.

After his return to Ireland Desmond resented the imposition by the Irish government of stringent regulations which substantially added to the conditions he had agreed to with the queen. He entered in July 1574 into a "combination" with other southern Geraldines to resist Lord Deputy FitzWilliam but again submitted and was pardoned in October. In the meantime he made a trust deed for his family which was subsequently regarded as a precaution taken in case he should be driven into rebellion. Fitzmaurice left Ireland in 1575 but the situation deteriorated under Sir William Drury whose iron rule and wholesale executions exasperated Desmond. The return of Fitzmaurice, in July 1579, with a small force of Italians and Spaniards, and a papal commissary, Nicholas Sanders, was not at first supported by Desmond. But after Fitzmaurice's death (1579), Sanders induced him to take up the position of general of the papal army. For some time he had attempted to keep in with both sides but he was proclaimed a traitor in Nov. 1579, although the evidence of his complicity did not emerge until later.

Desmond had no military ability and depended upon his prestige in Munster and upon the hope of substantial reinforcement from the continent. He appealed to many Irish lords to join in the defense of "our Catholic faith against Englishmen which had overun our country." The papal army was defeated by Lord Grey de Wilton, but his savagery in suppressing the rebellion led to his recall and the conduct of the war was entrusted to Ormonde who ultimately defeated Desmond's forces piecemeal. The earl was killed on Nov. 11, 1583, in a minor affray in Kerry. (R. D. Es.)

DESMOND (*Des-muma,* "south Munster"), an ancient territorial division of Ireland approximating to the counties of Kerry and Cork. In the 11th century the expansion of the O'Briens in Thomond (Tuadmuma, "north Munster") led to the occupation of Desmond by the Mac Carthaigh (Mac Carthies) of Cashel. After the Anglo-Norman invasion, and until the 17th century, it is necessary to distinguish two areas described as Desmond. Gaelic Desmond was divided among families like the Mac Carthies, O'Sullivans, O'Donoghues, O'Driscolls, O'Mahonies, O'Keeffes and O'Callaghans. It extended over the modern County Kerry south of the river Maine, and over the modern County Cork west and north of that city but excluding a western coastal strip between that city and Bandon. This is the area usually described as Desmond in 16th-century Anglo-Irish records. Anglo-Norman Desmond, including the liberty of Kerry and the lordship of the Decies, extended over north Kerry from the river Maine, over most of the modern county of Limerick, southwest Tipperary, east and south County Cork and east Waterford.

Maurice FitzGerald was created 1st earl of Desmond by Edward III in 1329. His descendants had acquired enormous powers and a large measure of independence by mid-15th century. After Thomas, 7th earl, had been executed by order of Edward IV's viceroy in 1468, his successors practically withdrew all allegiance to the kings of England. The Desmond earls maintained a semi-regal state and, early in the reign of Henry VIII, negotiated directly with the emperor Charles V and the French king Francis I. However, after the destruction of the Kildare FitzGeralds (1537), later Desmonds, handicapped by domestic succession disputes, gave nominal recognition to English royal authority. James, 13th earl, accepted the Tudor rule from 1540 but feared the expansion of the Butlers of Ormonde who, through marriage, claimed the Desmond territory. His successor, Gerald (*see* DESMOND, GERALD FITZGERALD), lost his life and lordship in 1583 after he had become involved in the rebellion of his cousin James (FitzMaurice) FitzGerald (*q.v.*) against Elizabeth I. An act of the Irish parliament in 1586 declared the FitzGerald lordship of Desmond forfeited, but grants of the title of earl were made to the 14th earl's son James (d. 1601) in 1600 and to Richard Preston, Lord Dingwall (d. 1628), in 1619. After 1675 the title was held in conjunction with the earldom of Denbigh. (R. D. Es.)

DESMOULINS, CAMILLE (1760–1794), one of the greatest and most influential pamphleteers and journalists of the French Revolution, was born on March 2, 1760, at Guise, in Picardy, where his father was lieutenant-general of the *bailliage*. On completing his studies with distinction at the Collège Louis-le-Grand in Paris (where Robespierre was his contemporary), Desmoulins planned to become a lawyer and was called to the bar in March 1785, but his stammer made this choice unfortunate. The opening of the estates-general in 1789, however, roused him to enthusiasm and he went to watch its sessions at Versailles.

On July 12, 1789, when Louis XVI's dismissal of Jacques Necker became known in Paris, Desmoulins, with a green leaf in his hat to symbolize hope, delivered an impromptu speech to the crowd in the Palais-Royal and was the only orator there to make an impression. After the storming of the Bastille, he issued a pamphlet, *La France libre,* summing up the main charges against the *ancien régime.* During the September crisis, when the king refused to sanction the Declaration of the Rights of Man and the Citizen and the decrees of Aug. 4, Desmoulins issued another pamphlet, *Discours de la lanterne aux Parisiens,* supposedly giving the views of the streetlamp in the Place de Grève, on which several people had been summarily hanged in July. These two pamphlets established his reputation. He then launched a paper, *Révolutions de France et de Brabant* (86 nos., Nov. 1789–July 1791), in which his lively style and his ready attacks on everyone who seemed to him to be deviating from the common cause did much to advance the Revolution. He lost heart, however, after Louis XVI's flight to Varennes (June 21, 1791) and the massacre on the Champ-de-Mars (July 17, 1791) and said farewell to his readers in his paper's 86th issue. On July 22, 1791, the arrest of Desmoulins was ordered together with that of other patriots, and he had to go into hiding until the Assembly granted an amnesty on the voting of the new constitution (September). It was during this period, as a member of the Cordeliers club, that he had formed his close association with Georges Danton (*q.v.*).

In the early days of the Legislative Assembly, Desmoulins attended the Jacobin club, where on Oct. 21, 1791, he delivered his *Discours sur la situation politique de la nation,* violently attacking the new constitution as based on a property qualification for electoral rights. On the great question of war or peace, he supported Robespierre for a time against Brissot's war policy. This period of his career, however, is chiefly important for his break with the future Girondins. At the beginning of 1792 he posted up in Paris a counsel's opinion signed by himself, contesting the right of the correctional tribunal to imprison two people condemned for keeping a gaming house. Thereupon he was violently attacked in Brissot's paper *Le Patriote français.* Holding Brissot himself responsible for this attack, he answered him with an angry pamphlet, *Jean-Pierre Brissot démasqué.*

On July 24, 1792, Desmoulins delivered his *Discours sur la situation de la capitale,* before the general council of the Paris Commune. In this he denounced the distinction made by the constitution between "active" and "passive" citizens in qualification

for the vote; foretold the overthrow of the monarchy; and demanded precautionary measures against court intrigue and foreign invasion. His actual role in the overthrow of the monarchy (Aug. 10) is hard to assess, but on Aug. 12 he became secretary-general to the ministry of justice, under Danton. In September he was elected to the Convention as a deputy for Paris. During the trial of Louis XVI he published his condemnatory *Opinion. . . sur le jugement de Louis XVI* and voted for the death sentence without reprieve.

In 1793 at the height of the struggle between the Girondins and the Mountain, Desmoulins wrote his *Histoire des Brissotins* as a pamphlet against the former; and on the overthrow of the Girondins (May 31) it was he who composed the Jacobin club's explanation to the *départements* about what had happened. In October, however, when the Revolutionary tribunal sentenced the Girondins, he sadly blamed himself and his *Brissot démasqué* for their deaths.

When the Mountain began to split into factions, Desmoulins sided with Danton and the "Indulgents" or moderates against Hébert and the "Exagérés." In the first two numbers of his new paper, *Le Vieux Cordelier* (6 nos., Dec. 5–30, 1793) he attacked those responsible for the policy of dechristianization (specifically P. G. Chaumette and Anacharsis Cloots). Robespierre tacitly approved of this attack, but in the third number (Dec. 15) Desmoulins criticized the law of the suspects and the policy of the Terror, and in the fifth he attacked Hébert and his friends openly. Robespierre, seeing how the factional dispute might upset the Revolutionary government, now called on Desmoulins to explain himself to the Jacobins, proposed the burning of the paper and frankly condemned his conduct (Jan. 7–8, 1794), but still saved him from expulsion from the club. Desmoulins was expelled, however, from the Cordeliers. This was the end of his political career. Then, in March, a few days after striking the Hébertists down, the government struck finally at the "Indulgents." In the night of March 29–30, Danton, Desmoulins and their friends were arrested. Sentenced by the Revolutionary tribunal, they were guillotined on April 5, 1794. Eight days later, on April 13, Desmoulin's widow, née Lucile Duplessis, whom he had married in Dec. 1790 and dearly loved, was likewise executed—with Hébert's widow and Chaumette.

There is a critical edition of *Le Vieux Cordelier* by A. Mathiez and H. Calvet (1936).

See G. Claretie, *Camille Desmoulins, Lucile Desmoulins* (1875). (A. So.)

DESNOYERS, AUGUSTE GASPARD LOUIS BOUCHER, Baron (1779–1857), French engraver, was born in Paris on Dec. 19, 1779. He studied engraving under Louis Dareis and drawing in the atelier of Lethière. After visiting Italy he entered the studio of Alexandre Tardieu in 1800 and became one of the most eminent line engravers of his time. His fame was established in 1805 by an engraving after Raphael, whereupon Napoleon I commissioned him to reproduce his full-length portrait in coronation robes by Gerard. He became a member of the Institute (1816) and engraver to the king (1825). He is accredited with 75 plates. He died in Paris on Feb. 16, 1857.

DE SOTO, HERNANDO (Fernando) (1496?–1542), Spanish explorer of southeastern United States and discoverer of the Mississippi river, was born at Jeréz de los Caballeros, Estremadura, Spain. He became the protégé of Pedrarias Dávila and accompanied him to Central America in 1519. In 1532 he joined Francisco Pizarro in Peru, aided in capturing the Inca king, Atahualpa, and led the way to the Inca capital, Cuzco. (*See* Peru: *History.*) He then retired to Spain but in 1536, inspired by the reports of Cabeza de Vaca, he secured permission from Charles V to conquer Florida, then a vast undefined region in North America. As *adelantado* of Florida and governor of Cuba, De Soto left San Lucar in April, 1538. His greatest achievement was his exploration of the southeastern part of the present United States.

Sailing from Havana, May 18, 1539, with nine vessels and a force, besides sailors, of over 500 men and more than 200 horses, he reached Tampa Bay, on May 25. Exploring the interior northwest he wintered in the Tallahassee area and left in March traveling northeast to the Indian town, Cofitachequi, near Silver Bluff, or possibly, Columbia, S.C. Carrying a treasure in pearls, De Soto moved northwest, east of the Savannah river, into the area that later became North Carolina. Turning west, the Spaniards reached the Coosa Indians in what is now Talladega county, Ala. Below, in Chief Tuscaloosa's territory, they turned west and crossed the Alabama river near modern Camden. In the northern part of what is now Clark county, De Soto fought his memorable battle at Mabila, the location of which remains unidentified. Forgoing contact with Cuba, De Soto marched northwest between the Tombigbee and Alabama rivers and entered the area that later became the state of Mississippi near Columbus. In Pontotoc county, or near Tupelo, the expedition established winter quarters. Modern authorities believe the Spaniards discovered the Mississippi river, June 18, 1541, in the southern part of what is now Tunica county, Miss. Crossing the great river into modern Arkansas, the explorers circled north and east above the mouth of the St. Francis river, whence they marched southwest to the White river and along it to the White-Arkansas delta. Moving up the Arkansas to the vicinity of modern Little Rock, the Spaniards crossed over the Ouachita river, and far down that stream wintered near Camden, Ark. Early in March, the expedition followed the Ouachita to a point near modern Ferriday, La., where De Soto died, May 21, 1542, and was buried in the Mississippi.

Luis de Moscoso now led the expedition overland to reach Mexico. However, after crossing the Red river near modern Shreveport, La., he possibly reached only the Trinity river before he returned to the Mississippi near Ferriday. There the Spaniards made boats, floated into the Gulf of Mexico, and coasted westward until they reached Tampico, Sept. 10, 1543. The expedition is significant for giving the first view of Indian cultures from Georgia to Texas and opening southeastern North America to European colonization.

Bibliography.—The most scholarly tracing of De Soto's route is *Final Report of the United States De Soto Expedition Commission,* 76th Congress, House Document no. 71 (10328) (1939). Directed by John R. Swanton, Smithsonian institution, it includes an extensive bibliography, and rests upon an examination of the terrain and on the De Soto narratives: Elvas, Garcilaso, Biedma and Rangel. For Elvas, *see* James Alexander Robertson, *True Relation of the Hardships Suffered by Governor Fernando de Soto . . . by a Gentleman of Elvas,* 2 vol. (1933). For Garcilaso, *see* John G. Varner and Jeanette J. Varner, *The Florida of the Inca* (1951). For Rangel and Biedma, *see* Edward Gaylord Bourne, *Narratives of the Career of Hernando de Soto,* 2 vol. (1904). The best biography of De Soto is Theodore Maynard, *De Soto and the Conquistadores* (1930). (A. B. T.)

DESPARD, EDWARD MARCUS (1751–1803), Irish soldier, who organized a large-scale conspiracy against the British government in 1803, was born in Queen's county, Ire., in 1751. He entered the British army in 1766 and was stationed at Jamaica. He was promoted captain after the San Juan expedition of 1779; at his trial Nelson testified to his bravery on that occasion. Despard was made governor of Roatan in 1781, and soon afterward of the Mosquito shore and Bay of Honduras. He led a successful expedition against the Spanish possessions on the Black river in 1782. Despard took over the administration of Yucatan in 1784. In his six years' rule he supported the claims of new immigrants against the old settlers, and on the complaints of the latter group he was recalled in 1790. The charges against him were dismissed in 1792, but he was given no further employment. He was imprisoned from 1798 to 1800 on no specific charge, probably as a result of his persistent demands for employment or compensation. It has however been suggested that he was involved in the Irish rebellion. On his release he began to organize a conspiracy, in which he hoped to combine a mutiny in the army with a rising by the London mob, and to assassinate George III and capture the Tower of London and the Bank of England. This overambitious plot was soon revealed to the government, and Despard, with six of his fellow conspirators, was convicted of high treason in 1803. He was executed at Newington jail on Feb. 21, 1803.

See Sir Charles Oman, *The Unfortunate Colonel Despard* (1922).

DESPENSER, the name, probably derived from the office of *dispensator* (steward) to the earls or constables of Chester, of an English family, two of whose members achieved notoriety during the reign of Edward II.

HUGH LE DESPENSER (*c.* 1223–65), was a prominent member of the baronial opposition to Henry III from 1258 to 1265. He was one of the 12 baronial nominees on the council of 24 chosen by the 1258 Oxford parliament to inaugurate reforms. The barons nominated him justiciar in 1260; he was removed by the king a year later, but his reinstatement as justiciar and constable of the Tower in 1263 had the assent of both parties. He fought at the battle of Lewes in May 1264, and subsequently arbitrated between the king and the barons, and in the dispute between Simon de Montfort and Gilbert de Clare, earl of Gloucester. Despenser was killed at the battle of Evesham on Aug. 4, 1265.

HUGH LE DESPENSER (1261–1326), "the elder," son of the justiciar, was summoned to parliament as a baron in 1295. He fought in France and Scotland for Edward I and was sent by him on several embassies, including two to the pope. He was one of the few supporters, in 1308, of Piers Gaveston, Edward II's favourite; after Gaveston's death in 1312 he became the king's chief adviser until Thomas, earl of Lancaster, leader of the baronial opposition, procured his dismissal from court and council in Feb. 1315. He then worked to further the interests of his son, HUGH LE DESPENSER (d. 1326), "the younger," who had been in the king's household when he was prince of Wales. The younger Hugh was appointed chamberlain in 1318, but both father and son were attacked in parliament by the magnates in 1321 and the king was forced to agree to their disinheritance and exile. The elder Hugh went abroad but the younger remained in the Cinque Ports and engaged in piracy. After the collapse of the opposition at the battle of Boroughbridge (March 1322), the Despensers returned to power and the elder Hugh was created earl of Winchester. Hugh the younger worked to enhance the importance of the chamber, diverting to it from the exchequer the revenue from certain lands and developing it as a department equipped with its own seal and providing private income for the king. But he was rapacious and grasping, and his administration aroused discontent. He had married (1306) Eleanor, coheiress of Gilbert de Clare, earl of Gloucester (d. 1314). Hugh's attempt to acquire the sole inheritance had been foiled by a division of Clare's estates in 1317; but even so he received lands then worth £1,276 in Glamorgan and Wales. At the rebellion of Queen Isabella and Roger Mortimer, both Despensers fled westward with the king. The elder, sent to defend Bristol, surrendered it to Isabella on Oct. 26, and after summary trial was hanged on Oct. 27, 1326. The younger Despenser was captured with the king, tried and hanged at Hereford on Nov. 24, 1326. He left two sons, HUGH (*c.* 1308–49) and EDWARD (d. 1342). A younger son of Edward, HENRY LE DESPENSER (*c.* 1341–1406) became bishop of Norwich in 1370. A soldier in early life, Henry was always addicted to warfare, and in the Peasants' Revolt (1381) he effectively suppressed the Norfolk rising, capturing and hanging the rebel leader at North Walsham. Pope Urban VI commissioned him in 1382 to lead a crusade in Flanders against the supporters of Clement VII, the antipope elected by the French cardinals. Although such an abuse of the crusading ideal was denounced by John Wycliffe and the Lollards, the project was favoured in England as victory would have assisted the wool trade; but after capturing several towns, Henry was checked at Ypres and defeated by the French. He was impeached and deprived of his temporalities; but he regained his revenues after two years. Almost alone among his peers, Henry remained faithful to Richard II in 1399, attempting to raise an army in his support. He was subsequently imprisoned for a short while. He died on Aug. 23, 1406.

Henry's elder brother, EDWARD LE DESPENSER (1336–75), fought in the French wars. Edward's son THOMAS LE DESPENSER (1373–1400) achieved prominence through his marriage with Constance, daughter of Edmund Langley, duke of York, and granddaughter of Edward III. He was among the eight who, acting for Richard II, accused Thomas of Woodstock, duke of Gloucester, and the other lords appellant of treason in 1397, and caused their fall. In the parliament of Sept. 1397 Despenser was created earl of Gloucester, and shortly afterward obtained the reversal of the 1321 attainder which had been confirmed in 1326. He deserted Richard II in 1399 but was deprived of his earldom on a charge of complicity in Gloucester's death. He joined in a plot against Henry IV, but was seized and executed by a mob at Bristol on Jan. 13, 1400.

The barony of Despenser, called out of abeyance in 1604, was held by the Fanes, earls of Westmorland, from 1626 to 1762; by the notorious Sir Francis Dashwood, friend of John Wilkes and member of the Hell Fire club, from 1763 to 1781; and by the Stapletons from 1788 to 1891. It was inherited in 1891, through his mother, by the 7th Viscount Falmouth, and is now held by his son, the 8th viscount.

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DES PÉRIERS, BONAVENTURE (*c.* 1500–*c.* 1544), French writer and humanist, who attained notoriety as a freethinker. He was born at the end of the 15th century, probably at Arnay-le-duc in Burgundy, although both the date and place of his birth are in dispute. In 1533 or 1534 Des Périers visited Lyons, then the most enlightened town of France and a refuge for many liberal scholars. He gave some assistance to Robert Olivetan and Lefèvre d'Étaples in the preparation of the vernacular version of the Old Testament, and to Étienne Dolet in the *Commentarii linguae Latinae*. In 1536 he put himself under the protection of Marguerite d'Angoulême, queen of Navarre, who made him her *valet-de-chambre*. He acted as the queen's secretary and transcribed the *Heptaméron* for her. It is probable that his duties extended beyond those of a mere copyist and some writers have gone so far as to say that the *Heptaméron* was his work. The free discussions permitted at Marguerite's court encouraged a licence of thought as displeasing to the Calvinists as to the Catholics. This free inquiry became skepticism in Bonaventure's *Cymbalum Mundi* (1537), at which the queen disavowed the author, though she continued to help him privately until 1541. The book consisted of four dialogues in imitation of Lucian. Its allegorical form did not conceal its real meaning and the Sorbonne secured its suppression (*c.* 1538) before it was offered for sale, but the book was reprinted in Paris in the same year. It made many bitter enemies for Des Périers, who prudently left Paris and settled at Lyons. Tradition has it that he killed himself in 1544 by falling on his sword, but this is questionable.

In 1544 his collected works were printed at Lyons. The volume, *Recueil des oeuvres de feu Bonaventure des Périers*, included his poems, the *Traité des quatre vertus cardinales après Sénèque* and a translation of the *Lysis* of Plato. In 1558 appeared at Lyons the collection of stories and fables entitled the *Nouvelles récréations et joyeux devis* on which his fame rests. Some of the tales are attributed to the editors, Nicholas Denisot and Jacques Pelletier, but their share is certainly limited to the later ones. The stories are models of simple, direct narration in the vigorous and picturesque French of the 16th century.

BIBLIOGRAPHY.—Des Périer's *Oeuvres françaises* were ed. by L. Lacour (1856); *see* also A. Chenevière, *Bonaventure Despériers, sa vie, ses poésies* (1885); P. A. Becker, *Bonaventure des Périers als Dichter und Erzähler* (1924); L. Febvre, *Origène et Des Périers* in *Bibliothèque d'Humanisme et Renaissance*, vol. II (1942).

DESPIAU, CHARLES (1874–1946), French sculptor, was born at Mont-de-Massan (Landes), Nov. 4, 1874. His heroic "Appollon" stands in front of the Musée d'Art Moderne in Paris. Although associated with Auguste Rodin at the beginning of the 20th century, his style showed a more pronounced influence of classical sculpture. Modeling principally in plaster but sometimes working in stone, Despiau was interested in portrait heads, busts, life-size figures, often nude and usually of classical inspiration. Among his works in bronze are: "Faunesse" (1924), "Eve" (1925), "Dominique" (1926), "Petite Fille de Landes," "Mme. André Derain," "Mme. Othon Friesz," "Assis" (1938). He is noted also for his drawings of nudes. He died on Oct. 30, 1946, at Paris.

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Deshairs, *Charles Despiau* (1930); Paul Fieriens, "The Sculpture of Charles Despiau," *The Studio* (Dec. 1930); "Hommage à Despiau" in *La Renaissance* (June 1938). (I. S. McN.)

DES PLAINES, a city of Cook county, Ill., U.S., on the Des Plaines river, is best known for its greenhouses and for the Methodist summer encampment held there annually since 1860. Originally called Rand, for Socrates Rand, from Massachusetts, who settled there in 1835 and established the first school in his home, it was renamed after the river in 1869 and incorporated as a city in 1925. Explanations of the origin of the designation Des Plaines vary: some attribute it to the French word for a maple found locally, others to the flat terrain. Early settlers were mainly from the northeast United States, Canada and Great Britain, but the German element soon came to predominate. A rapidly growing suburb of Chicago, Des Plaines is primarily a residential commuting centre and a market garden area (mushrooms are a leading product). Its industries are greenhouses, hothouse plants and equipment and small manufactures, including electrical appliances and radio parts. For comparative population figures *see* table in ILLINOIS: *Population.* (M. Ws.)

DESPOINA, "mistress," the Greek word used from the earliest times as an honorific address to a woman, and also, particularly, to a goddess. In Arcadia, the queen of the underworld was called Despoina. She had had originally no personal name, probably from superstitious fear; and in later times was usually identified with Persephone. (H. W. Pa.)

DESPORTES, PHILIPPE (1546–1606), French courtier poet second to Pierre de Ronsard, was born at Chartres in 1546. He modeled his poetry on that of the Italians Petrarch, Ariosto and Bembo, and also on minor poets. About 1567 he became the favourite poet of Henry, duke of Anjou, whom he accompanied to Kracow when Henry was elected king of Poland (1573), returning with him on the death of Charles IX (1574). Desportes' *Premières Oeuvres* (1573) made him Ronsard's rival. In fluid, graceful alexandrines he wrote sonnets and elegies for Henry III and others to present to their mistresses. In 1582 he received the abbeys of Tiron and Josaphat. He enjoyed the revenues of other benefices also and entertained an intellectual circle in a princely manner. His *Dernières Oeuvres* (1583) mark his farewell to secular verse. His translations of the Psalms (1591, 1598, 1603) provoked the brutal *mot* of Malherbe: *Votre potage vaut mieux que vos psaumes* ("Your soup is better than your psalms"). Desportes died on Oct. 5, 1606, at the abbey of Bonport.

Desportes is not a personal poet like Ronsard. His elegant poems, often imitated in England, sound much the same whether addressed to his own mistresses or to those of the great. His poetry never reaches Ronsard's loftiness or variety of inspiration but it avoids obscurity and pedantry. Clear, harmonious and seductively smooth, it prepared the way for the new taste of the 17th century.

BIBLIOGRAPHY.—There were many 16th-century editions of Desportes' works. Later editions include *Oeuvres,* ed. A. Michiels (1858); *Cartels et masquarades; Epitaphes,* ed. V. E. Graham (1958). *See* also J. Lavaud, *Un poète de cour aux temps des derniers Valois: Philippe Desportes* (1936); R. M. Burgess, *Platonism in Desportes* (1954). (M. G. M.)

DESPRÉS, JOSQUIN (usually known as JOSQUIN) (*c.* 1440–1521), Flemish composer whose works mark the transition from the late middle ages to the Renaissance, was the most renowned musical figure of his time. Born at Condé-sur-L'Escaut or elsewhere in the province of Hainaut, he was probably a chorister at the collegiate church of St. Quentin. He was a singer in Milan cathedral from 1459 to 1472, in the service of Duke Galeazzo Maria Sforza in Milan from 1473 to about 1479 and later in the papal chapel (1486–*c.* 1494). Between his service in the papal chapel and 1503, when he became choirmaster of the chapel of Ercole I, duke of Ferrara, he seems to have had connections with the chapel of Louis XII of France and probably also with the cathedral of Cambrai. In Ferrara he wrote in honour of his employer the Mass *Hercules Dux Ferrariae* (based on the theme *re ut re ut re fa mi re,* the Guidonian syllables corresponding to the vowels of the title), and his motet *Miserere* was composed at the duke's request. On the death of the duke (1505) Josquin seems to have left Ferrara. On the conclusion of an alliance between the Netherlands and England he composed the chanson *Plus nulz regretz.* From about this time onward he was provost of the collegiate church of Notre Dame in Condé, where he died on Aug. 27, 1521.

Of the 20 Masses that survive complete and are certainly written by him, 17 were printed in his lifetime in three sets (1502, 1505 and 1514) by Ottaviano del Petrucci. His motets and chansons were included in other Petrucci publications from the *Odhecaton* of 1501 onward. Three musical laments on his death by Nicolas Gombert, Benedictus Appenzeller and Hieronymus Vinders are extant. Luther expressed great admiration for Josquin's music, calling him "master of the notes, which must do as he wishes; other composers must do as the notes wish." Adrian Petit Coclico, self-styled pupil of Josquin, described and praised his methods of teaching. Until late in the 16th century his works were widely copied, examples of his technique were cited by theorists and his pieces were used as models by many composers.

In his Masses Josquin developed notably the methods he inherited from Guillaume Dufay, Jean d'Okeghem and Jakob Obrecht (*qq.v.*), progressing from the *cantus-firmus* type, in which a pre-existing theme was used in a single part in the medieval manner, to the paraphrase and parody types, in which pre-existing melodic and contrapuntal material was woven into the texture of the writing in the Renaissance manner. His motets and antiphons show a parallel growth in integration by the use of imitative and antiphonal techniques. Many of his secular chansons also employ canonic and closely imitative writing. A modern edition of his complete works was begun under the editorship of A. Smijers in 1921. (F. L. Ha.)

DESSALINES, JEAN JACQUES (*c.* 1748–1806), regarded in Haiti as the chief hero of the Haitian war for independence, was the illiterate slave of a free Negro. He reached high rank and acquired a reputation for bravery and cruelty in the war after the slave revolt of 1791. He surrendered to the French with other Negro leaders in 1802, but became the principal leader of the revolt that ended French rule in 1803. After his election as governor general of Haiti for life in Jan. 1804, he ordered the massacre of the French remaining in the country. In Sept. 1804 he was proclaimed emperor. He revived agricultural production by reinstituting forced labour under military control on the plantations. His cruel and corrupt rule caused discontent, especially among the mulattoes in the south, and while attempting to suppress a revolt there he was killed in an ambush at Port-au-Prince in 1806. (D. G. M.)

DESSAU, a town of Germany which after partition of the nation following World War II became a regional capital in the *Bezirk* of Halle in the German Democratic Republic. It extends along both sides of the Mulde up to its confluence with the Elbe and is 108 km. (69 mi.) S.W. of Berlin. Pop. (1961 est.) 93,968. Until World War II Dessau, which was extensively bombed, had many historic buildings such as the Schlosskirche with paintings by Lucas Cranach, the old Landestheater and the Amalienstift with its valuable collection of paintings. After the war the town, including the Landestheater, was rebuilt. In the Mosigkau castle there is also a large collection of paintings with works by Peter Paul Rubens, Titian and Sir Anthony Van Dyke. Dessau, a railway junction, with repair shops, on the Berlin-Belzig-Leipzig line, has an inland harbour, and at the confluence of the Mulde and Elbe there is a big shipyard where dredging machines are produced. The large armaments enterprises are nationally owned. Industry is mainly machinery, vehicle and apparatus manufacturing. The town developed from a Sorbish settlement. Lower Saxon and Flemish colonists expanded it in the 12th century and it was granted municipal rights in the 13th century. From 1340 until 1918 it was the residence of the counts, princes and dukes of Anhalt. In the 18th century they had a castle built in the Mosigkau district of the town in the southwest; it contains a museum of the rococo period.

DESSOIR, LUDWIG (1810–1874), German actor, whose fame rested on his portrayals of Shakespearean parts, notably those of Othello and Richard III, was born in Posen on Dec. 15,

1810. After years of apprenticeship on many stages he joined, in 1839, the court theatre at Karlsruhe, where he stayed for ten years. From 1849 to 1872 he was associated with the Berlin court theatre, traveling extensively all over Germany to give guest performances. In 1855 he played Othello in London, and G. H. Lewes placed him in certain scenes above Edmund Kean, while the *Athenaeum* critic preferred him in this part to W. Macready. There was a quiet intensity about his Othello that was in marked contrast to the melodramatic violence with which it had become customary to play the Moor. Dessoir died in Berlin on Dec. 30, 1874. (A. M. N.)

DESTINN, EMMY (Ema Destinnova) (1878–1930), Czech soprano whose reputation was based not only on the power and vibrant richness of her voice but also on her great intelligence and dramatic gifts. She was born Ema Kittl in Prague, Feb. 26, 1878, but adopted the name of her singing teacher, Maria Loewe-Destinn. She made her debut in 1898 at the Berlin Kroll opera as Santuzza in Mascagni's *Cavalleria Rusticana*, and Richard Strauss chose her to sing the title part in the first performances at Berlin and Paris of his *Salome* (1906). Destinn made her Covent Garden debut in 1904 as Donna Anna in Mozart's *Don Giovanni* and a triumphant first appearance at the Metropolitan opera, New York, in 1908. In 1910 she sang Minnie there in the première of Puccini's *La Fanciulla del West*, and she continued to appear in New York until 1916 in roles as varied as Pamina in Mozart's *Die Zauberflöte*, Valentine in Meyerbeer's *Les Huguenots* and Eva in Wagner's *Die Meistersinger*. She sang again in London and New York after World War I but retired in 1921. She died at České Budějovice (Budweis) on Jan. 28, 1930. (Wi. S. M.)

DESTOUCHES, ANDRÉ CARDINAL (1672–1749), French opera composer. Born in Paris, April 1672, he was a pupil of the College des Jésuites there, and was one of the few Europeans to visit Siam in the 17th century. Later he became a "mousquetaire du Roy" before finally leaving military service to study with André Campra, to whose opera-ballet, *L'Europe Galante*, he contributed three airs. Destouches' first opera, *Issé*, was produced in 1697. He wrote nine further operas (one in collaboration with M. de Lalande) and in 1713 was appointed inspector-general of the Paris Opéra. Fifteen years later he became director and in the same year "surintendant de la musique du roy" and remained in that post until his death in Paris on Feb. 7, 1749. His works also include drinking songs, cantatas, motets and a *Te Deum*. (B. P.)

DESTOUCHES, PHILIPPE (real surname probably Néricault) (1680–1754), French dramatist, author of more than 20 successful comedies, was born at Tours, April 9, 1680. He was attached successively to the French embassies in Switzerland and in London. His election to the Academy on his return to France (1723) probably rewarded public service rather than literary merit, although his early comedies such as *Le Curieux impertinent* (1710), *L'Ingrat* (1712), *L'Irrésolu* (1713) and *Le Médisant* (1715) were well received. His masterpiece, *Le Glorieux* (1732), depicting the conflict between the old nobility and the *nouveaux riches*, was acclaimed on its debut and received 30 performances. Destouches purchased the governorship of Melun in 1735 but continued to write plays, and also produced more than 800 epigrams and an indifferent verse translation of *The Tempest*. He died at Fortoiseau, July 4, 1754. As a comic dramatist in the tradition of Molière he differed from Molière in giving greater emphasis to character and in making virtue attractive, as well as satirizing vice. His additional moral seriousness was an element of the so-called *comédie larmoyante*.

Bibliography.—G. Leroy, *Néricault Destouches* (1862); J. Hankiss, *Philippe Néricault Destouches, l'homme et l'oeuvre* (1918); *see* also his collected works in editions of 1745, 1757, 1811 and 1820.

DESTROYER, a speedy, heavily armed naval vessel, smaller than a cruiser (*q.v.*), capable of performing many naval tasks. Although destroyers have grown from 320 to nearly 4,000 tons, most modern destroyers displace between 1,500 to 2,600 tons and are from 320 to 450 ft. long. Destroyers have a complement of from 140 to 350 officers and men, are armed with torpedoes, guns and depth charges, and have underwater sonar (asdic) devices; speeds vary between 30 and 37 knots. They have no armour although their gun shields protect against machine gun fire. The U.S. navy designates a destroyer as a DD, while a larger type fitted to serve as a flagship is a DL, destroyer leader or frigate. A smaller, slower, less powerful type designed for escorting convoys is a DE, destroyer escort, and vessels especially fitted for radar picket duties are designated DDR and DER. Guided missile destroyers are designated DDG.

Role of the Destroyer.—Because the destroyer is generally considered the most versatile of modern naval vessels, it follows that different navies and commanders have held divergent views as to its proper role. No fleet commander has ever considered that he had enough destroyers; and yet, as is shown in the paragraphs which follow, destroyers have been in great demand for specialized activities such as antisubmarine warfare in all phases. The destroyer started as a supertorpedo boat, and the torpedo has remained one of its primary weapons, but the passing of the battle line has not decreased the demand for destroyers. Destroyers may be compared with the cavalry of a former day and the tanks of a modern army.

Origin and Development of Destroyers.—The torpedo boat, the destroyer and the submarine were developed in their modern form to use the torpedo invented by Robert Whitehead (*q.v.*). The first torpedo boat (TB), completed for the Royal Navy in 1878, was the "Lightning," designed to carry a spar torpedo. She was 84 ft. long and had a speed of 19 knots. Two tubes for Whitehead torpedoes were installed in her in 1879. The first torpedo boat for the U.S. navy, the "Cushing," was named for Lieut. W. B. Cushing who sank the Confederate ironclad "Albemarle" with a spar torpedo, Oct. 27, 1864. Authorized in 1886, she displaced 130 tons, was 139 ft. long, had a speed of 22 knots and a complement of 22. (*See* Torpedoes.) Adm. John A. Fisher of the Royal Navy ordered "Havoc" and "Hornet" from the Yarrow shipbuilding firm; when they were completed in 1893 he called them torpedo-boat destroyers, later shortened to destroyer. As the Royal Navy expected to retain superiority in capital ships, Fisher intended to use the new vessels in two roles: defensively against enemy torpedo boats and offensively as TB's against enemy big ships. Fitted with three 18-in. torpedo tubes instead of the earlier 14-in. tubes, these ships made a record speed of 28 knots. They mounted one 12-pounder and three 6-pounder guns, were 180 ft. long with 5½ ft. draft and displaced 320 tons fully loaded.

The earliest destroyers for the U.S. navy were authorized in 1898; they displaced 510 tons and carried 3 officers and 60 men. Five destroyers authorized in 1907 were the first turbine ships in the U.S. navy; they displaced 800 tons and carried 4 officers and 90 men. The Royal Navy and other navies still had a number of torpedo boats in service in World War I.

Destroyers in World War I.—Great Britain had nearly 300 and Germany 144 destroyers in Aug. 1914. Although the Royal Navy built many new destroyers it never had enough during the war. The admiralty was unable to adopt the convoy system when unrestricted submarine warfare began, Feb. 1, 1917, because of a shortage of destroyers. But, after 196 ships of about 600,000 tons were sunk in the month of April 1917, destroyers were employed in convoys in the North Atlantic beginning in May. When the United States entered the war, 67 destroyers of the U.S. navy were in commission and 27 others under construction. Convoys were established in the Mediterranean in Aug. 1917 and Japan sent some destroyers for use with these convoys. British, French and U.S. destroyers were used for the escort of merchant convoys in the North Atlantic and in the Mediterranean, and proved effective.

Losses of shipping declined steadily under the destroyer escort system. The destroyers employed guns, torpedoes and depth charges against the submarines. The depth charges were rolled from racks on the stern or shot out by Y guns to form a pattern around the calculated position of the submerged submarine which had been determined sometimes by echo-ranging equipment. Later depth charges carried 300 lb. of TNT, during the war, and they could be set to explode at various depths. Destroyers ranged

in size from 500 to 1,200 tons, carried from 100 to 150 officers and men, mounted 3- or 4-in. guns and had a speed of 28 to 32 knots.

Adm. Sir John R. Jellicoe did not use his grand fleet destroyers to attack the German high seas fleet during daylight in the battle of Jutland (*q.v.*), May 31, 1916. His destroyers attacked that night and their torpedoes sank the pre-"Dreadnought" "Pommern" and the small cruiser "Rostock." Jellicoe was severely criticized afterward by Comdr. C. Bellairs, M.P., and others for his alleged failure to use his destroyers aggressively. By contrast, Adm. Reinhard Scheer twice used his destroyers for daylight attacks at Jutland and on both occasions the British battle line turned away. "Destroyers Dismiss Battleships" was the heading of one chapter of the book by Bellairs on the battle. The Royal Navy had 80 destroyers in the battle and lost 8; the Germans had 63 and lost 5. Effective use of the German destroyers saved their fleet from destruction.

Perhaps the most dramatic of many fights between British and German destroyers took place on the night of April 20, 1917, in the English channel, when the British destroyers "Swift" and "Broke" sank two German destroyers after a hand-to-hand struggle. After entering the war, the United States began a huge building program which included 247 destroyers, but very few of these were completed prior to the Armistice of Nov. 11, 1918. Wartime losses of destroyers were: Great Britain 67, Germany 66, Russia 20, France 12, Italy 8, Austria 6, Turkey 3, United States 2 and Japan 1. Germany also surrendered 92 destroyers.

For many years after 1919 tactical doctrine for destroyers was based on studies of the battle of Jutland and the escort-of-convoy experience of 1917–18. Day and night torpedo attacks by groups of destroyers were rehearsed. In war maneuvers at sea a fleet commander would attempt to deploy about two-thirds of his destroyers ahead of his battle line and one-third astern, while dividing his cruisers in the same way. His objective was to enable his destroyers, accompanied by cruisers to protect them, to reach a position ahead of the enemy battle line from which they could launch a torpedo attack on the enemy battleships, thus lessening the enemy's gunnery efficiency at the most critical moment of battle and possibly inflicting severe damage on the enemy ships. Destroyers also accompanied aircraft carriers for plane guard duty and for antisubmarine and antiaircraft protection. Limitations of the Washington treaty of 1922 and London treaty of 1930 did not apply to destroyers.

Destroyers in World War II.—Destroyers enhanced their earlier reputation and won new prestige during World War II. Improved devices for underwater sound detection and the introduction of radar made them more effective than before. The demand for destroyers to escort convoys was so great that a new subordinate class of vessel, the destroyer escort (DE), was introduced, as mentioned above. These vessels had less speed, less armament, and were less costly to build than destroyers, but, with depth charges and underwater echo-sounding devices, as well as radar, they proved highly effective as escorts for merchant-ship convoys.

The U.S. navy evolved the carrier task group which included two to five carriers, fast battleships, cruisers and eight to ten destroyers. Hunter-killer groups consisting of one carrier and five or six DD's operated against submarines in the Atlantic with great success. By rescuing many friendly aviators in the Pacific, the destroyers not only saved trained men but kept up morale among naval pilots and crewmen. With special equipment, destroyers undertook a new assignment in the battle of Okinawa when they served as radar picket ships. On the coast of Sicily, at Salerno and in the Pacific, destroyers close inshore used their guns to support troops who had just landed. This fire support was effective even against tanks. In the struggle for Guadalcanal, Aug. 1942 to Feb. 1943, Japanese destroyers under Rear Adm. N. Tanaka made a brilliant record. There and elsewhere Japanese destroyers gave the U.S. navy some unpleasant surprises with efficient night fighting tactics and torpedo firing. Around Guadalcanal the Japanese lost 11 destroyers to 14 lost by the U.S., while inflicting very severe damage to U.S. cruisers.

In Sept. 1939 the Royal Navy had 188 destroyers; Germany had 30; Japan had 138; and the U.S., 97 modern vessels besides 153 that were begun in 1917. Fifty of the latter were transferred to Britain in the "destroyers-bases deal" of Sept. 1940. Between Dec. 7, 1941, and Oct. 1, 1945, the U.S. completed 349 new DD's and 412 DE's besides 92 of the DE's transferred to Allies. Various navies built motor torpedo boats which accomplished little. U.S. losses were 71 DD's and 11 DE's during the war.

Postwar Developments.—Both the Royal Navy and the U.S. navy continued to build larger DD's while the type replaced cruisers in the great majority of the navies of the world. A number of DD's were converted to DE's or antisubmarine frigates in the 1950s. The British "Daring" class displaced 3,700 tons, fully loaded; it carried 308 officers and men and had 5 torpedo tubes and 6 guns of 4.5 in.; its length was 390 ft., beam 43 ft. and draft 13 ft. The U.S. "Forrest Sherman" class displaced 3,850 tons. In the late 1950s the major navies introduced large destroyers equipped with antiaircraft guided missiles such as the U.S. "Tartar" and "Terrier" and British "Seaslug" and "Seacat" weapons.

Naming of Destroyers.—The Royal Navy names destroyers by classes. The names of the eight ships of the "Daring" class begin with the letter *d*, such as "Decoy," "Defender" and "Delight." The weapons class includes "Battleaxe" and "Crossbow." The battle class includes "Trafalgar," "Camperdown" and "Solebay." The U.S. navy names destroyers for heroic officers and men of the navy, marine corps and coast guard, for other deceased officers with distinguished records, for deceased former secretaries of the navy and for members of congress who have had special association with naval affairs.

See Aircraft Carrier; Battleship; Corvette; Cruiser; Frigate.

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DESTRUCTOR: *see* Incinerator.

DESTUTT DE TRACY, ANTOINE LOUIS CLAUDE, Comte (1754–1836), French philosopher and one of the chief "Idéologues," was born in Bourbonnais on July 20, 1754. He belonged to a noble family of soldiers originating from Scotland and settled in France in the 15th century. He made a brilliant career in the army and was colonel of the Penthièvre regiment. Elected deputy of the nobility to the estates-general (1789) he voted the reunion of the nobility and clergy with the *tiers-état*. He was raised to the rank of *maréchal de camp* in the spring of 1792, but, when the Marquis de La Fayette crossed into the Austrian lines, refused to follow him and later resigned his commission. He settled with his family in the village of Auteuil and joined the group of younger "philosophes" who gathered in Madame Helvétius' salon. Under the Terror he was imprisoned for nearly a year; liberated after the fall of Robespierre (July 1794) he returned to Auteuil, where he met with D. J. Garat, the Comte de Volney and P. J. G. Cabanis. He was an associate member of the Institut and a member of the Académie Française (1808), a senator under Napoleon and a peer under the Restoration. He never actively engaged in politics, but accepted the different regimes, while holding on to his liberal creed. He corresponded with Thomas Jefferson. He died in Paris on March 9, 1836.

Of his philosophy, which he called "ideology," he gave a first outline in 1801. It was an offspring of Condillac's sensationalism; but under the influence of Cabanis, with whom he closely associated, Destutt refined the analysis of sensations and emphasized their physiological character. "Ideology is a part of zoology;" but it was far more inclusive and corresponded to the "anthropology" of the German philosophers. The four activities of conscious

U.S. navy antisubmarine task group Alfa, a hunter-killer unit developed in 1959. Composed of both sea and air craft, it includes the aircraft carrier "Valley Forge" (the flagship), seven escort destroyers (DDE), two submarines, and supporting planes of both conventional and helicopter types for search and patrol

"Witek," experimental destroyer (EDD) of the U.S. navy, world's first jet-propelled warship. Launched (as conventional destroyer) in 1946; equipped with pump-jet propulsion system in 1959

"John Paul Jones," U.S. navy destroyer (DD) of the "Forrest Sherman" class, heaviest (displacement 3,900-4,000 tons full load) conventional destroyer class in the fleet. Launched 1955

"Basilone," U.S. navy escort destroyer (DDE) of the "Gearing" class. Launched as a destroyer (DD) in 1945, later converted for antisubmarine warfare and completed as an escort vessel in 1949

"Mitscher," U.S. navy destroyer leader (DL), officially rated as a frigate. The vessels of the "Mitscher" class are larger than some rated as light cruisers in other countries. The "Mitscher" was launched in 1952

"Cayuga," destroyer escort (DDE) of the Royal Canadian navy, improved "Tribal" class; displacement 2,200 tons standard, 2,800 tons full load. Launched 1945, refitted and modernized 1953–54

"Crescent," antisubmarine destroyer (DDE), Royal Canadian navy, "Algonquin" class. "Crescent" originally a British "C" class destroyer, converted in 1958 for antisubmarine duty

"Bordelon," radar picket destroyer (DDR), U.S. navy, converted "Gearing" class destroyer equipped with early-warning radar. Originally launched 1945

"Assiniboine," antisubmarine destroyer (DDE), Royal Canadian navy, of the "St. Laurent" class designed especially for ice conditions in the North Atlantic. The "Assiniboine" was launched in 1954

DESTROYERS AND DESTROYER ESCORTS OF THE U.S. AND CANADA

BY COURTESY OF U.S. NAVY AND ROYAL CANADIAN NAVY

DESTROYER

"Battleaxe," British Royal navy. A radar picket destroyer of the "Weapon" class. Originally equipped as an antisubmarine escort, it was launched in 1945; converted 1958–59

"Dainty," British destroyer of the "Daring" class, launched in 1950. The "Dainty" and other vessels of the class are the largest regular armament destroyers in the fleet

"Blackpool," antisubmarine frigate, British Royal navy. Launched in 1957, it is of the "Whitby" type, a class of fast ships equipped with detection and destruction devices to combat modern submarines

"Alamein," British destroyer of the "Battle" class, somewhat larger than vessels of the "Weapon" class. Outfitted as a destroyer leader when it was launched in 1945, it was scheduled for eventual conversion to radar picket service

"Svobodni," a modern Soviet destroyer of the "Skoryi" class in service in the Baltic sea. Equipped with radar fire control and depth charge throwers; displacement 2,600 tons standard (3,500 tons full load)

"Akizuki," Japanese destroyer built under the auspices of the U.S. military aid program and launched in 1959. Designed as flotilla leader, it was equipped with radar and sonar systems, two homing torpedo launchers and 5-in. guns

"Forbin," French radar picket destroyer (rated as *Escorteurs d'Escadre*) of the "Surcouf" group equipped as aircraft direction and command ships. "Forbin" was launched in 1955

"Vauquelin," also of the French "Surcouf" group but designed for anti-aircraft service. The 5-in. guns were built to operate with standard U.S. ammunition. Launched in 1954

"Indomito," Italian destroyer officially rated as *Cacciatorpediniere*. Launched in 1955, the "Indomito" and its sister ship "Impetuoso" (1956) the name ship of its class, were the first Italian destroyers built after World War II

"Hälsingland," destroyer of the Royal Swedish navy, "östergötland" class equipped with improved antiaircraft and antisubmarine devices. "Hälsingland" was launched in 1957

DESTROYERS OF GREAT BRITAIN, EUROPE, THE U.S.S.R. AND JAPAN

BY COURTESY OF (ALL EXCEPT THIRD ROW RIGHT) "JANE'S FIGHTING SHIPS"; PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, FOURTH ROW LEFT) WRIGHT & LOGAN, (SECOND ROW LEFT) OFFICIAL BRITISH ADMIRALTY PHOTOGRAPH, (SECOND ROW RIGHT) ANTHONY & JOSEPH PAVIA, (THIRD ROW LEFT) SKYFOTOS, (THIRD ROW RIGHT) UNITED PRESS INTERNATIONAL, (FOURTH ROW RIGHT) FRENCH NAVY OFFICIAL PHOTOGRAPH, (BOTTOM LEFT) ITALIAN NAVY OFFICIAL PHOTOGRAPH, (BOTTOM RIGHT) ROYAL SWEDISH NAVY OFFICIAL PHOTOGRAPH

life, perception, memory, judgment and will are all varieties and combinations of sensations. Thought is nothing but an elaboration of sensations and an activity of the nervous system. Destutt developed the consequences and applications of his theories in memoirs and treatises published between 1801 and 1815 under the general title of *Eléments d'Idéologie* and dealing with grammar, logic and political economy; he left unfinished his *Traité de la volonté,* to which Stendhal was much indebted. His *Commentaire sur l'Esprit des Lois de Montesquieu* written in 1808 was published in a translation revised by Jefferson in 1811 and in French only in 1819.

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DETAILLE, (JEAN BAPTISTE) EDOUARD (1848–1912), French painter of battles and military life, was born in Paris on Oct. 5, 1848. In his youth he studied with J. L. E. Messionier and employed a technique of literal exactitude based on that of his master. Detaille developed a wide knowledge of military detail. He first exhibited at the Salon of 1867, but it was his paintings of the war of 1870–71 which made him famous. His most characteristic works, infused with legend and sentiment, are his pictures of Napoleon I and his armies. Detaille visited Algeria, England and Russia, and worked for the prince of Wales and Tsar Alexander III. In 1883 he produced, together with A. de Neuville, a profusely illustrated two-volume work: *L'Armée française.* Detaille also painted some portraits and nonmilitary subjects. He was a gifted actor. He died in Paris on Dec. 23, 1912.

(D. C. T. T.; X.)

DETECTION (ELECTRONIC), the process whereby the information or audio signal is recovered from the modulated radio-frequency carrier wave. This process is also commonly referred to as demodulation and is accomplished by a circuit arrangement which is termed a detector or demodulator.

One or more detectors may be used in radio receiving apparatus depending upon whether the radio-frequency power, received at the antenna in the form of electric oscillations, is converted directly into audio power or into some intermediate-frequency power and then into audio power. After the audio-frequency wave is detected it is amplified sufficiently to operate an indicator, of which the loud-speaker is the most common type. The speaker actually converts the audio signals into mechanical vibrations which the ear interprets as sound. This sound has essentially the same wave form as that picked up by the microphone in the broadcast station from which the modulated carrier wave originated.

There are as many detection or demodulation schemes as there are types of modulation, namely, amplitude demodulation, frequency demodulation, phase demodulation and pulse demodulation. The last three types are of later development and the circuit arrangements for detecting these are not so numerous as those for detecting amplitude-modulated waves. The most common type of detector is the diode vacuum tube operated on the nonlinear portion of its characteristic curve, thereby converting a modulated radio-frequency current into a modulated direct current. *See* also ELECTRON TUBE; HIGH-FIDELITY SOUND SYSTEMS; RADIO. (A. L. SY.)

DETECTIVE STORIES: *see* MYSTERY AND DETECTIVE STORIES.

DETERDING, SIR HENRI WILHELM AUGUST (1866–1939), the first managing director of the Royal Dutch-Shell group of companies, was born in Amsterdam on April 19, 1866. He rose rapidly in the Indonesian branches of the Nederlandsche Handel Maatschappij, showing that grasp of essential figures and data which throughout his life allowed him to take quick, well-balanced decisions in complicated situations. In 1896 he joined the Royal Dutch Petroleum company to reorganize the sales in north Sumatra, and on the death of J. B. A. Kessler, Sr. (1900), succeeded him as managing director.

He convinced the other East Indian producers that only combined sales would maintain them against Russian and U.S. competition. Contacts with the Shell Transport and Trading company led to the formation of the Royal Dutch-Shell group in 1907, of which Deterding remained director-general until 1936. He was the first to see the importance of the European gasoline market for Indonesian producers, and this provided a return cargo for his tankers transporting Russian kerosene to the far east. Deterding unified the Royal Dutch-Shell group and gave it world-wide interests. In 1920 he was made a knight of the British empire. He died on Feb. 4, 1939, at St. Moritz, Switz. (R. J. F.)

DETERGENTS AND WETTING AGENTS are substances that, when dissolved in a liquid, give it cleansing and penetrating properties; soap (*q.v.*) is the best-known agent of this type. Soap has disadvantages, however, in many applications: when used with hard water it reacts with calcium and magnesium in the water and leaves a sticky residue of lime soaps; soap also hydrolyzes in slightly acid solutions, decomposing into insoluble fatty acids or acid soaps. The detergent and wetting properties of soap are physical rather than chemical: they depend not on specific chemical reactions with dirt or with surfaces but on physical effects such as adsorption and surface tension. A large number of different substances that vary widely in chemical composition possess the physical characteristics that enable them to act as substitutes for soap. The prime property required of such agents is that they be surface-active; *i.e.,* that they concentrate at surfaces and interfaces (adsorption). To possess this property the molecule of the agent must contain a polar or hydrophilic (soluble in water) portion combined with an oily or lipophilic (soluble in lipids) portion; the hydrophilic part confers affinity for water or polar surfaces and the lipophilic part confers affinity for hydrocarbons or nonpolar surfaces. The balance or ratio between these parts of the molecule can be controlled by the organic chemist, who is thus able to produce compounds particularly suited for specific detergent or wetting applications. In the early 1960s several hundred such preparations were on the market.

The first requirement in designing a synthetic detergent is to adjust the hydrophilic-lipophilic balance of the molecule so that the agent will be soluble in the medium in which it is to be carried: if this medium is water, hydrophilic groups that can be used are: $-COO^-$, $-SO_3^-$, $-NH_3^+$, $-CONH_2$, $-SH$, or $-(CH_2CH_2O)_nH$; if the medium is nonaqueous, then alkyl, aryl (aromatic) or combinations of the alkyl and aryl organic units are to be emphasized and the contribution of the hydrophilic group is either directly diminished by using one of minor power or overbalanced by the lipophile. At the same time, care must be taken not to carry the balance too far in favour of solubility in the medium, since detergent and wetting action depend on adsorption, and in adsorption the solvent competes for the agent with the surface to be cleaned or wetted; if the agent is too closely linked to the solvent, therefore, it will have less tendency to be adsorbed by the surface. Apart from this general rule, the fine adjustment of the hydrophilic-lipophilic balance of the agent to make it optimum for its application is a matter of trial and error, although experience and a number of empirical aids can reduce the number of necessary trials.

Types of Detergents.—The major classification of detergents is based on the nature of the ionic dissociation of the molecule in aqueous solution. Four types are recognized: (a) anionic-active, in which the surface-active part of the molecule is a negative ion; (b) cationic-active, in which the surface-active part of the molecule is a positive ion; (c) nonionic, in which the whole molecule is surface-active; (d) ampholytic, in which the surface-active part of the molecule may be either positively or negatively charged, depending on the pH of the solution.

Anionic-active.—Soaps are the commonest examples of anionic-active agents. The usual soaps of daily use are the sodium or potassium salts of fatty acids, which are derived from vegetable oils or animal fats. These soaps are mixtures of homologs (members of a family of compounds having the same general formula) ranging from 12 to 18 carbon atoms in the alkyl chain, although longer chains can be tolerated if the fatty acids are unsaturated. Soaps are gradually being replaced in industrially advanced countries by synthetic detergents, which are also, save for special applications, anionic-active agents. The most common of these, for

use as a heavy-duty household detergent, is sodium dodecylbenzene sulfonate, which is prepared from petroleum products and sulfuric acid. The general formula of a sulfonate detergent is RSO_3Na, where R refers to a lipophilic or organic group containing about 18 carbon atoms. Next in importance are the alkyl sulfates, made by the reaction of a fatty alcohol with sulfuric acid; the general formula of an alkyl sulfate is $ROSO_3Na$; these too are based on petroleum products. Synthetic detergents are superior to soap in many respects; for example, they are more stable to chemical change and have superior detergent action.

Cationic-active agents are strong electrolytes; the surface-active part is the positive ion, or cation. The salts of long-chain amines are examples, though they are ionized only in acid solution. Another type is the quaternary ammonium salt, which is a substituted ammonium chloride; *e.g.*, cetyltrimethylammonium bromide (CTAB) or cetylpyridinium chloride; these substances dissociate in aqueous solution into large positive ions and small inorganic anions. (*Cetyl* is used in industrial chemistry to denote an alkyl chain 16 carbon atoms long.) The cationic-active agents are incompatible with anionic-active agents, since the two large ions of opposite charge tend to combine to form a water-insoluble substance. The cationic-active agents are also more costly and may be poisonous; for these reasons they are not used as household detergents. But because of their properties they are used in surgery as bactericidal agents and, in dilute nonpoisonous concentrations, as detergents in bars and restaurants, where care must be taken to avoid mixing them with ordinary (anionic) detergents. Cationic-active agents also are used as emulsifying agents for asphalt in the surfacing of roads; these emulsions are expected to "break" soon after being applied and to deposit an adhering coat of asphalt on the surface of the stone aggregate; cationic-active agents adsorb strongly on minerals, particularly silicates, and so make a strong adhesive bond between the asphalt and the aggregate.

Nonionic agents do not dissociate in water and therefore depend on structural features other than ions for their ability to confer sufficient hydrophilicity to make the substance soluble in water. The presence of hydroxyl groups and amide, ether or ester linkages helps to offset the lipophilic radicals; and double or multiple use can be made of the hydrophilic nature of amide, ether or ester linkages by placing them as connections between two or more carbon atom segments that are themselves too small to add much lipophilic character. For this purpose a useful reagent is diethanolamine, $HN(CH_2CH_2OH)_2$, which can react with a fatty acid or its methyl ester to form a surface-active alkanolamide. Adding a polyoxethylene chain offers another way of introducing a number of oxygen atoms, and this can be done by reacting ethylene oxide with a fatty alcohol, such as an alkylphenol: the ethylene oxide polymerizes and confers more hydrophilicity upon the original lipophile; but its effectiveness in this respect does not continue beyond about 20 ethoxy groups. Polyhydric alcohols (those containing two or more hydroxyl, or —OH, groups) such as the sugars, provide oxygen atoms, which are hydrophilic, and so can be used to make surface-active agents by esterification with a fatty acid.

All these nonionic agents are unaffected by hard water, salts, acids and mild alkalies; they are also compatible with either anionic- or cationic-active agents. They are in fact often used in combination with anionic-active detergents, *e.g.*, in shampoos, since they stabilize the foam and enhance the detergent action. Another application is in the food industries: nonionic surface-active agents are used as wetting agents—*e.g.*, the deep frying of fish or doughnuts, where even action of the hot fat over the entire surface is desired. Ionic agents cannot be used in foods because they have an unpleasant taste and may have more serious adverse physiological effects.

Ampholytic detergents contain both anionic and cationic groups, such as are found in amino acids; some actions of ampholytic detergents are similar to those of amino acids. For example, in acid solution the carboxyl group of an amino acid is not dissociated, but the amino group is a cation; in alkaline solution the amino group is not dissociated, but the carboxyl group is an anion. Ampholytic agents can be designed to combine useful features of both anionic- and cationic-active detergents, but their applications are for special and limited purposes.

Miscellaneous.—Other surface-active substances that can be used for special purposes are water-soluble polymers, such as sodium carboxymethylcellulose, polyvinylpyridine and polyvinyl alcohol; these are anionic, cationic and nonionic respectively. The surface activity of these polymers is conferred by the hydrophilic-lipophilic balance of the final molecule; the monomer is not surface-active since it does not possess enough of each characteristic, though they are present in the same ratio.

Other types of polymeric surface-active agents can be made by co-polymerizing lipophilic and hydrophilic monomers, or by synthesizing block co-polymers, in which one block is hydrophilic (*e.g.*, polyethylene oxide) and the other lipophilic (*e.g.*, polypropylene oxide). The low free energy of surfaces that are formed of silicones or of fluorocarbons make these materials extremely effective as hydrophobic or lipophobic constituents of a surface-active molecule: a fluorocarbon chain of only 5 carbon atoms has the same effect as 16 carbon atoms in an alkyl chain. Silicone or fluorocarbon surface-active agents can lower the surface tension of water from 72 dynes/cm. to less than 20 dynes/cm., whereas agents based on hydrocarbon chains generally cannot reduce it below 28 dynes/cm.; for this reason silicone or fluorocarbon agents are surface-active not only in water but also in hydrocarbons and other organic liquids. Polyurethane foam makes use of a block co-polymer containing silicone and designed to be surface active in a nonaqueous medium.

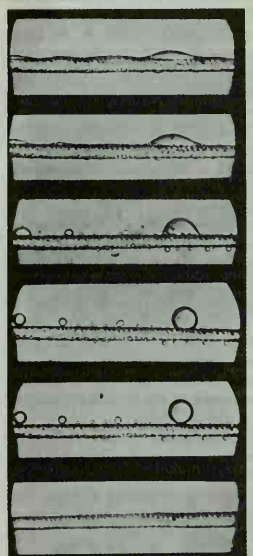

PHOTO: R. C. PALMER, COURTESY OF WOOL INDUSTRIES RESEARCH ASSOCIATION

FIG. 1.—STAGES IN THE "ROLLING-UP" OF OLEIC ACID, BY MEANS OF A DETERGENT SOLUTION, FROM THE SURFACE OF OILED WOOL FIBRE

Physical Process of Surface Action.—A detergent replaces dirt on a surface by (1) being preferentially adsorbed and (2) then facilitating the carrying away of the dirt as a stabilized emulsion or suspension. The process is illustrated in the series of photomicrographs shown in fig. 1: a wool fibre that had been "dirtied" by an oily deposit of oleic acid was placed in an aqueous solution of a detergent; in a short time irregular swellings were observed on the surface; they were accumulations of oleic acid, which had been replaced by detergent and so "washed off" the surface of the wool; when the oleic acid had been removed completely, it appeared as drops clinging to the fibre; but these drops were only loosely attached, so that gentle agitation was enough to detach them; after the drops were detached they became emulsified particles in the body of the solution.

The surface and interfacial tensions that determine this behaviour are shown diagrammatically in fig. 2; they are related by the expression (Thomas Young's equation):

$$F_{so} = F_{sw} + \gamma_{ow} \cos \theta$$

where F_{so} is surface-free energy of the solid-oil interface, F_{sw} is the surface-free energy of the solid-water interface, γ_{ow} is the surface tension of the oil-water interface, and θ is measured in water as shown in fig. 2. For a greasy surface θ may be about 150°, but when a surface-active agent is dissolved in the water both F_{sw} and γ_{ow} are greatly decreased. To regain the equilibrium expressed by Young's equation cos θ must change sign; *i.e.*, θ becomes less than 90°. To "roll up" the oil from

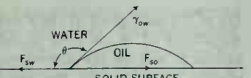

FIG. 2.—SURFACE AND INTERFACIAL TENSIONS THAT DETERMINE THE CONTACT ANGLE OF A LIQUID DROP ON A SOLID SURFACE

the surface of the solid, θ should be nearly zero, at which point the adsorbed layer of detergent may be regarded as preferred energetically to the grease on the surface; finally, if F_{sw} and γ_{ow} are reduced sufficiently, no value of θ, no matter how low, can restore the equilibrium condition, with the result that the oil is completely displaced from the surface. The decrease of F_{sw} results from the adsorption of surface-active solute molecules onto the solid, and the decrease of γ_{ow} results from the adsorption of the same molecules at the oil-water interface. The latter action also produces the second effect of the detergent: it causes the globules of oil or grease to be more readily dispersed as a stable emulsion in the water. This effect is important in preventing the redeposition of the dirt back onto the surface.

N. K. Adam has summarized the process as follows: "In their action on the solid surface, the detergent molecules undermine the grease, performing much the same function as road-sweepers—who collect the dirt, at first spread more or less uniformly over the roads, into heaps that may easily be transferred to a cart."

It is possible to imagine another set of conditions under which the surface-active solute adsorbs well at the oil-water interface but is not much adsorbed at the solid surface: the aqueous solution would then be able to spread evenly over the surface of the oily layer, but it would not displace the oil from the solid surface. Agents of this type are wetting agents but not good detergents. A good detergent, however, is necessarily also a wetting agent. To some extent the specific nature of the solid and of the oily contaminant enter into these relations; for solids of extremely low surface energies, such as certain tetrafluoroethylene resins, it is difficult to find a wetting agent; and for certain oily contaminants, such as silicone oils, it is difficult to find a detergent. But apart from these extreme situations, agents that are surface-active in water will affect γ_{ow} or both γ_{ow} and F_{sw} for most common oily and solid surfaces, and so will display a general ability to act as wetting agents or as detergents.

A detergent solution as a rule does not spontaneously remove solid dirt particles from the surface of a fibre, even when such a removal is favoured by a decrease in total free energy. Additional mechanical force is needed to release large particles from between fibres or to break the adsorptive bonds between small particles (less than 1 micron) and the fibre surface; hence the need for the mechanical action of fabric rubbing against fabric, as in the washtub or washing machine. The smaller the size of the particle, the more adsorptive bonds per unit of mass it forms with the surface, and the greater the mechanical difficulty in removing it. An extreme case is that of an adsorbed dye, where the particles are molecules and contact points are so numerous that often the stain cannot be removed by washing; in such cases, bleaching (*i.e.*, chemical modification) is necessary.

Other Uses for Surfactants.—Surface-active agents (surfactants) have practical uses other than as detergents or wetting agents. These uses are varied; frequently the function that is performed by one surface-active agent can be reversed by another, which displaces it from the surface or forms a mixed film of different properties. Thus one is used as an emulsifier, another as a demulsifier; one is a foam promoter and another is an antifoaming agent; one disperses a powder into a suspension and another flocculates the suspension. These pronounced differences in effect are due entirely to differences in the hydrophilic-lipophilic balance of the molecular structure. For example, the substance may be too lipophilic to be soluble in water, which would be a requirement of a foaming agent or an emulsifying agent, but sufficiently hydrophilic to be spread at an aqueous surface or to adsorb at oil-water interfaces; such substances act as antifoams or demulsifiers respectively. The molecular structure of surface-active agents can also be adjusted to obtain optimum effects as germicides, fungicides or insecticides. Surface-active agents are also used in corrosion inhibition; in ore flotation; as aids in the dyeing of textiles, where they promote even penetration of the fabric; as carriers for insoluble dyes or perfumes; to promote flow of oil in porous rocks; to produce aerosols; and to retard the process of evaporation.

Historical.—(For a history of soap *see* the article SOAP.) The first synthetic detergent was turkey red oil, an anion-active sulfated castor oil introduced in the middle of the 19th century as a carrier in the application of the dye alizarin in the dyeing of fabrics to produce the colour turkey red. The synthetic detergents that gained favour about a century later as replacements for soap were introduced in Germany in 1930 as sulfates of long-chain alcohols prepared by the hydrogenation of fats. These agents gradually were improved and became widely adopted. For example, by 1953 the production of synthetic detergents in the United States exceeded that of soap.

Widespread household use of synthetic detergents introduced a new and vexatious problem in sewage treatment and disposal: the foam stability of synthetic detergents, which is superior to that of soap and was welcomed at first as an advantage, often results in the accumulation of large volumes of unmanageable foam not only in the treatment plants but occasionally in canals, rivers and other waterways. The problem is particularly severe in Britain. Remedies consist of using detergents with low foaming action, such as those used in automatic clothes washing machines, or designing the detergent to be more susceptible to bacterial attack, which destroys it as a foaming agent during the usual course of sewage treatment. Straight-chain alkyl groups are readily destroyed by bacteria; branched chain or aromatic substituents are resistant to bacterial action.

See also references under "Detergents and Wetting Agents" in the Index volume.

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DETERMINANT, an algebraic expression associated with a square array of numbers or other numberlike mathematical quantities. Determinants form a branch of matrix theory (*see* MATRIX) and simplify the solution of simultaneous linear equations.

A determinant of n rows and n columns is called an n-rowed determinant, or a determinant of order n. Let the element in its ith row and jth column be designated by the symbol a_{ij}. Then the accepted notation for the array or matrix of elements is

$$A = (a_{ij}) \qquad (i, j = 1, \ldots, n)$$

and the notation for the determinant of this square matrix A is

$$|A| = |a_{ij}|$$

Determinants of orders one and two, respectively, are defined as follows:

$$|a| = a \qquad \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

Thus a number a defines a one-by-one matrix (a) whose determinant is the number a.

Determinants of order n are defined as follows: let $A = (a_{ij})$ be an n-rowed square matrix. The diagonal term of $|A|$ is the product $d = a_{11}a_{22} \ldots a_{nn}$. If P is the permutation which carries the integers $1, 2, \ldots, n$ into the rearrangement $i_1 i_2 \ldots i_n$ there is a corresponding product $d_p = a_{i_1 1} \ldots a_{i_n n}$. There are $n! = n(n-1) \ldots 3.2$ permutations P on the first n integers and so there are $n!$ products d_P. These are all the possible products obtainable by selecting one and only one element from each row and column of A. Apply P to the so-called alternating function $f = f(x_1, \ldots, x_n) = (x_n - x_{n-1})(x_n - x_{n-2}) \ldots (x_2 - x_1)$ and obtain the function $f_P = f(x_{i_1} \ldots, x_{i_n})$. It can be shown that $f_P = t_P f$ where $t_P = 1$ or -1. Add the $n!$ terms $t_P d_P$ and define the n-rowed determinant $|A|$ to be the sum of these $n!$ signed products.

This definition appears to have been formulated first by Leibniz in a letter which he wrote to Guillaume F. l'Hôpital in 1693. The

discovery does not seem to have had any influence, and determinants did not come into general use until they were rediscovered by G. Cramer, who published this same definition in 1750. The vertical bar notation was first introduced by Arthur Cayley in 1841.

Determinants arise in the study of the solution of a simultaneous system of n linear equations in n unknowns. For example, consider the system

$$\begin{aligned} ax + by &= e \\ cx + dy &= f \end{aligned}$$

in which the letters a, b, c, d stand for known quantities and x and y are to be determined. We may eliminate y by subtracting b times the second equation from d times the first equation and obtain $(ad - bc)x = ed - bf$. Hence if $D = ad - bc$ is not zero, we can express x as the quotient of two determinants. Indeed,

$$x = \frac{\begin{vmatrix} e & b \\ f & d \end{vmatrix}}{D} \qquad y = \frac{\begin{vmatrix} a & e \\ c & f \end{vmatrix}}{D}.$$

Similarly, consider a system of n linear equations of the form

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n &= k_1 \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n &= k_2 \\ \cdots\quad \cdots\quad &\cdots\quad \cdots \\ a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n &= k_n \end{aligned}$$

with $D = |a_{ij}|$ as the determinant of its coefficients. Define K_j to be the determinant obtained by replacing the jth column of D by the column of constants $k_1, \ldots, k_n$. Then $Dx_j = K_j$. This is called Cramer's rule for the solution of linear equations. It implies that if $D \neq 0$ the system has the unique solution $x_j = K_j/D$.

Determinants are useful as an instrument by means of which systems of linear equations may be classified. Thus, in dealing with linear equations with $D = 0$, one possibility is that in which one K_j is not zero. Then there will be no values whatever satisfying all the equations. Criteria for deciding when systems of linear equations have solutions and how many of these solutions are independent can be obtained from the theory of determinants.

Expansions of Determinants.—The array formed by the elements in r rows and r columns of a matrix A is an r-rowed square matrix whose determinant is called a minor of A. The minors of a determinant $|A|$ are merely the minors of the square matrix A. If r rows and r columns of an n-rowed square matrix A are selected the remaining $n - r$ rows and columns are thereby also selected. Thus every r-rowed minor of an n-rowed determinant $|A|$ determines an $(n - r)$-rowed minor of $|A|$, and these two minors are said to be complementary minors of $|A|$.

Every element of a determinant $|A|$ may be regarded as a one-rowed minor of $|A|$ and the elements of $|A|$ then have complementary minors which are $(n - 1)$-rowed. If d_{ji} is the complementary minor of the element a_{ij} we shall call the signed determinant, $k_{ji} = (-1)^{i+j}d_{ji}$, the cofactor of a_{ij}. If we multiply the elements of any row (or column) of $|A|$ by their cofactors, and add, the resulting sum is the determinant of A. For example,

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} = a_{11}\begin{vmatrix} a_{22} & a_{23} \\ a_{32} & a_{33} \end{vmatrix} - a_{12}\begin{vmatrix} a_{21} & a_{23} \\ a_{31} & a_{33} \end{vmatrix} + a_{13}\begin{vmatrix} a_{21} & a_{22} \\ a_{31} & a_{32} \end{vmatrix}$$

The sum of the products of the elements of the ith row (column) by their cofactors is called the expansion of $|A|$ according to its ith row (column). The expansion of a determinant according to the elements of its first row may be used as an inductive definition of a determinant and provides an alternative basis of the theory of determinants. Note, finally, that the sums obtained by multiplying the elements of any row (column) by the cofactors of the elements of any other row (column) are all zero.

A generalization of the expansions given above is due to P. S. Laplace and may be described as follows: select any r rows of $|A|$. Compute all r-rowed minors with elements in these r rows. There are $C_{n,r} = n(n-1)\ldots(n-r+1)(r!)^{-1}$ such minors, where $C_{n,r}$ is then the number of ways of selecting r columns from n columns. Multiply each of these r-rowed minors M_r by its complementary minor M_{n-r} and prefix the sign $+1$ or -1 according as the sum of all of the r row subscripts and all of the r column subscripts of M_r is even or odd. The sum of these $C_{n,r}$ signed products will be the determinant of A. The sum of the signed minors in r rows by the complementary minors of a different selection of r rows is zero. There are corresponding results on column expansions.

The Laplace expansions imply the following important consequence. Suppose that the matrix of a determinant has the form

$$A = \begin{pmatrix} B & O \\ C & D \end{pmatrix}$$

where B is an r-rowed square matrix, C has $n - r$ rows and n columns, D is an $(m - r)$-rowed square matrix and the symbol O represents an array with r rows and $n - r$ columns of elements all zero. Then $|A| = |B|\,|D|$. Matrices of this kind occur frequently in algebraic research. The main use of the result is that we can state that if $|A| \neq 0$ then $|B| \neq 0$ and $|D| \neq 0$ and conversely if $|D| \neq 0$ and $|B| \neq 0$ then $|A| \neq 0$.

Elementary Properties of Determinants.—The computation of a determinant whose elements are numbers may be simplified to a considerable extent by the use of certain properties of determinants. Suppose first that the rows of the matrix of a determinant are interchanged with the columns. Then the value of the determinant is unchanged. This law permits the restatement of any property given in terms of the rows of a determinant as a corresponding property in terms of columns. The row properties are the following:

If two rows of a determinant are interchanged, the determinant is changed in sign only.

If a row of a determinant is multiplied by a number k the determinant is multiplied by k.

A determinant is not changed in value if a multiple of any one of its rows is added to another row.

If two rows of a determinant are proportional or one row consists of elements all zero, the value of the determinant is zero.

Let $|A|$, $|B|$ and $|C|$ differ only in the ith row and suppose that every element of the ith row of C is the sum of the corresponding elements in the ith row of A and B. Then $|A| + |B| = |C|$.

The properties above—which, as explained, are applicable to both rows and columns—are not only useful for the computation of determinants but are also of fundamental importance in the theory of matrices.

Special Properties.—Determinants may be used to determine whether or not two polynomial equations in one variable have a solution in common. Let the equations be

$$\begin{aligned} f(x) &= a_1x^n + a_2x^{n-1} + \cdots + a_{n+1} = 0 \\ g(x) &= b_1x^m + b_2x^{m-1} + \cdots + b_{m+1} = 0 \end{aligned}$$

Form the determinant of order $m + n + 2$ given by

$$D = \begin{vmatrix} A \\ B \end{vmatrix}$$

where A has $m + 1$ rows, B has $n + 1$ rows and we have the formulas

$$A = \begin{pmatrix} a_1a_2\cdots a_{n+1} & 0 & \cdots 0 \\ 0\ a_1\cdots a_n & a_{n+1}\cdots 0 \\ \cdots\ \cdots & \cdots\ \cdots \\ 0\ 0\ \cdots & \cdots a_{n+1} \end{pmatrix} \qquad B = \begin{pmatrix} b_1b_2\cdots b_{m+1} & 0 & \cdots 0 \\ 0\ b_1\cdots b_m & b_{m+1}\cdots 0 \\ \cdots\ \cdots & \cdots\ \cdots \\ 0\ 0\ \cdots & \cdots b_{m+1} \end{pmatrix}$$

The two equations will have a solution in common if and only if $D = 0$. For example let $f(x) = x^2 + x - 2$ and $g(x) = x - 1$. Then the expansions we have given may be used to show that

$$D = \begin{vmatrix} 1 & 1 & -2 & 0 & 0 \\ 0 & 1 & 1 & -2 & 0 \\ 0 & 0 & 1 & 1 & -2 \\ 1 & -1 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 \end{vmatrix} = -4\begin{vmatrix} 2 & 0 & -2 \\ 1 & -1 & 0 \\ 1 & 0 & -1 \end{vmatrix} = 0$$

and the equations have a solution in common. The result was due to James J. Sylvester and is called Sylvester's dialytic method of elimination.

Another topic connected with the theory of equations is the subject of alternants. An alternant is an n-rowed determinant

which is a function $d = d(x_1, \ldots, x_n)$ such that the interchange of any two of the variables changes the sign of d. The alternating function $f(x_1, \ldots, x_n) = (x_n - x_{n-1})(x_n - x_{n-2}) \ldots (x_2 - x_1)$ which was used in the definition of determinants is expressible as an alternant; namely,

$$f(x_1, \cdots, x_n) = \begin{vmatrix} 1 & x_1 x_1^2 & \cdots & x_1^{n-1} \\ 1 & x_2 & x_2^2 & \cdots x_2^{n-1} \\ \cdot & \cdot & \cdot & \cdot \\ 1 & x_n & x_n^2 & \cdots x_n^{n-1} \end{vmatrix}$$

and this determinant is called the Vandermonde determinant of order n. Every alternant with polynomial elements has the alternating function as a factor. The discriminant δ of the equation $F(x) = (x - x_1)(x - x_2) \ldots (x - x_n) = 0$, whose roots are $x_1, \ldots, x_n$, is the square of the alternating function. The coefficients of δ are polynomials in the coefficients of $F(x)$ with integer coefficients. The importance of δ lies in the fact that formulas for computing it in terms of the coefficients of $F(x)$ are known and $F(x) = 0$ has a multiple root if and only if $\delta = 0$.

Symmetry and Skewness.—Symmetric and skew determinants are especially interesting. Since there may be symmetry with respect to a line or a point there are two kinds of determinants which possess symmetry. Those which are symmetric with respect to the centre are called centrosymmetric. The term "symmetric" is usually reserved for those determinants which are symmetric with respect to the main diagonal.

In a centrosymmetric determinant the $(n - r)$th row coincides with the rth row read in reverse order. Every centrosymmetric determinant of even order $2m$ is expressible as a product of two determinants each of order m. A determinant is said to be skew-centrosymmetric when every element is the negative of the element symmetrically placed with respect to the centre. Every skew-centrosymmetric determinant of even order is expressible as the difference of two squares.

A symmetric determinant $|A| = |a_{ij}|$ is defined by the property that $a_{ij} = a_{ji}$ for $i, j = 1, \ldots, n$. Determinants may be multiplied by the law for the product of matrices (*see* MATRIX) and so $|A|^2 = |A|\,|A'| = |AA'|$, where A' is the result of interchanging rows and columns in A. The product AA' is symmetric and it follows that the square of every determinant is expressible as a symmetric determinant. The product $|A|\,|B|^2 = |BAB'|$ of any symmetric n-rowed determinant $|A|$ by the square of any n-rowed determinant $|B|$ is expressible as the n-rowed symmetric determinant of the matrix product BAB'. It is also true that any power of a symmetric n-rowed determinant is expressible as a symmetric n-rowed determinant.

A determinant $|a_{ij}|$ is called a skew determinant if $a_{ij} = -a_{ji}$. The diagonal elements are then all zero. Every skew determinant of odd order is zero. A skew determinant of even order is the square of a polynomial in its elements.

The adjoint of a determinant $A = |a_{ij}|$ is the determinant $|d_{ij}|$ where d_{ji} is the cofactor of a_{ij}. Then $|d_{ij}| = |a_{ij}|^{n-1}$. The adjoint of a skew determinant of even order is again skew.

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DETERMINISM, the name given to the theory that all events, even moral choices, are completely determined by previously existing causes (Latin *determinare*, "to fix or settle"), opposed to indeterminism or free will. On this theory an agent cannot be held responsible in the indeterminist sense, according to which a man is responsible if and only if he could have still acted differently, everything before, including his character, being what it was. The indeterminist view is supported by the experience of remorse. It need not involve saying that our actions are not affected by causes, only that they are not completely determined by them. Determinists, however, have commonly claimed that their view is quite compatible with moral responsibility in any sense in which this is really needed for practical purposes. Even if determinism is true, it remains a fact that some actions have bad consequences and that most agents are in some degree influenced against an act by having its badness pointed out to them, so that ethical argument and blame will still be useful as decreasing the number of undesirable acts. Even punishment will have a point insofar as it prevents wrongdoing, though the indeterminist will rejoin that it is unjust unless the action punished is free. It has also been argued by determinists that a rational action must be determined by motives and that, if a man's wrong action is not due to something bad in his nature, he is not to blame for it, so that it is indeterminism, not determinism, that is incompatible with responsibility. The indeterminist would usually reply that a man's nature is not something there already, prior to and apart from his free actions, and that propositions about a man's character are simply generalizations about the kinds of free actions that he performs. He cannot avoid admitting that a man causes his free actions in the sense of doing them, but he would deny that they could even conceivably be predicted with certainty from events which had occurred in the past together with properties of the agent and of his environment existing prior to the action.

There is a lack of arguments outside ethics to settle the issue, and in the absence of a generally accepted philosophical proof of universal causation it would seem best to accept indeterminism if this is really entailed by ethics. For we know some ethical propositions as well as we know anything. It may be doubted however whether determinism need involve more than a minor modification of ethics, and a world in which everything is causally explicable would seem more rational.

By the second half of the 20th century indeterminism had come to be the more popular doctrine among philosophers and even among physical scientists, but the issue remained open and was clearly not to be settled in the sphere of science. It has been argued also that determinism is incompatible with freedom only if we introduce illegitimately into causation the notion of compulsion over and above regular sequence.

The question raises great theological difficulties: theologians have often argued that, if determinism be true, the problem of evil is insoluble because God would then be responsible for sin; but others (less numerous) have deduced determinism from the omnipotence and omniscience of God.

See ETHICS, HISTORY OF; FREE WILL; PREDESTINATION. *See* also references under "Determinism" in the Index volume.

(A. C. E.)

DETMOLD, a town of Germany which after partition of the nation following World War II was included in the *Land* of North Rhine-Westphalia, Federal Republic of Germany. It is situated on the east slope of the Teutoburger Wald and on the Werre river, 30 km. (18.6 mi.) E.S.E. of Bielefeld by road. Pop. (1961) 31,236.

Detmold was the capital of the former *Land* of Lippe. The Renaissance château of the princes of Lippe-Detmold (1550) is an imposing building in the town centre, while at the entrance to the large park on the south is the New palace (1708–18; enlarged 1850). Detmold possesses a natural history museum, an opera house, the North West German Music academy, trade schools for painters and cabinetmakers, a *Land* library and the Federal Institute for Grain Research. The furniture industry is predominant, and the town is also a well-known tourist centre.

On the Grotenburg, 5 km. (3 mi.) S.W., stands Ernst von Bandel's colossal statue of Arminius (*q.v.*), or Hermann, the leader of the Cherusci who defeated the Roman legions in A.D. 9. Detmold (Thiatmelli) was in 783 the scene of a conflict between the Saxons and the troops of Charlemagne. In World War II Detmold was captured by the Allies in April 1945.

DETONATOR, a device employing certain sensitive explosives, called initiating or primary, to cause explosion of other less sensitive materials, called high explosives. Mercury fulminate (*q.v.*), lead azide and some organic diazo derivatives are used in the initiating charge of the detonators.

This charge is usually followed by a larger charge of a sensitive high explosive, such as tetryl or PETN (*q.v.*; pentaerythritol tetranitrate) to enhance the initiating action of a detonator without employing a large quantity of a hazardous primary explosive. The

charge of a detonator is usually contained in a thin-walled copper or aluminum capsule sealed against moisture.

Detonators are manufactured in various sizes, numbered 1 to 8, to indicate the strength of the charge they contain. They may be exploded by heating electrically a thin bridge wire (of electric detonators) or by igniting the initiating charge (of blasting caps) by a fuze.

In some military fuzes the detonator is exploded by the action of a primer. Each high explosive requires a certain minimum size of detonator for a reliable initiation. In general, the less sensitive to percussion an explosive is (*i.e.*, the safer it is to handle), the stronger is the detonator required to explode it. *See* EXPLOSIVES; *see* also references under "Detonator" in the Index volume.

(G. B. K.)

DETROIT, a city of southeastern Michigan, U.S., seat of Wayne county, is 267 mi. E. and slightly north of Chicago. It is on the Detroit river, connecting Lake St. Clair and Lake Erie and a link in the St. Lawrence seaway (*q.v.*). The course of the river puts Canada to the south; directly across from the city of Detroit, in Ontario, is Windsor (*q.v.*), a chief gateway to Canada. Traffic to Canada is facilitated by the Ambassador bridge, a vehicular tunnel, a railroad tunnel and two railroad-car ferries. The mean average temperature is 49.3° F. and the average rainfall is approximately 31.03 in.

History.—Detroit was founded by Antoine de la Mothe Cadillac, who was seeking a strategic location for a new post to protect and encourage the French fur trade and to advance his own economic interests. On July 24, 1701, he landed near the present site of the Veterans' Memorial building with 50 soldiers, an equal number of voyageurs and settlers and about 100 friendly Indians. A palisaded enclosure, about 200 ft. square, was erected and named Fort Pontchartrain in honour of Cadillac's patron, Count Pontchartrain, one of Louis XIV's ministers. The civilian community within the walls was called the Ville d'Etroit ("town of the strait"), but in time the name was shortened and anglicized to Detroit. Despite his success, Cadillac was plagued by enemies in Quebec and Paris. To placate them the king removed Cadillac from Detroit in 1710 and appointed him governor of Louisiana.

In the next half century Detroit grew in size and importance, and was eyed enviously by the British. On Nov. 29, 1760, during the French and Indian War, it was surrendered without resistance to a British force under the command of the famous ranger Major Robert Rogers. Some of France's Indian allies, notably the Ottawas under Chief Pontiac, disliked and distrusted the English. In May 1763 Pontiac devised a plan to seize the fort through a ruse, but Major Henry Gladwin, commandant, learned of the plan and foiled the conspiracy. In the treaty of peace, France ceded her claims to the territory east of the Mississippi, and England came into undisputed possession of the area.

At the close of the American Revolution, Great Britain ceded the lands west of the Alleghenies to the U.S., but, in violation of the treaty, refused to withdraw troops from Detroit and various other posts. Since England then had the friendship of the Indians, it kept stirring them up against the Americans migrating to the west. After a series of campaigns against the Indians culminating in the battle of Fallen Timbers and the Treaty of Greenville, the Jay treaty provided for the evacuation of the British posts. On July 11, 1796, Capt. Moses Porter arrived at Detroit with 65 soldiers to receive the surrender.

In Jan. 1802 Detroit was incorporated as a town with a board of trustees as the governing body. Immigration into the surrounding region was so great that the federal government opened a land office in the city which did a brisk business. In 1805, Michigan Territory (later to be Michigan, Wisconsin and a part of Minnesota) was created by congress and placed under a governor and judges, with Detroit as the capital. Gen. William Hull was appointed governor; Augustus B. Woodward and Frederick Bates, judges; and Stanley Griswold, secretary.

On June 11, 1805, the whole town was swept by a devastating fire. Every building except one was burned to the ground, but miraculously no lives were lost and only two persons were injured. When the new territorial officials arrived later in June, they saw only blackened ruins. Under Woodward's inspiration and leadership, a new, larger city was soon rebuilt, his plan being based on a design of Pierre Charles l'Enfant who had laid out Washington, D.C. There were squares, circles and radial streets, but as the city spread beyond its original boundaries the plan was not extended. In the second half of the 20th century, therefore, Woodward's plan existed only in the downtown area. Each citizen whose home was burned was awarded a larger piece of land than he had previously held, and the city became less compact. The Michigan Territory government revoked the charter of 1802; a new charter in 1806 provided a mayor appointed by the governor and an elected council of two houses with three members each.

Soon after the outbreak of the War of 1812, General Hull surrendered the town to the British without a defense. The British held Detroit until Sept. 28, 1813, when Lieut. (later Commodore) Oliver Perry's victory in the battle of Lake Erie (Sept. 10) made further occupation untenable. Back in U.S. hands, Detroit became the base for Gen. William Henry Harrison's invasion of Canada to the Thames (Moraviantown).

Michigan became a state in 1837 and the capital remained at Detroit until 1847 when it was moved to the new town of Lansing. The change in the capital in no way hindered Detroit's progress. The city emerged from the status of a frontier post soon after the War of 1812. In 1815 it was reincorporated as a city, with a board of trustees, who chose their own president, as the governing body. In 1824 a new charter provided for a mayor and a council of aldermen elected by wards. With variations this form of government prevailed until a new charter in 1918 provided for a nonpartisan mayor and a council of nine, the latter being elected at large. The same act also provided for similar changes in the school system of the city. The old board of education, composed of inspectors elected by wards on party tickets, was supplanted by a new board of seven members elected at large for staggered terms and without a party designation.

In 1817 the first newspaper, the *Detroit Gazette*, was published, and in 1818 the "Walk-in-the-Water," the first steamboat on the Great Lakes, began regular runs between Buffalo and Detroit. Soon thereafter other lines appeared, and shipbuilding and chandlering became profitable enterprises. Forwarding and commission houses also flourished. By mid-century, although not the queen of the Great Lakes, Detroit was a prominent member of the queen's court. The peak of water transportation was reached in the 1880s. Then gradual decline set in until the St. Lawrence seaway project of the mid-20th century revived interest in the port of Detroit, not only for domestic but for foreign commerce as well.

In the 1830s several railroads were incorporated and construction started from Detroit. A decade later a number of miles of track stretched into the hinterland. In 1852 through-rail connection was made with Chicago when the Michigan Central completed its line. By railroad and water, grain and other produce poured into Detroit for reprocessing and forwarding to other parts of the nation or to Europe. By mid-century, Detroit was one of the recognized flour-milling centres of the United States with lively transactions on the Board of Trade.

Before the Civil War the city was an important station on the Underground Railroad, and through it hundreds of runaway slaves passed to freedom in Canada. During the war Detroit furnished about 6,000 men, money, provisions and supplies of all kinds. It was not immune from the draft and anti-Negro riots that spread throughout the north in 1863, but the disturbances were not so virulent as in other cities. Detroit was also a centre of a plot by the Confederacy to free prisoners of war. In Sept. 1864 southern agents and sympathizers seized the "Philo H. Parsons" and sailed for Johnson's Island to free the prisoners there. Before reaching the island, however, the scheme fell apart, and the conspirators took refuge in Canada.

In the 35 years following the Civil War, Detroit changed from its earlier role as a country merchant to that of industrial magnate. Iron and steel, foundry, railroad car, boot and shoe, stove, wheel and axle, chemical and pharmaceutical industries all flourished by the end of the century. In 1896, Charles B. King drove a horseless carriage through the streets of Detroit, and the city's automotive

industry was born. A new era dawned for Detroit which was to make it the automobile capital of the world. Soon thereafter Henry Ford and other men who were to become giants in the industry were producing automobiles, and by the second decade of the 20th century the name Detroit was synonymous with the word "automobile." The booming industry acted as a magnet which drew increasing numbers of people to the city, especially after Ford's announcement in 1914 of a $5-a-day minimum wage.

Detroit furnished its share of men during the Spanish-American War and World War I (about 65,000 in the latter). During World War I it was also noted for its contributions of the materials of war, and during World War II the city was popularly nicknamed the "Arsenal of Democracy."

Although Detroit did not become a one-industry city, the manufacture of automobiles dominated its economy, and after World Wars I and II the city suffered from normal recessions. The depression of the 1930s struck Detroit particularly hard. There was a gradual recovery, but in 1936 the average wage of the auto workers was only 76 cents per hour. In Feb. 1937 sit-down strikes against General Motors were settled by recognition of the United Auto Workers as the bargaining agent. Ford did not recognize the U.A.W. until 1941.

Detroit is more than a mere industrial complex; its citizens have long been interested in sponsoring education and the arts. In 1817, through the efforts of Woodward, Gov. Lewis Cass, Father Gabriel Richard and Rev. John Montieth the territorial legislature created the University of Michigania in Detroit. In reality the university was a sort of public school system culminating in an academy. It was not a successful venture, however, and in 1821 the legislature repealed the act (*see* MICHIGAN: *Education*).

Until 1842, Detroit was a school district under territorial and state control. In 1842 the legislature made the city an autonomous school district with its own board of education and the right to establish and control its own school system. Graded elementary schools were immediately organized, but not until 1858 was a high school added. A normal school for teacher training, the Detroit Teachers college, was started in 1881. In 1917 the board of education established a junior college which in 1923 became a four-year school, the College of the City of Detroit. Meanwhile, the board acquired a medical school (the privately owned Detroit College of Medicine begun in 1868), a law school and a college of pharmacy, the last two created by the board. In 1933 a reorganization of the administration of all the colleges of the city resulted in Wayne university, which remained under the board of education until July 1956, when the state assumed control and the name was changed to Wayne State university. In addition to public schools, private and parochial schools helped meet the demand for education from the elementary to the college level.

Numerous cultural and social societies, such as the Lyceum, Mechanics' society, Young Men's society, Athenaeum, fraternal groups, musical, charitable and religious societies, reading clubs, and scientific organizations contributed to the intellectual life of the citizens. Some of these established libraries for members' use, and when the organization disbanded the books were given to the Detroit Public library, which was started in 1865. With the great influx of immigrants in the 70 years after 1850, numerous cultural and social societies of the various nationality groups were started, some of which existed into the second half of the 20th century. The city also officially sponsored such projects as the Detroit Institute of Arts, Detroit Historical museum and Detroit Zoological park. In 1920 the city created a department of recreation, which became a recognized leader in public recreation.

Population.—In 1810 the population of Detroit was 1,650. By 1820 it had declined slightly to 1,442, partly due to the War of 1812. The opening of the Erie canal, growing commerce on the Great Lakes and development of the railroads helped increase the population to 21,019 by 1850. The importance of the city continued to draw increasing numbers of people, so that in 1860 the population had jumped to 45,516. In 1870, with a population of 79,577, it was the 18th largest U.S. city, and by 1900 the population had reached 285,704.

The development of the automobile and other industries after 1900 was the greatest stimulant in Detroit's rapid increase in population. By 1910, the population was 465,766, and in 1920, with 993,678, it passed St. Louis to become the nation's fourth largest city, a rank it held until 1950 when it was passed by Los Angeles. The population of the city in 1960 was 1,670,144; of the standard metropolitan statistical area (Macomb, Oakland and Wayne counties) 3,762,360. Other cities in the metropolitan area include Dearborn, East Detroit, Ferndale, Hamtramck, Highland Park, Lincoln Park, Pontiac, Royal Oak and Wyandotte (*qq.v.*).

From the early part of the 19th century Detroit was a cosmopolitan community. French, Canadians and Americans were prominent. In 1850, 47% of the population was of foreign birth. The Irish and the Germans predominated, respectively, making up more than 50% of the foreign born. Although an increasing number of foreigners moved to Detroit before the immigration laws of 1921 and 1924, the percentage of total foreign-born population gradually declined, and the composition of the foreign born also changed. In 1880 those of German birth alone constituted 20.4% of the total population in the city, while the Irish made up only 5.8%. By 1900 the foreign born constituted about 34% of the population. Russians, Austrians and Hungarians began arriving in considerable numbers between 1900 and 1910, and in 1910 made up 8% of the total population, ranking behind the Germans (9.6%) and the Canadians (9%). The greatest Polish immigration came in the next decade; by 1920 they constituted 6% of the population. In 1920 the foreign born were 29% of the whole population. The percentage dropped to about 26% in 1930, about 20% in 1940 and about 17% in 1950. By 1950 most of the foreign born were older people, with less than 20% under 35 years of age. After the immigration laws of the 1920s, the great migration from the south set in, and continued in the second half of the 20th century.

Administration and Finance.—Detroit has a mayor-council, nonpartisan type of government. The charter adopted in 1918, which abolished the ward system, provided for the nomination and election of the mayor, city clerk, city treasurer, council and board of education, without party designations. The mayor has broad powers to appoint most of the administrative officials and commissions: board of assessors, board of health, city planning, public lighting, water, street railway, fire, public welfare, police and other commissions. The common council is composed of nine members elected at large. In the primary elections the 18 highest candidates receive the nomination, and in the regular election the nine receiving the highest number of votes are declared elected. The councilman-elect with the most votes automatically becomes president of the council and acting mayor in the absence of the mayor. The new nonpartisan government took office in Jan. 1919. Originally the officials were chosen for two-year terms, but in 1953 an amendment to the charter lengthened the terms to four years. The charter also provides for recall, and in 1930, at a special election, Mayor Charles Bowles was recalled, the first mayor of a major U.S. city to be recalled.

The chief source of revenue for Detroit is the real estate tax. It was one of the hardest hit U.S. cities in the depression of the 1930s; by early 1932 thousands of unemployed were on public welfare. In Feb. 1933 Governor Comstock proclaimed the Michigan bank holiday and many Detroit banks never reopened. In April of that year the city issued script to meet obligations. Although the script was receivable at face value in payment of city taxes and other debts, the public market value fluctuated. Eventually all script was retired under a refunding program.

Housing and Planning.—In 1934 when the federal housing program began, Detroit sponsored slum clearance and low-cost housing projects, which continued into the second half of the 20th century, notable examples being the Edward J. Jeffries, Brewster, Parkside and Conant Gardens projects.

After World War II municipal planning included a new civic centre on a 58.3 ac. river-front site. Many old and unsightly buildings were demolished, and in 1950 the first of the new civic buildings was completed, the Veterans' Memorial. Other buildings include a combined city-county building, replacing the former city hall and the old court house; the Henry and Edsel Ford

auditorium where the Detroit symphony orchestra plays; and the Cobo Convention and Exhibit building. At the time of condemnation of the old area, a famous seafarers' mission, Mariners' Church, was moved several blocks and kept not only for religious services but as a historical shrine.

Expressways and Transit.—After World War II two limited access expressways were built to accommodate traffic pouring into the city from the outlying industrial and residential communities. The north-south John Lodge expressway, on the west side, connects with the James Couzens highway near the northwestern city limits and runs south to the Detroit river. The east-west expressway, the Edsel Ford, extends from the eastern side of the city westward to the Industrial expressway at the western limits. A complex interchange where the Lodge and Ford expressways meet allows transfer from one to the other. Davison, an important east-west artery on the northside, is also depressed through the more congested traffic areas. Other streets, such as Woodward, Gratiot and Grand River, were widened, with over- or underpasses at important cross streets.

Dissatisfied with privately owned streetcar lines as early as the 1890s, Detroit in 1913 voted for a change in the city charter to allow for municipal ownership, but it was not until 1921 that the first such line was operated. The bitter feud between the city and the private lines ended when the city purchased the lines in Jan. 1929. In the late 1920s, the city began operation of a few motorbuses, but again met with private competition, the Detroit Motor Bus company, the lines of which were taken over by the city in Jan. 1932 and brought under complete municipal ownership. After 1950 streetcars were discontinued and replaced by buses, although one or two trackless trolleys still operated. The Detroit Street railway, under control of a commission, is organized along the lines of a private company, designed to be self-supporting with no appropriations from the city budget, and paying taxes as though it were a private corporation. This system was not very successful and the D.S.R., despite rising fares, operated mostly in the red. Various proposals submitted to the voters to relieve it of payment of taxes were defeated.

Buildings.—Most of the city's largest office buildings, hotels, department stores and banks are in the downtown area. The tallest is the 47-story Penobscot building, and the largest office building outside downtown is the General Motors building in the New Center area at Grand boulevard and Second avenue. Another large office building in the same neighbourhood is the Fisher building. The General Motors, Fisher and New Center buildings (a third but smaller office building) are connected by underground pedestrian tunnels.

To accommodate the growing metropolitan area, two large out-city shopping centres, Northland and Eastland, were built by private capital. They are laid out with co-ordinated architecture, flower beds, fountains and adequate parking space. Many of the downtown stores have branches at these centres. To meet the parking needs downtown, where curb parking is prohibited, the city built two large underground parking garages—one under Grand Circus park and another under the Ford auditorium, which together accommodate about 2,000 cars.

Industry, Commerce, Transportation, Communications and Welfare.—In the early days, fur was the only trading commodity. This trade continued to be of prime importance until after the War of 1812 when a gradual decline set in. A few gristmills, soap factories and distilleries, making products chiefly for local use, were in existence by 1810, with a total annual volume of approximately $25,000. The growth and development of water transportation after the first quarter of the 19th century made Detroit one of the large shipbuilding cities on the Great Lakes. By mid-19th century it was also a recognized flour and grain centre, and manufactured steam engines and other machinery. At the outbreak of the Civil War, the total annual volume of business was over $600,000. By 1900, Detroit had a diversity of industries —foundry and machine shops, druggist preparations, stoves and furnaces, carriages, woodcrafts, meat packing and cigar making.

The invention of the automobile was, perhaps, the greatest industrial stimulant that Detroit experienced. Charles King's first automobile in 1896 provoked considerable excitement, and other men immediately became interested. Pioneers in the field were W. C. Durant, Walter P. Chrysler, Henry Ford (*qq.v.*), Ransom Olds, Henry Leland and the Dodge brothers. Although many automobiles were made elsewhere, the industry centred in Detroit. As early as 1904, with only 0.4% of the U.S. population, Detroit made 20% of the country's automotive products. By the second half of the 20th century the big three (Ford, General Motors and Chrysler) had greatly decentralized production.

Detroit is more than an automobile city, however, even though at mid-20th century it still made one-half of the products of the country's largest industry. About 1920 Detroit became a steel centre. The chemical business also prospered after the discovery of a layer of rock salt 34 ft. thick, 1,000 ft. below the surface. The Detroit Rock Salt mine has approximately 60 mi. of tunnels with fully mechanized equipment and transportation. In the second half of the 20th century Detroit ranked at or near the top in U.S. production of pharmaceuticals, adding machines and calculators, foundry products, machine-tool accessories, paints and heavy chemicals. Other important industries include light machinery, metal stampings, hardware, wirework, machine-shop products, rubber products and electrical household appliances. The Chrysler corporation is the city's largest single employer.

During World War II more prime contracts for war materials were awarded to Detroit area plants than to any other region in the U.S. Reconversion to peacetime production was accomplished without great disruption. Government contracts, especially for missile work, continued after World War II.

Because of Detroit's location on the Great Lakes, the Michigan customs district ranked third of U.S. ports in foreign trade at mid-20th century. Exports totaled about $700,000,000 a year. Imports included about 300 various items used in automobile production. Detroit is a port of call for cargo boats and ocean-going freighters operating on the Great Lakes.

Nine major railroad systems serve the city. Three airports, City, Metropolitan and Willow Run, serve more than a dozen private passenger and freight-carrying air lines. Motor-truck lines also facilitate intra- and interstate transportation.

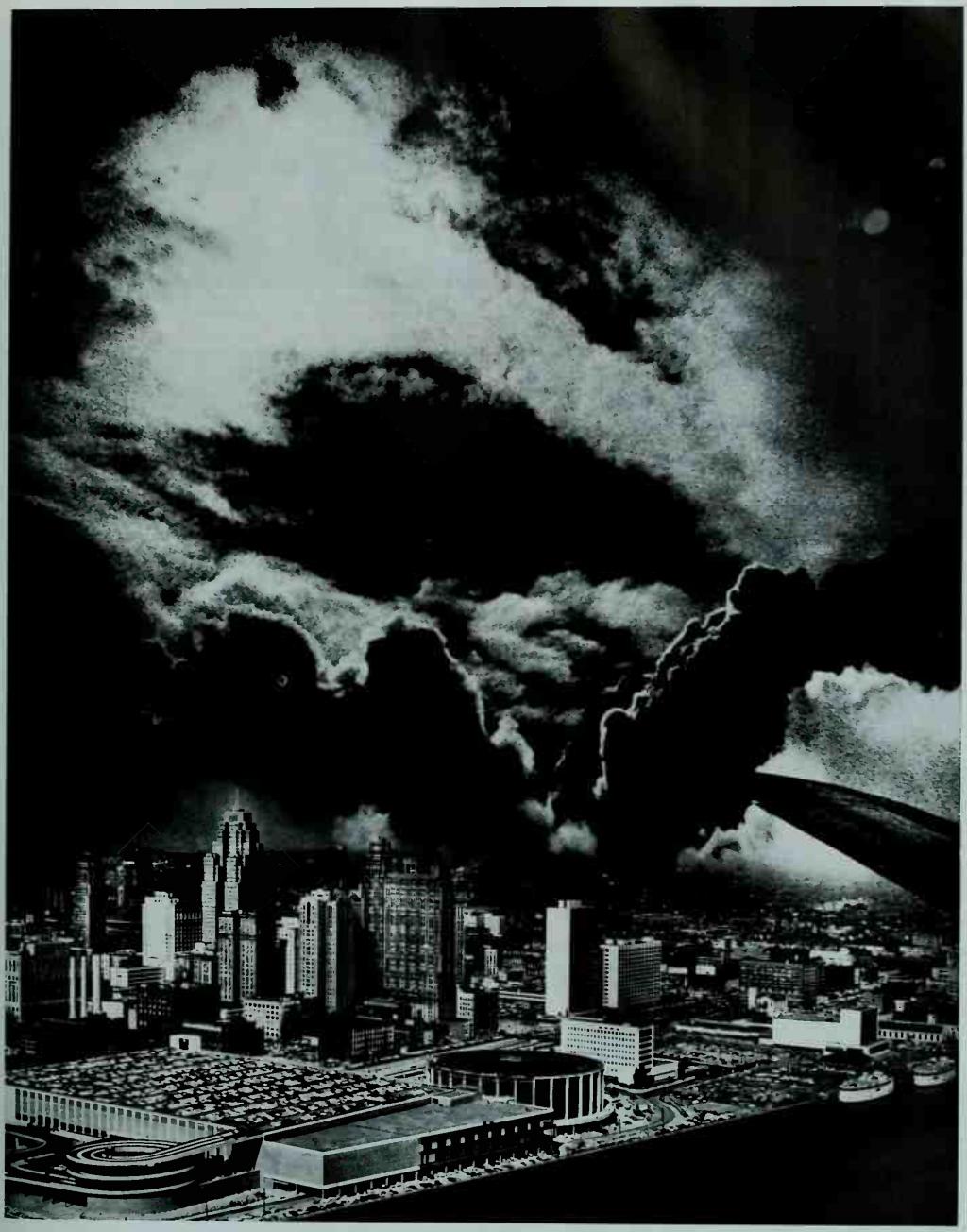
There were in the late 1950s 3 daily papers in Detroit, the *Free Press, News* and *Times;* 7 Detroit and 6 area AM radio stations; and 16 Detroit and area FM stations. There were five TV stations (one a UHF).

Industrial and civic groups have long co-operated on various community projects. In the 1880s the Associated charities was organized to centralize aid to the unfortunate. In the 20th century the United foundation permitted all agencies that solicit for charity and similar purposes to concentrate their efforts into one sustained drive for funds, the Torch drive.

Education and Culture.—The public school system, begun in 1842, had over 250,000 students in the second half of the 20th century. Its physical facilities include trade schools as well as the usual elementary, junior high and high schools. The great influx of rural people, particularly from the south, placed a great strain on the accommodations as well as on the curriculum. A citizen's committee completed in 1958 a survey of school needs and suggestions for reform.

Parochial and private schools had over 80,000 students. Higher education is provided for by Wayne State university and by the University of Detroit (Roman Catholic, established 1877); Marygrove college (chartered 1910) and Mercy college (established 1941), both Roman Catholic colleges for women; Highland Park Junior college in Highland Park (established 1918) and Henry Ford Community college in Dearborn (founded 1938), both public junior colleges. The University of Michigan has a branch campus at Fairlane, the old Ford estate in Dearborn. Wayne State university and the University of Michigan co-operate in an adult non-credit educational program and jointly operate the Institute of Labor and Industrial Relations, located on Wayne's campus.

Several wealthy individuals have done much to contribute to the cultural development of Detroit. In 1927 George and Ellen Booth created the Cranbrook foundation, and in 1928 the Cranbrook Academy of Arts was opened on their estate, Cranbrook, in sub-

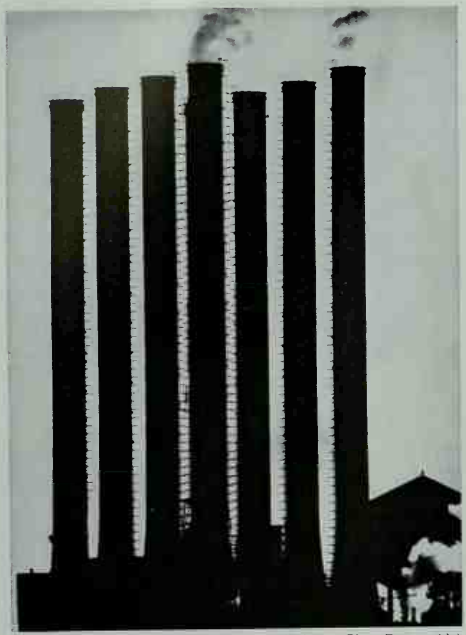


AERIAL VIEW OF DOWNTOWN DETROIT

The Penobscot building, tallest in Detroit, is at the left; the Cobo Convention and Exhibit building is in the left foreground

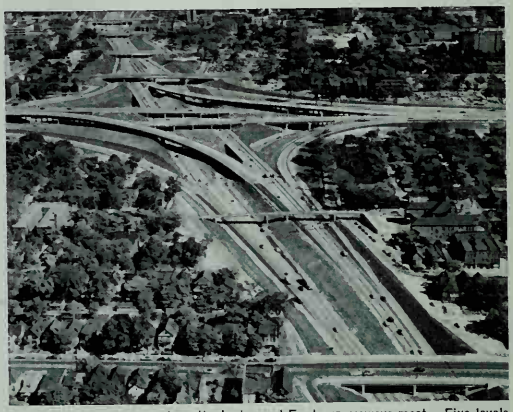
PHOTOGRAPH, JOE CLARK, H.B.S.S.

DETROIT



Smokestacks of the Ford Motor company's plant near River Rouge which borders Detroit on the southwest side

Belle Isle park, a wooded island in the Detroit river noted for its beautiful drives, formal rose gardens, carillon tower and fountains



Expressway interchange where the Lodge and Ford expressways meet. Five levels separate the traffic lanes and permit transfer from one expressway to another

City-county building, a part of the civic centre built along Detroit's river front

Workmen's houses near City airport, built during the early 1930s as part of a low-cost housing project sponsored by Detroit

SCENES IN DETROIT

BY COURTESY OF (CENTRE RIGHT) MICHIGAN AERIAL SURVEY CORP. AND DETROIT CONVENTION AND TOURIST BUREAU; PHOTOGRAPHS, JOE CLARK, H.B.S.S.

urban Bloomfield Hills. In 1930 the Cranbrook Institute of Science was founded. Such renowned men as Eliel Saarinen, the architect, and Carl Milles, the sculptor, have been associated with Cranbrook. Also at Cranbrook are the Cranbrook School for Boys, the Kingswood School for Girls, and the Brookside School for Young Children. In 1926 Sebastian S. Kresge established a $25,000,000 foundation for education, religion and charity. A Detroit beneficiary is the Kresge Science library of Wayne State university. In 1929 Henry Ford opened Greenfield village and the Edison institute as a tribute to his old friend Thomas A. Edison and because of his own interest in preserving the history of the past. In 1936 the Ford foundation was established and has done much to aid and encourage cultural, social and economic advancement. The will of Lizzie Merrill Palmer provided for a school in 1920, which accepts advanced students from co-operating colleges all over the U.S. for special work in human growth and child development. It has pioneered also in home economics.

Bordering Wayne State university is the Cultural centre. Here are located the main public library, the Detroit Institute of Arts, the Detroit Historical museum, the Horace H. Rackham Educational memorial and the Children's museum. The municipally owned Institute of Arts houses paintings, sculptures and decorative arts from prehistoric to modern times. The Detroit Historical museum preserves the city's history in physical survivals. In cooperation with the Detroit Historical society it also sponsors a large number of historical projects. The Children's museum contains mobile and permanent exhibits to supplement the curriculum of the public schools. The Rackham Educational memorial is the Detroit headquarters for the University of Michigan's extension services, and the home of the Engineering Society of Detroit.

Since 1914 Detroiters have maintained a symphony orchestra, by private subscription and benefits, which gives 20 regular concerts a season in addition to a series of "Family Concerts" and "Children's Concerts." In 1928, the Detroit Civic theatre, with Jessie Bonstelle as director, was begun as a community venture. Its playhouse, named after its director, was later taken over by Wayne State university for its drama projects. Because of the large number of foreign born or persons of foreign extraction an International institute has been organized, and in addition to other activities it maintains a program of folk music and dancing.

Detroit is also a city of churches, there being more than 1,000 of all denominations. St. Anne's Catholic church is the oldest, dating from the settlement in 1701. The first Protestant society, interdenominational, was organized in 1820, and in 1825 became the First Presbyterian church. All other main Protestant faiths are represented in Detroit. Temple Beth-El, the first Jewish society, was organized in 1850.

Parks and Recreation.—Detroit and the metropolitan area is well supplied with parks and recreational facilities. In the second half of the 20th century there were 46 parks in the city covering an area of approximately 3,400 ac. Among the larger ones that offer a variety of entertainment are Belle Isle and Palmer parks. Belle Isle, a wooded, 1,000-ac. island in the Detroit river, was acquired by the city in 1879. Noted for its beautiful drives, formal rose gardens, carillon tower and fountains, it has riding stables and bridle paths, a bathing beach, a small zoo and a children's zoo, a botanical conservatory, boating and picnic areas. Palmer park, on the north side of the city, has no waterfront, but offers ice skating in season, golf, riding, tennis, archery and picnic grounds. Other parks in the metropolitan region (under county or state jurisdiction) which offer similar diversions, including swimming and skiing, are the Rouge, Kensington, Lola valley, Metropolitan beach and Plymouth.

Spectator sports are popular, and Detroit is the home of several professional teams: the Tigers (baseball), Lions (football), Red Wings (ice hockey) and Pistons (basketball). Briggs and Olympia stadiums are the scenes of most professional sporting events. Throughout the city and metropolitan area there are a large number of public and private golf courses. Bois Blanc (Bob Lo) Island on the Canadian side of the Detroit river offers typical amusement-park entertainment. Great Lakes cruises and various excursion trips are available during the summer months.

See also references under "Detroit" in the Index volume.

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(J. L. N.)

DETROIT RIVER, long an artery for Great Lakes shipping and, with the opening of the St. Lawrence seaway in 1959, an important link in the seaway system, connects Lake Erie with Lake St. Clair and, through the St. Clair river, with Lake Huron. About 32 mi. long, it forms a part of the U.S.-Canadian boundary between southeastern Michigan and southwestern Ontario. The major cities on the river are Detroit, Mich., on the north bank and, across the river, Windsor, Ont., on the south. The river channel, which formerly provided a minimum depth of 21 ft. for vessels sailing up to Lake Huron and 25 ft. for those sailing down to Lake Erie, was deepened to 27 ft. to accommodate seaway shipping. *See* GREAT LAKES, THE; SAINT LAWRENCE SEAWAY.

DETTINGEN, BATTLE OF, an engagement in the War of the Austrian Succession (*q.v.*), fought on June 27, 1743, near Dettingen on the Main in Bavaria (10 mi. N.W. of Aschaffenburg) and resulting in a victory for the allied Anglo-Hanoverian and Austrian forces under George II of England, the 2nd earl of Stair (John Dalrymple) and the duke of Arenberg (Leopold Philip) over French forces under the marshal duc de Noailles (Adrien Maurice) and the duc de Gramont (Antoine Adrien Charles). The superior strategy of Noailles had caught 40,000 allied troops between the Spessart hills and the Main river: Gramont with some 30,000 men was blocking the route to Hanau at Dettingen, while Noailles advanced on the allied rear from Aschaffenburg. The allies were thus forced to fight to continue their retreat. Gramont, however, unwisely took the initiative, and his attacking cavalry and infantry were roughly handled by the allies. The confined terrain gave no scope for the exercise of tactical skill, and the allies' success was mainly due to the steady bearing of the British and Austrian infantry. Suffering some 6,000 casualties and having inflicted about 2,500, the French withdrew across the Main; the allies marched on to Hanau. The day is famous as the last time that a British monarch personally led his troops in battle.

(D. M. Sc.)

DEUCALION, in Greek legend, son of Prometheus, king of Phthia in Thessaly, husband of Pyrrha and father of Hellen, the mythical ancestor of the Hellenic race. When Zeus had resolved to destroy all mankind by a flood, Deucalion constructed a boat in which he landed on Mt. Parnassus with his wife.

Having offered sacrifice and inquired how to renew the human race, they were ordered to cast behind them the "bones of their mother"; that is, the stones from the hillside. Those thrown by Deucalion became men; those thrown by Pyrrha, women. Other versions of the legend made Deucalion land in other mountainous parts of northern Greece. Alternatively the myth of a flood was linked by the Greeks with Ogyges or Ogygos, a primeval king of Boeotia. He, however, remains an entirely shadowy figure. *See* also FLOOD (IN RELIGION AND MYTH).

(H. W. Pa.)

DEURNE, an eastern suburb of Antwerp, Belg., 3 km. (2 mi.) from the city, is situated on the arterial road to Liège. Pop. (1955 est.) 61,715. Deurne, formerly agricultural, is now mainly residential, though there are industries. The chief of these is the manufacture of bottle tops, the factory being one of the largest in Europe. At Deurne is the airport for Antwerp. Burned down during the Norman conquest (836), Deurne was later owned by the bishops of Liège and dukes of Brabant. During the 16th century rich merchants from Antwerp settled there in their newly built *hofs* or castles and the little town was temporarily prosperous. It was almost wiped out by Spanish troops in 1586 during the wars of religion. Merchants and bankers from Antwerp brought prosperity again in the 18th century, and five castles built then survive. Under French rule from 1795 to 1814, Deurne became part of the United Netherlands in 1815 and of Belgium in 1830.

(R. M. An.)

DEUS, JOÃO DE (1830–1896), eminent Portuguese Roman-

tic poet, was born at Messines, in Algarve, on March 8, 1830. He graduated in the faculty of law at the University of Coimbra in 1859, having taken ten years to complete an ordinary course of five. While an undergraduate he spent most of his time in writing verses, which circulated in manuscript. He had a versatile talent and a gift for improvisation. Many of his short poems were declaimed to a small group of friends, accompanied by a guitar. This explains in part the musical quality and the sprightly rhythm of his poems, which range from satires to lyrics, in simple or elaborate forms. He never cared much about the publication of his own poems and the first to be printed were *Pomba* (1851) and *A Lata* (1860) in an edition organized by his friends.

After a brief career at the bar, João de Deus left Coimbra for Beja to become the editor of *O Bejense* (1862–64) and the *Folha do Sul* (1866). Constantly in financial difficulties, he moved to Lisbon, where he was forced to take menial jobs. His friends tried to assist him and in 1869 succeeded in having him elected as liberal deputy for the constituency of Silves. But João de Deus was a man of dour Catonian rectitude and promptly renounced his mandate. This attitude won him as much popularity as his verse, which had appeared in book form the previous year in a collection (*Flores do Campo*) compiled by José António Garcia Blanco, who rushed a new series to the press in 1869. At about this time, João de Deus noticed the old-fashioned primers in use at the Portuguese schools and devoted his attention to educational problems, writing the *Cartilha Maternal* (1876), which was officially approved in 1888. Despite his modesty he was by now a famous man and the first comprehensive edition of his poems, including the *Folhas soltas* (1876), was published by Teófilo Braga in 1893 (*Campo de Flores*) and reprinted in an enlarged version in 1896, soon after his death in Lisbon on Jan. 11.

Publicly acclaimed in 1895 as the greatest Portuguese poet of his generation, João de Deus was widely read and greatly admired in the first quarter of the 20th century. He is mainly appreciated for the directness of his imagery, which is visual rather than aural, and for his tender sincerity and simplicity in the expression of love. By combining the lyrical tradition of the old medieval songs with the more refined manner of the Renaissance he succeeds in being natural and unrhetorical. In some of his best works ("Marina," "Adeus," "Descalça," "Vida") he conceals eroticism under a delicately expressed religious ideal in which woman is regarded as the supreme power of creation. Lacking deep intellectual interests, he was confined to a limited number of themes and could not avoid a certain monotony in form and content. Among his contemporaries he had the merit of pruning the excesses of romanticism and of coining a new and more expressive poetic language.

See "O lirismo de João de Deus" in Vitorino Nemésio, *Sob os signos de agora* (1932). (L. DE S. R.)

DEUSDEDIT, SAINT (d. 618), pope from 615 to 618, sometimes styled ADEODATUS I, was a Roman, the son of a subdeacon. Very little is known of his pontificate, which began in Oct. 615 and witnessed an unsuccessful resumption of the Byzantine war against the Lombards in Italy. Reversing the policy of Gregory I and Boniface IV, Deusdedit favoured the secular clergy rather than monks. Rome experienced an earthquake and pestilence in 618, and in November the pope died. His feast day is Nov. 8. (A. G. Bi.)

DEUTERIUM AND TRITIUM, sometimes described as forms of "heavy hydrogen," are the isotopes of hydrogen of approximate atomic weights 2 and 3; their nuclei have double and triple, respectively, the mass of the nucleus of ordinary hydrogen. The hydrogen bomb, with its uncontrolled thermonuclear reaction, exploits the nuclear properties of deuterium and tritium; the explosion represents the collision and fusion of the nuclei. Should a method be found of controlling this process of fusion, as was done with the fission process of the earlier atomic bomb, the raw material for a practically unlimited supply of energy would be available in the hydrogen content of water.

Deuterium is a stable atomic species found in natural hydrogen compounds (water being the most abundant) to the extent of 0.014% to 0.015%. Tritium is a radioactive species emitting negative beta particles of 19,000 electron volts energy and having a half life of 12.5 years; it occurs in natural water with an abundance of 10^{-18} of that of natural hydrogen. The names, symbols and some atomic constants of the three hydrogens and the neutron are given in Table I.

TABLE I.—*Atomic Constants of Neutron and Hydrogens*

Name	Symbol	Atomic weight (physical scale)	Nuclear spin	Nuclear magnetic moment*
Neutron	n^1	1.008938	½	−1.9135
Protium	H or H^1	1.008128	½	2.7926
Deuterium	D or H^2	2.014719	1	0.8576
Tritium	T or H^3	3.01703	½	2.9795

*In units of nuclear Bohr magnetons $\left(=\frac{eh}{4\pi M_{HC}}\right)$.

Deuterium was discovered (1931) by H. C. Urey with the help of F. G. Brickwedde and G. M. Murphy. Urey, using the third law of thermodynamics and the Debye theory of the solid state, predicted a difference in vapour pressures of H_2 and HD and thus the possibility of separating these substances by distillation of liquid hydrogen. The deuterium was detected in the residue of a distillation of liquid hydrogen by its atomic spectrum. E. Rutherford, with M. L. Oliphant and P. Hartack (1934), discovered tritium by bombarding deuterium with high-energy deuterons,

$$D^2+D^2=H^1+T^3 \qquad (1)$$

W. F. Libby and A. V. Grosse showed that it is present in natural water. Neutrons produced by the action of cosmic rays probably produce this tritium by reacting with nitrogen in the high atmosphere,

$$N^{14}+n^1=C^{12}+T^3 \qquad (2)$$

Deuterium was first prepared in pure form by G. N. Lewis using the electrolytic method of concentration discovered by E. W. Washburn. When a water solution of an electrolyte (NaOH usually) is electrolyzed, the hydrogen produced contains a smaller fraction of deuterium than the water and hence deuterium is concentrated in the residue. Very nearly pure deuterium oxide (heavy water) is secured when the residue is reduced to $\frac{1}{100,000}$ of the original water. This method of preparation was used before World War II for the commercial preparation of D_2O and later in Norway for the large-scale preparation.

During the war other methods for the preparation of D_2O were devised and subsequently used to produce large quantities of this substance. These methods depend upon the substantial differences in chemical and physical properties of the compounds of protium and deuterium. F. G. Brickwedde used the distillation of liquid hydrogen to produce hydrogen deuteride (HD) and studied its properties (*see* below).

Tritium is produced most effectively by the nuclear reaction between Li^6 and neutrons from nuclear fission reactors; *i.e.*,

$$Li^6+n^1=He^4+T^3 \qquad (3)$$

The compounds of the three hydrogen isotopes differ quantitatively in their physical properties though they are very similar to each other qualitatively. This is shown by the physical properties of the waters (*see* Table II) and of the elementary substances (*see* Table III). The same is true of their chemical properties as is illustrated by the exchange reactions,

$$HD+H_2O=H_2+HDO \qquad K \text{ (at } 25^\circ \text{ C.)}=3.6$$
$$HT+H_2O=H_2+HTO \qquad K \text{ (at } 25^\circ \text{ C.)}=6.0$$

If the protium and deuterium or tritium compounds had exactly the same chemical properties, the equilibrium constant for each reaction would be unity. Since both constants are greater than unity the ratios of the isotopes D/H and T/H are less in the hydrogen gases than in the corresponding waters when equilibrium is established. Similar differences are characteristic of other exchange reactions of this type. Such differences in properties are potentially useful for devising separation processes for protium and deuterium.

The velocities of reactions of the compounds containing deuterium or tritium are usually less than those in which protium is present and these differences are often large. Protium reacts 13.4

times as rapidly with chlorine at 0° C. than does deuterium.

The nucleus of the deuterium atom, the deuteron, proved to be especially useful in understanding the structure of atomic nuclei. It consists of one proton and one neutron and hence is the nuclear two-body problem just as the hydrogen atom consisting of one nucleus and one electron is the two-body problem of atomic structure and theory. Because of the comparative simplicity of the theoretical problem it has been possible to compare theoretical calculations effectively with observational data. The theory shows that the attractive forces between the neutron and proton are very short range in character and cannot follow any inverse square law. They appear to be the meson forces introduced by H. Yukawa. The normal state of the deuteron is $^3S_1$, with a binding energy of 2,186,000 electron volts. The symbol signifies that the spins of the proton and neutron composing the deuteron are parallel and add vectorially to one unit of spin. This is the only stable

TABLE II.—*Physical Properties of the Waters*

	D_2O	H_2O
Specific gravity $d_{25}^{25°}$	1.10775	1.00000
Melting point (° C.)	3.81	0
Boiling point (° C.)	101.41	100
Temperature of maximum density (° C.)	11.2	3.98
Critical temperature (° C.)	371.5	374.2
Critical pressure (atm.)	218.6	218.5
Critical density (g./ml.)	0.363	0.325

TABLE III.—*Physical Properties of the Elementary Substances*

	H_2	DH	D_2	T_2
Gram molecular volume of the solid (c.c.) at the triple point (° K.)	23.25	21.84	20.48	—
Triple point, ° K.	13.96	16.60	18.73	20.62
Vapour pressure at triple point (mm.)	54.0	92.8	128.6	162.0
Boiling point (° K.)	20.39	22.13	23.67	25.04
Heat of fusion at triple poiot	28.0	38.1	47.0	—
Heat of vaporization (cal./mol. at temperature shown)	216. (20.39° K.)	257. (22.54° K.)	293. (23.67° K.)	333. (25.04° K.)

state. The triton consists of two neutrons and one proton and already presents a three body problem of much greater complexity, but still of great usefulness in these problems.

The biological effects of deuterium oxide are of considerable interest. It has been established that neither plants nor animals continue to live and thrive in water containing deuterium oxide of high concentrations. In the early 1960s, no case of acclimatization to the deuterium oxide was known.

Both deuterium and tritium are very useful as isotopic tracers in the investigation of chemical and biochemical reactions, although the rather marked differences in chemical properties are sometimes troublesome (more so in the case of tritium than in that of deuterium). Deuterium particularly has been used in this way since it is readily available and easy to analyze. These tracers made possible a much greater understanding of biochemical processes. In general the heavier isotopes of hydrogen have proved to be of interest in so many aspects of the chemistry of hydrogen that no general review is possible since an adequate review would cover the entire chemistry of the element.

Deuterium oxide is useful in atomic energy engineering problems as a moderator in reactors. It has the advantage of being a liquid which absorbs neutrons only slightly, with an absorption cross section of only 0.00002×10^{-24} cm.^{2} for D_2O as compared with 0.6×10^{-24} cm.^{2} for H_2O.

Because of their low atomic numbers, *i.e.*, charges on their nuclei, deuterium and tritium are of interest in connection with thermonuclear reactions. The mass change in reaction (1) is 0.004285 g., and using the relativity relation between mass and energy, namely, $E = mc^2$, this gives 4.5×10^{13} calories per gram atom of deuterium. Thus about 0.1% of the mass is converted to heat energy. Tritium is likewise capable of liberating large quantities of energy but must be produced by costly processes, while deuterium is relatively inexpensive.

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(H. C. U.)

DEUTERONOMY (in the Hebrew Bible, DEVARIM), the fifth and last book of the Law, or Pentateuch, in the Old Testament. The name is derived from a mistranslation in the Greek Septuagint of the Hebrew term *Mishneh hat-Torah*, "copy of the Law," found in Deut. xvii, 18 (*cf.* Josh. viii, 32). The Greek name apparently meant "the second Law." The book purports to consist largely of speeches of Moses delivered in the plains of Moab just before his death; the theory of the book is apparently that the first Law given 38 years earlier at Horeb was confined to the "Ten Words" (*see* DECALOGUE), and that the present precepts and exhortations are offered for life in the land of Canaan which Israel will soon enter.

Outline.—The book falls into the following well-marked divisions:

i, 1–iv, 43:	introductory discourse by Moses, mainly a historical retrospect of the journey of Israel from Horeb to the place where he was speaking
iv, 44–xi, 32:	a second introduction, consisting of a repetition of the Decalogue and an exhortation to observe the Law
xii–xxviii:	a code containing both religious and civil laws, and including in ch. xxvii instructions for the solemn ratification of the Law after the conquest of Canaan
xxix–xxxi:	concluding exhortation, with Moses' farewell to Israel
xxxii–xxxiii:	two poems ascribed to Moses, the latter being a "blessing," or collection of tribal songs, similar in form to Gen. xlix
xxxiv:	death and burial of Moses

The tone and style of Deuteronomy are very clearly marked, and are fairly homogeneous throughout the book. It is not a legal code in the usual sense, since it includes repeated exhortations to Israel and explanations as to why the people should keep the Law. Because of its strongly homiletical tone, it has been aptly described by Gerhard von Rad as "preached law." The whole has a strong humanitarian outlook, manifested both in modifications of existing laws and in the promulgation of new regulations.

Themes.—Deuteronomy has a very lofty set of religious teachings, usually set forth with clarity and force and found in various parts of the book. Yahweh is the only God for Israel, and he is a divine being of both power and grace. The only passage in which monotheism is clearly expressed is in iv, 35–39—probably a later addition to the original work—where it is said: "The Lord is God; there is no other besides him." On the whole the book is concerned to teach not that Yahweh is the God of the entire world but that he is the God of Israel. He has chosen Israel to be a people holy to him. He led them out of Egyptian slavery and has led them through the wilderness; now he is about to give them the land of Canaan as their inheritance. The reason for the Lord's choice of Israel was not her merit or her size but rather his gracious love for the nation. Deuteronomy says this clearly in several passages; for example, "The Lord [Yahweh] your God has chosen you to be a people for his own possession, out of all the peoples that are on the face of the earth. It was not because you were more in number than any other people that the Lord set his love upon you and chose you, for you were the fewest of all peoples; but it is because the Lord loves you, and is keeping the oath which he swore to your fathers" (vii, 6–8; *cf.* also iv, 37; x, 15).

Deuteronomy emphasizes the promise that Yahweh will destroy the original inhabitants of the land he is about to give his chosen people. Thus the book places much stress upon the ancient institution of the "holy war," which had existed during the period of the judges and through the time of David. In their concept of the holy war, the Israelites believed that Yahweh himself would fight for them and destroy their enemies. The warriors had to

consecrate themselves to him, but the number of warriors was not in itself important, since the Lord was thought of as the principal agent in battle. Thus Deuteronomy has a number of regulations regarding war in xx–xxv, and the principle of the holy war is set forth in vii, 16–26; ix, 1–5; xxxi, 3–8. It is possible that the authors thought of this institution as being directed against the Assyrians and other enemies of their own age.

Israel is expected to worship Yahweh both by a purified ritual and by a high social morality. Though Deuteronomy often enjoins Israel to fear Yahweh, this does not mean so much dread and terror before his power as reverence arising from love and gratitude for what he has done for Israel in the past. The basic attitude is expressed in vi, 5: "you shall love the Lord your God with all your heart, and with all your soul, and with all your might."

The statutes or legal prescriptions of Deuteronomy cover a great variety of subjects, including both religious duties and moral or social obligations. Israel is to worship God by bringing tithes and offerings, observing the three festivals described in ch. xvi, and withal by a pure and properly motivated cult. Israel must also worship Yahweh by practising justice in the law courts, honesty in commercial dealings, good family life and so on. Generosity and charity toward the unfortunate members of society are repeatedly enjoined. In this book the teachings of Amos, Hosea and other prophets become crystallized in law.

Yet Deuteronomy insists that the laws it contains are not visionary but quite practicable. Israel can obey the Lord: "For this commandment which I command you this day is not too hard for you, neither is it far off. . . . But the word is very near you; it is in your mouth and in your heart, so that you can do it" (xxx, 11, 14).

The principle of divine retribution is important. The righteous God rewards with temporal blessings those who obey him and punishes those who disobey. This is set forth most fully in ch. xxviii; it is a basic principle of the Deuteronomic history.

There is an element of exclusiveness or particularism in this book that is not attractive, but it can be understood in the light of the book's origin and purpose. The law is for the Israelite, and Yahweh is the God of Israel. The relationship of Yahweh to other nations is rarely mentioned, but there are passages that express antagonism toward foreigners (xv, 3; xxiii, 3–6, 20). As a program for the reforms of Josiah, Deuteronomy could not be expected to show the universalism found in some parts of the Old Testament.

Literary History.—Though it appears to consist of speeches by Moses, Deuteronomy does not claim to have been written by him, and the last chapter recounts his death and burial. The theological outlook and the type of society presupposed by the regulations it contains make it most unlikely that the book is from the Mosaic age. Most modern Old Testament scholars believe that it is the third in the four strands that comprise the Pentateuch, the two preceding it being "J" and "E" and the one that follows being "P" (*see* PENTATEUCH).

Specifically, Deuteronomy in its original form is believed to have been the "book of the Law" or "book of the covenant" that was found in the Jerusalem Temple in the 18th year of King Josiah, 621 B.C., and made the basis of far-reaching religious and civil reforms. This view, first propounded by W. M. L. de Wette in 1805, has come to be accepted by the majority of Old Testament scholars. It rests upon the fact that the reforms of Josiah, as described in II Kings xxii–xxiii, correspond in large measure to the prescriptions of Deuteronomy. They involved the centralization of sacrificial worship in the Temple at Jerusalem, the purification of the cultus from foreign influences and the renewal of the convenant between Israel and Yahweh.

It is not certain how much of the present Book of Deuteronomy constituted the original nucleus found in 621 B.C. It may have been iv, 44–xxvi, xxviii. Ch. xxvii, xxix–xxxi, xxxii–xxxiii and xxxiv are apparently later additions, the dates of which cannot be accurately determined. The present introduction to the whole book, i, 1–iv, 43, may have been written to serve as an introduction to the Deuteronomic history, which was compiled in the 6th century B.C.

The question as to the origin and authorship of Deuteronomy, however, is not settled simply by stating that the book in its original form constituted the basis for Josiah's reforms. According to II Kings xxii, 8, Hilkiah the high priest reported to a royal official that he had "found" the book of the Law in the Temple. Why was it there? Who had put it in that place? When was the book written? Widely differing answers have been given to these questions.

Deuteronomy undoubtedly contains old laws, some of which are similar to those in the covenant code, Ex. xxi–xxiii. Some of the practices it enjoins may be ancient, though they are not known from other sources. A law such as that in xvi, 21, which forbids the planting of any tree as an Asherah beside the altar of Yahweh, must have originated in a time before centralization of worship in a single sanctuary was envisaged. On the other hand, the sections in Deuteronomy concerning matters such as prophets (xiii, 1–5; xviii, 9–22), kings (xvii, 14–20) and divorce (xxiv, 1–4) must be relatively late.

The theory that is perhaps most widely held is that the original Deuteronomy was written by someone (or a group) living in the reign of Manasseh (*c.* 692–*c.* 638 B.C.), a period when prophets were persecuted and the religion of Israel was suffering a serious decline. Deuteronomy was composed as a compromise of priestly and prophetic ideals of religion, and then set aside to be brought forth at the first opportune moment. This moment appeared with the 18th year of Josiah. Whether the book was deposited in the Temple and actually found there at a later time, or whether it was planted there and intentionally "found" by a priest, no one can say. In any event, there was no element of pious fraud involved.

Since King Hezekiah (*c.* 715–*c.* 686 B.C.) made certain religious reforms similar to those of Josiah (II Kings xviii, 3–6; *cf.* II Chron. xxix–xxxi), it has been conjectured that Deuteronomy may have originated in his reign, or that the book may have been the result of the experience with the short-lived reform under Hezekiah.

A few interpreters of Deuteronomy have placed the origin of the book, or of its original nucleus, much earlier than the 7th century, and some have placed it later than Josiah. Deuteronomy does not name Jerusalem as the place where sacrifice is to be offered, and passages such as xi, 26–32 and xxvii seem to imply centralization in the northern kingdom, at Shechem, rather than at Jerusalem. Some Old Testament scholars believe that the original work was composed in the period of the early monarchy in north Israel, and was concerned with cultic purity rather than with cultic unity; Deut. xii, 1–7 is an addition to the original code, and the phrase usually translated "the place which the Lord your God will choose" should be rendered "every place which the Lord your God will choose." According to other scholars, the ultimate source of the Deuteronomic tradition was the sanctuary at Shechem.

The view has been advanced that Deuteronomy originated with the rural Levites, who were teachers of the laity and had access to priestly traditions. They acted on behalf of the "people of the land," the property-owning, free citizens of the land, who were interested in reviving the old institution of the holy war. In this case, centralization of worship and prophetic elements were not important constituents of the original work.

On the other hand, a few scholars date Deuteronomy later than Josiah, and view it as the product of that king's reforms rather than their basis. They emphasize the impracticality of some of the regulations of the book, believing that they originated with visionary priests in the small land of Judah in the postexilic period, rather than in the pre-exilic period when the nation was larger and had its own king. These objections to a 7th-century date for Deuteronomy can be met by pointing out that the book embodies a program rather than a law code, and that every reformation necessarily includes both old and new elements—and some of the latter may in time prove to be impractical.

If it is recognized that the Book of Deuteronomy includes some old laws and traditions, stemming very likely from the northern kingdom, and that it was by no means a completely new work, there is no objection to the view that the form of the book used by

Josiah comes from the latter part of the 8th century, or the early part of the 7th century (perhaps from the reign of Manasseh); that it represents a compromise or harmonization of both priestly and prophetic viewpoints; and that it was "found" at an opportune time when Josiah was favourable to a revival of what was believed to be the old Yahwistic faith. The reformation concerned itself with both cultic unity and cultic purity, and included civil as well as religious reforms. The opportunity for such reforms was made in part by the decline of Assyrian power in Palestine. Josiah promoted independence from Assyria, and in fact extended Judaean political control over territory that had been in the Assyrian province of Samaria. Centralization of political power in Jerusalem went along with centralization of worship in the Jerusalem Temple.

Influence.—Deuteronomy had great influence in Hebrew-Jewish history. It forms a middle point in the history of Old Testament literature: before it were the Yahwist and Elohist documents (*see* PENTATEUCH) and most of the great prophets of Israel; after it was to come a new era in the religion of Israel, when the written book and the priesthood were to have commanding roles. It is the one document of the Pentateuch whose date of publication or promulgation can be fixed with approximate precision.

It is probable, too, that Deuteronomy was the first part of the Old Testament to be considered as "Scripture." It had the sanction of both priestly and prophetic circles, and was apparently enforced by royal authority as a kind of constitution of the nation. "For the first time in the history of mankind," said Robert H. Pfeiffer, "a book was canonized as sacred scripture" (*Introduction to the Old Testament*, p. 52, Harper & Brothers, New York, 1941).

Deuteronomy provided some of the inspiration for the writing of an extensive history of Israel. An editor (or editors) imbued with the spirit and ideas of Deuteronomy, and in the same style as that book, wrote and compiled the long history that is now contained in the books of Joshua, Judges, I–II Samuel and I–II Kings. Deut. i, 1–iv, 43 may have been written to serve as the introduction to the complete corpus Deuteronomy–II Kings. The two important Deuteronomic doctrines of cultic centralization and divine retribution are basic in this history. The same editor or editors compiled an edition of the book of Jeremiah.

Deuteronomy is one of the four books of the Old Testament that are cited most frequently in the New Testament (the others being Genesis, Isaiah and Psalms). Jesus is reported to have quoted it three times in his temptation (Matt. iv, 1–11, quoting Deut. viii, 3; vi, 16; and vi, 13). The first commandment is cited from Deut. vi, 5 (Matt. xxii, 37; Mark xii, 29–30). Deuteronomy is quoted 83 times in the New Testament, and only six New Testament books fail to quote it.

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DEUX-SÈVRES, an inland *département* of western France, formed in 1790 mainly from Poitou, together with small portions of Saintonge and Aunis (*qq.v.*). It is bounded north by Maine-et-Loire, east by Vienne, south by Charente and Charente-Maritime and west by Vendée. Pop. (1954) 312,842. Area 6,055 sq.km. (2,338 sq.mi.). The Sèvre Niortaise crosses the south of the *département* toward its mouth in the Bay of Biscay and the north is drained to the Loire river by the Sèvre Nantaise and the Thouet, the low-lying watershed area forming the western part of the gate of Poitou which connects the fertile, populous lowlands of north and south France between the Massif Central and the Armorican massif. The eastern part of the extension of the Armorican massif south of the Loire, in the district known as the Gâtine, is included in Deux-Sèvres. It is hilly country with poor soils and, as its name indicates, is occupied by extensive stretches of heath and degraded forest. Farther east is the Plaine, highly cultivated farmland on smooth, dry limestone country. It is traditionally cornland, with old-established village clusters. In the southwest the *département* includes the inland portion of the Marais Poitevin, reclaimed marshland along the alluvial flats of the Sèvre Niortaise below Niort. Market gardens and lush meadows occupy the checkerboard of plots lined by drainage ditches.

The climate has mild winters and warm summers and is within the northern limit of cultivation of the vine. Wheat, potatoes and fodder crops are important features of the mixed farming practised in this part of France, and a variety of livestock is maintained. More specialized farming is especially concerned with co-operative dairying in some districts and with market gardening near Niort. The *département* is predominantly rural, with little mineral wealth or manufacturing, and its largest town and capital, Niort (*q.v.*), has only 30,199 inhabitants (1954). There is still a considerable Protestant element in the population in some districts. Bressuire, Niort and Parthenay, the centres of its three *arrondissements*, are market towns that have grown up round castles occupying naturally defensible sites. Melle has three fine Romanesque churches. Deux-Sèvres forms the western part of the bishopric of Poitiers and also comes under its *académie* (educational division) and court of appeal. (AR. E. S.)

DEVA (DEWA), the Sanskrit word for god. Whereas in Vedic India the *devas* were the gods of polytheism (*e.g.*, Indra, Agni, Soma), in the later monotheistic or atheistic systems (Brahmanism, Hinduism, Buddhism, Jainism) they became subordinate to the one supreme being (who was never called *deva*, but *Ishvara* [lord], etc.) and/or subject to *samsara* (rebirth). In Iran, under the Iranian form of the name, *daeva*, their cult was opposed by Zoroaster and in Zoroastrianism, which spread all over Iran prior to Islam, they were regarded as demons. They still survive as such in the *divs* of Persian folklore, especially through Firdousi's famous epic, *Shahnama*. (J. D.-G.)

DEVADATTA, a cousin of the Buddha. Both he and Ananda (*q.v.*), who may have been his brother, joined the brotherhood in the 20th year of the Buddha's ministry. Devadatta, 15 years afterward, having won over the crown prince of Magadha, Ajatasattu, to his side, made a formal proposition, at the meeting of the order, that the Buddha should retire and hand over the leadership to Devadatta. This proposal was rejected, and Devadatta is said in the tradition to have successfully instigated the prince to the execution of his aged father and to have made three abortive attempts to bring about the death of the Buddha. Shortly afterward, relying upon the feeling of the people in favour of asceticism, he brought forward four propositions for ascetic rules to be imposed on the order. These being refused, he appealed to the people, started an order of his own, and persuaded over 500 of the Buddha's community to join in the secession. Nothing further is heard about the success or otherwise of the new order, but it may possibly be referred to under the name of the Gotamakas, in the *Anguttara* (see *Dialogues of the Buddha*, i, 222), for Devadatta's family name was Gotama (Gautama). His community was certainly still in existence in the 4th century A.D., for it is especially mentioned by Fa-hsien (*q.v.*), the Chinese pilgrim. It possibly lasted till the 7th century, for Hsuan Tsang (*q.v.*) mentions that in a monastery in Bengal the monks then followed a certain regulation of Devadatta's. There is no mention in the canon as to how or when Devadatta died; but the commentary on the *Jātaka*, written in the 5th century A.D., has preserved a tradition that he was swallowed up by the earth near Savatthi, when on his way to ask pardon of the Buddha. The spot where this occurred was shown to both Fa-hsien and Hsuan Tsang.

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DE VALERA, EAMON (1882–), Irish statesman, was head of his country's government with little interruption between 1932 and 1959, when he became president of the Republic of Ireland. He was born in New York city on Oct. 14, 1882. His father, a Spanish artist, having died, De Valera was sent as an infant to his mother's family in a labourer's cottage in County Limerick. Educated at the local national school and at Blackrock college,

Dublin, he graduated in the Royal university and became a teacher of mathematics and an ardent supporter of the Irish language revival. In 1913 he joined the Irish Volunteers organized to resist the Ulster Unionist campaign, and in the Dublin uprising of Easter 1916 he commanded one of the occupied buildings and was the last commander to surrender. Because of his U.S. birth he escaped execution, but was sentenced to penal servitude.

Released in 1917 but arrested again and deported to England in May 1918, De Valera was acclaimed as the chief survivor of the uprising and elected president of the Sinn Fein party, which won three-quarters of all the Irish constituencies in Dec. 1918. After a dramatic escape from Lincoln jail in Feb. 1919, he went in disguise to the United States, where he collected funds. He returned to Ireland before military repression ended with the truce of 1921 and appointed plenipotentiaries to negotiate in London, but he repudiated the treaty which they signed, because it accepted the exclusion of "Northern Ireland" and imposed an oath of allegiance to the British crown.

Dail eireann (the assembly of Ireland) ratified the treaty by a small majority, but De Valera supported the republican resistance in the ensuing civil war. W. T. Cosgrave's Irish Free State ministry imprisoned him, but he was released in 1923 and then organized a Republican opposition party that would not sit in the *dail*. In 1927 he persuaded his followers to sign the oath of allegiance as "an empty political formula," and his new Fianna Fail party then entered the *dail*. They demanded abolition of the oath of allegiance, of the governor general and the senate as then constituted, and retention of the land purchase annuities payable to Great Britain. The Cosgrave ministry was defeated by Fianna Fail in 1932, and De Valera, as head of the new ministry, embarked quickly on severing connections with Great Britain. He withheld payment of the land annuities, and the economic war resulted. Increasing retaliation by both sides enabled him to develop his program of austere national self-sufficiency in an Irish-speaking Ireland, while building up industries behind protective tariffs. In 1937 the Free State declared itself a sovereign state, as Ireland or Eire, conceding voluntary allegiance to the British crown.

De Valera's prestige was enhanced by his success as president of the League of Nations council in 1932 and its assembly in 1938. The menace of war in Europe induced Neville Chamberlain in 1938 to conclude the "economic war" with mutual concessions. Great Britain relinquished the naval bases of Cobh, Berehaven and Lough Swilly, but De Valera gave no promise that Britain could use them in case of war. In Sept. 1939 he proclaimed at once that Ireland would remain neutral and resist attack from any quarter. His policy, backed by the enrolment of a formidable force for home defense, won general support in Ireland. Besides avoiding the burdens and destruction of war, he had brought temporary prosperity, and he retained office after repeated elections.

In 1948 a reaction against the long monopoly of power and patronage by De Valera's party enabled the opposition, with the help of smaller parties, to form an interparty government under John A. Costello. But this precarious coalition collapsed within three years, and De Valera resumed office until 1954, when he appealed unsuccessfully for a fresh mandate, and Costello formed his second interparty ministry. No clearly defined difference now existed between the opposing parties, in face of rising prices, continued emigration and a backward agriculture. But De Valera claimed that a strong single party government was indispensable and that all coalitions must be weak and insecure. On this plea, he obtained in March 1957 the over-all majority which he demanded, and he formed another ministry, consisting chiefly of his contemporaries in the early struggle for national independence. In 1959 De Valera agreed to stand as a candidate for the presidency. He resigned his position as *Taoiseach* (head of government) and leader of the Fianna Fail party. In June he was elected by 538,003 votes as against 417,536 for his opponent, Gen. S. MacEoin. He was installed as president on June 25, 1959.

De Valera's command of public confidence owed little to popular appeal, but rested upon his long record of austere integrity and patriotism and his sagacity as a political leader. His academic attainments and status also inspired wide respect; he became chancellor of the National University of Ireland in 1921 and was founder of the Dublin Institute of Advanced Studies. His greatest handicap was encroaching blindness, which for years made him almost unable to read or to see those whom he met. He was inevitably thrown back upon himself and his memories, relying largely upon the colleagues of early years.

See Mary C. Bromage, *De Valera and the March of a Nation* (1956); Dorothy MacArdle, *The Irish Republic*, 4th ed. (1951). (D. G.)

DE VALOIS, DAME NINETTE (Edris Stannus; 1898–), Irish dancer and choreographer, was founder and has since directed the ballet school and the company at Sadler's Wells that in Oct. 1956 became the Royal Ballet. She was born at Blessington, County Wicklow, Ire., on June 6, 1898. After a varied experience as a dancer, in pantomime, revue and opera, she joined the Diaghilev company as a soloist (1923–26) and after that as a guest artist. She then founded her own school in London and produced for Lennox Robinson at the Abbey theatre in Dublin and for Terence Gray at the Festival theatre in Cambridge. It was the success of her ballet *Job* for the Camargo society in 1930, followed by her association with Lilian Baylis at Sadler's Wells the year after, that led to the founding there of the ballet school and the company whose story she has traced in *Invitation to the Ballet* (1937) and *Come Dance With Me* (1957). Besides actively directing the company that she created, Ninette de Valois composed a remarkable series of ballets, typically English in inspiration, *The Rake's Progress* (1935), inspired by William Hogarth, and *The Prospect Before Us* (1940), after Thomas Rowlandson. She was created dame commander of the order of the British empire in 1951. (A. L. Hl.)

DEVELOPMENT, ANIMAL. During its lifetime each animal undergoes progressive changes that constitute its development. These changes probably occur continuously, but they proceed at very different rates at different times of life. They are conspicuously rapid in the earliest phase, in the embryo, so much so that the term "development" is often tacitly confined to this period. The concentration of so much change at the beginning of an animal's life is the outcome of the way that most new individuals arise.

Reproduction.—*Sexual.*—Sexual reproduction is paramount among animals. It is a mechanism by which a selection of the hereditary factors, the genes, of two individuals are mixed. The advantages to a species of having the offspring differ from their parents by mixing of the genes are enormous. Sexual reproduction achieves the maintenance of plentiful variability in the population and also provides opportunity for combining together the successful characteristics of different lineages. Natural selection (*see* Evolution, Organic; Selection) gains, thereby, a rich substrate to work on. Probably only in rather special circumstances can an animal species afford to dispense with sexual reproduction for long, in spite of its developmental complications. Sexual reproduction necessarily involves the fusion of one cell from each parent at fertilization; the outcome is a single cell, which is the new individual.

The multicellular animals therefore first appear in the world in a form extraordinarily different from their parents; they start as single-celled, motionless, spherical eggs. A period of rapid change has to ensue to produce an organism that can begin to obtain its living from the world around it without dependence on its own necessarily limited stores or on the succour of its parents.

Asexual.—Asexual reproduction, though uncommon as compared with sexual, is found as a supplementary reproductive method in a wide variety of animals. It usually entails a much less extensive development of its products; but it varies widely, from fission of a sea anemone into two organisms, which requires relatively little reconstruction, to the budding of ascidians, which requires almost as much as does embryonic development. (*See* Reproduction.)

Embryonic Development.—*Cell Division and Differentiation.*—The embryonic period of multicellular animals, during which very rapid transformation is made, essentially involves the building up of a large population of cells by repeated cell division and the syntheses of the special materials that distinguish the different tissues and organs of the functioning animal. In the vertebrate,

for instance, hemoglobin must be formed in the red blood cells, but keratin in the epidermis.

In all animals the construction of a large cellular population starts quickly after fertilization and during an initial period of cleavage it is the most conspicuous change. The development by the different regions of the embryo of their specific compositions, the process of differentiation, follows. Curiously enough it is unusual for cells to begin their differentiation in the precise relative position that they will ultimately occupy in the functional animal. During the process there is much movement of cells, in definite patterns, by means of their own powers of locomotion. Multicellular animals in all their developmental processes use cell locomotion to achieve the proper arrangement of cells; in this they are sharply distinct from higher plants. (*See* EMBRYOLOGY.)

Larval Phases.—When an animal has developed an organization sufficient to enable it to live off its surroundings, its rate of development is likely to slow down greatly, but it may not remain slow. For many animals the outcome of embryonic development is not a small edition of the adult, but a larva, an animal sexually immature and able to fend for itself, though in quite a different way from the adult. Often such larvae are the outcome of the development of an egg with limited food resources, and they occupy an ecological niche suitable for the very small, where they can feed and grow. Often larvae serve to disperse a species whose adults are sedentary.

The transitions from larval to adult form may involve a reorganization, a metamorphosis, as swift and radical as that of an embryo. An additional complication is that much larval tissue may have to be destroyed (destruction of temporary embryonic tissues is also quite common). An alternative way of achieving the same progression from niche to niche is to interpolate an episode of reproduction at each transition and in this way develop a suitably adapted phase of the species. Such an "alternation of generations" is highly characteristic of parasites.

Larval phases are particularly interesting to the student of evolution because, as W. Garstang and Sir Gavin de Beer have emphasized, if sexual maturity is shifted forward to the larva, it can become the starting point for a new line of evolution of organisms already adapted to a niche and now freed from the selection pressure on the old adult form. (*See* METAMORPHOSIS.)

Postembryonic Development.—Sexual maturation, with formation of associated secondary sexual characters, is rarely a part of embryonic development. It is deferred till later, and usually involves then a development spurt analogous to that of metamorphosis. Developmental spurts, since they involve synchronous change throughout the body, are often co-ordinated by hormones circulating in the blood (as with metamorphosis in Amphibia and insects, and sexual maturation in vertebrates).

Yet another kind of development spurt in postembryonic life must be noted. The majority of animals have powers of regeneration by which they can restore damaged or destroyed parts. The regeneration of the limb of a newt is not the same as its embryonic development, but it involves many of the same basic processes: division, locomotion and differentiation of cells. (*See* REGENERATION.)

These spurts of development apart, it seems improbable that any animal settles down to a state of complete immunity from progressive change. In many species it is known that growth, inevitably involving reorganization, is continuous, and in many, perhaps most, slow aging obviously occurs.

Aging.—The progress of aging and senescence is closely bound up with the cumulative effect of environmental damage, although there is also an intrinsic change in many cases. How far other developmental changes are referable to concomitant change in an individual's surroundings may now be considered. It is clear that the common course of embryonic development in members of a species is rarely referable to systematic environmental change, though instances could be found in viviparous animals, where the environment is provided by the parent and therefore subject to controlled change. Later in development environmental change is more important, in stimulating the onset of sexual maturity, for example; and learning is probably to be thought of as development. But examples are not easy to find, and on the whole, development seems to be very largely self-generating. (*See* also DEATH [BIOLOGICAL].)

Mechanisms of Development.—What the mechanisms of development are is best known for the embryo. It seems that the single cell from which the individual starts life is always different in its various parts and the cells that arise from it embody these differences, which may be of quite a simple kind. Interactions between the various parts of the embryo (*e.g.*, inductions) then elaborate the differences and after some time the special composition found in each of the parts of the functioning adult is laid down. The developmental interaction of cells and regions of the embryo decreases as development proceeds, and in some species their autonomy may be already high at the beginning. In fact, interaction in its different forms is so prominent in the embryo that it has been the main object of study of experimental embryologists.

The similarity of the development of all the individuals of a species is, as is known from genetics (*q.v.*), largely referable to the fact that they have similar sets of genes in the nuclei of their cells. Modern genetics strongly suggests that the primary function of each gene is to determine the exact structure of one particular protein, and the proteins hold a key position in the make-up of organisms since enzymes are proteins. On the other hand, within a single individual there are many kinds of cells, each kind characterized by specific proteins (though having many proteins in common). It appears, therefore, that differentiation must involve the activation or inactivation of certain genes in the cells of particular regions of the embryo and that the interactions within the early embryo are largely directed to bringing this about. The discovery of how gene activity is so controlled is likely to be the next major advance in genetics.

This account of development has concerned itself only with multicellular animals. It remains to be added that unicellular animals, whether reproducing sexually or asexually, show development too, which in certain forms with elaborate structure, such as ciliates, may be quite complicated.

See also EMBRYOLOGY, CHEMICAL; EMBRYOLOGY, EXPERIMENTAL; EMBRYOLOGY, HUMAN; EMBRYOS, BEHAVIOUR OF VERTEBRATE; GROWTH.

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(MI. A.)

DEVELOPMENT AREAS. This term denotes areas created in Great Britain by the Distribution of Industry act, 1945. This act was passed to rehabilitate the industrial life of certain parts of Great Britain which, because of the decline of their staple industries and the virtual lack of new industries during the years between World Wars I and II, suffered abnormal unemployment. Legislation designed to stimulate the building of factories and to promote the industrial development of these areas was passed in 1934, 1936 and 1937. The powers made available by it, however, were so limited and their use by the government was so meagre that few factories were erected. Not more than 12,000 persons were employed in them in 1939.

The Distribution of Industry act, 1945, stemmed from the report (Cmd. 6157) of the Royal Commission on the Distribution of the Industrial Population published in 1940 and the White paper on employment policy (Cmd. 6527) published in 1944. The former favoured control of the location of industry by the government as a means of injecting new industry into the special areas. The latter announced that the government would attack the problem of unemployment in "particular industries and areas" in three ways: "By so influencing the location of new enterprises as to diversify the industrial composition of areas which are particularly vulnerable to unemployment. By removing obstacles to the transfer of workers from one area to another, and from one occupation to another. By providing training facilities to fit workers from declining industries for jobs in expanding industries."

The 1945 act was concerned with the first of these. The act named four development areas embodying the former special

areas, but adding certain towns and districts not previously contained within those areas. The four areas were northeastern (Northumberland and Durham and the town of Middlesbrough together with surrounding districts in north Yorkshire); west Cumberland; south Wales (Glamorganshire, parts of Pembrokeshire, Brecknockshire and Monmouthshire); and Scottish (Dunbartonshire, Lanarkshire, Renfrewshire and parts of Ayrshire, Dumfriesshire, Stirlingshire, West Lothian, Midlothian and town of Dundee). In 1946, two more development areas were added: Wrexham (town of Wrexham and surrounding districts) and south Lancashire (towns of Wigan and St. Helens, together with surrounding districts). Another two followed in 1949: Merseyside (towns of Liverpool, Bootle, Birkenhead and Wallasey and adjacent parts of Lancashire and Cheshire) and north Scotland (towns of Inverness, Cromarty, Dingwall, Fortrose, Invergordon and Tain and nearby parishes). In 1953 the development area of north Lancashire was created (towns of Nelson, Colne and Burnley and nearby parts of Lancashire, the district of Barnoldswick and adjacent districts in the West Riding of Yorkshire).

The powers provided by the 1945 act included the building in the development areas (by industrial estate companies to be set up by the government) of factories to let; the improvement of public utility services; the reclamation of derelict land and its conversion into industrial sites; treasury grants and loans to firms which proposed to undertake industrial projects in the development areas and could satisfy the treasury that alternative sources of finance were not available; and the requirement that all firms should notify the government of proposed new industrial buildings of 10,000 sq.ft. or more. These powers were vested in the board of trade.

As events turned out, up to 1948 the board of trade found that its most important power derived from the necessity of firms to obtain a licence to build factories, due to the shortage of building materials immediately after World War II. The board of trade favoured the granting of licences to firms willing to build in the development areas and firms readily availed themselves of this valuable preference. The board of trade was also able to induce firms to undertake projects in the development areas by according them priority in access to scarce raw materials. Other useful inducements were provided by the building of "advance" factories for rent on new industrial estates; the offer of vacated munitions factories to buy or lease; and the imposition of restraints by the board of trade upon industrial building in congested areas. These inducements, coupled with the industrial activity generated by the postwar boom and reinforced by the abundant labour available in the development areas, were very effective. By June 1948 the development areas had acquired 443 new factories and 530 factories were being erected. This represented more than one-half of the industrial building undertaken in Great Britain.

By 1948, however, shortages of building materials and industrial raw materials had eased and preferences to firms to obtain these had therefore become less effective as inducements. But the Town and Country Planning acts, 1947, provided the board of trade with a new means of influencing the location of new factories which it used effectively after mid-1948. This required that firms which applied to planning authorities to build in excess of 5,000 sq.ft. must obtain an industrial development certificate from the board of trade stating that ". . . the development in question can be carried out consistently with the proper distribution of industry." The board of trade could refuse to grant this certificate. In practice, it refused only a small proportion of applications, preferring to grant industrial development certificates freely to firms willing to build in the development areas. More important, it successfully persuaded many firms which could operate effectively in a development area to locate their new projects there instead of elsewhere. Lastly, the board of trade greatly helped firms going to the development areas to establish themselves.

Other factors that favoured the growth of industry in development areas after 1948 were their plentiful labour; government-financed factories to let at attractive rents (although this inducement became less significant after the middle 1950s, when the building of "advance' factories was given up); the reluctance of the board of trade to acquiesce in new industrial development in congested areas which could be carried out elsewhere; and, lastly, the fact that many firms which sited their projects in the development areas (by 1954 over 500 firms from other parts of Great Britain had done so) found that they could operate successfully and so encouraged other firms to copy their example.

After 1952 the development areas received a smaller proportion of industrial building than before. One reason was that until then they had had much more than their share (nearly one-half) as judged by their share of Great Britain's insured population (under one-fifth). This favourable treatment could not be expected to be continued; other parts of Great Britain also needed new industrial development, such as the new towns and other areas having abnormal unemployment. Much more important, the need to foster national economic growth caused the board of trade to assent readily to industrial projects in other parts of Great Britain which could offer advantageous locations. Nevertheless, the 443 factories completed in the development areas by mid-1948 had grown to 3,488 by the end of 1958.

How far was the industrial rehabilitation of the development areas achieved? Between 1945 and 1958 they had nearly 28% of the total industrial building completed in Great Britain. Since their share of Great Britain's labour force was only about 18%, they had more than their share of industrial building and this helped the development areas to benefit from the prosperity enjoyed by Great Britain during the postwar period. Unemployment during 1945–48 was about two-and-a-half times the average percentage figure for Great Britain, but by 1958 it had fallen to about one-and-a-half times that figure. The new industries—representing most of the 112 industries in the standard industrial classification—diversified the industrial structure: there was less dependence upon a few industries. Moreover, a number of the new industries expanded their output and employment. Their workers were trained in modern industrial techniques. This training, together with schemes introduced by the ministry of labour to transfer unemployed workers—giving effect to the second and third measures announced in the White paper on employment policy mentioned earlier—enabled such workers to find employment elsewhere. The four administrative regions containing the development areas recorded higher rates of outward migration of workers than the other seven administrative regions of Great Britain.

But the number of persons employed increased less and the number unemployed decreased less in Scotland, northeast Lancashire and Merseyside than in the development areas as a whole. Moreover, some districts did not share the prosperity of the development areas as a whole; *e.g.*, west Wales and Lanarkshire. The development areas generally were much dependent upon contracting industries such as cotton textiles, shipbuilding and agriculture and upon investment goods industries peculiarly liable to suffer when industrial depression occurs. Many new firms from other parts of the country established branches only in the development areas and these were liable to be closed in bad times. Some of the new plants in the development areas had higher costs than similar plants in other parts of Great Britain, but this drawback was probably not marked, because over one-half of the new plants were in industries successfully located in the development areas before 1945 and some others were in industries that could operate successfully in widely different parts of Great Britain.

What verdict can be passed? The development areas were substantially rehabilitated, partly because the efficiency of old industries was improved and partly because they acquired new, expanding industries. The policy initiated by the Distribution of Industry act, 1945, of controlling the location of industry to revive the development areas, met with much success.

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and Diversification of Industry in the Development Areas," *Oxford Economic Papers*, pp. 60–77 (Feb. 1956); Board of Trade, *Distribution of Industry*, Cmd. 7540 (1948). (J. Sy.)

DEVELOPMENT COMMISSION. The development commission was founded by act of parliament (1909) "to promote the economic development of the United Kingdom." It was to recommend advances for aiding and developing agriculture and rural industries, forestry (which passed to the forestry commission on its creation in 1919), the reclamation and drainage of land (which later became mainly the responsibility of other departments), the development and improvement of fisheries and the construction and improvement of harbours (which passed to the ministry of agriculture, fisheries and food and the Scottish home department under the Fisheries act, 1955). After 1921 Ireland ceased to benefit under the act. There are eight commissioners appointed by royal warrant; one retires in each year, but may be reappointed. The grants or loans recommended are made by the treasury from the development fund, into which the total amount paid by the exchequer was by the middle of the 20th century of the order of £1,500,000 annually. The commissioners' recommendations require treasury approval. Before deciding upon an application, the commissioners must receive a report from any government departments concerned. The commissioners may frame schemes themselves. They may also appoint advisory committees. Advances may be made to government departments, public authorities or educational or other institutions but not to individuals or to associations or companies trading for profit.

In 1921, the Rural Industries bureau was set up to provide an intelligence and a technical advisory service for the development of rural industries in England and Wales. It is financed from the development fund, whence grants are also made to rural community councils for work carried out under a general policy framed by the bureau. A Scottish Country Industries Development trust was created in 1935. (B. E. L.)

DEVENTER, a town in the province of Overijssel, Neth., is situated on the IJssel river, 15 km. (9 mi.) E.N.E. of Apeldoorn by road. Pop. (1957 est.) 52,678 (mun.). Deventer has many buildings of historical interest, including the 11th–16th century Grote Kerk (St. Lebuinus) with an 11th-century crypt; the Bergkerk (St. Nicolaas), partly 13th century with Romanesque towers; the Broederenkerk and the ruins of the Mariakerk (both 14th–15th century); the small provost's palace (12th–17th century) with parts of a Carolingian building; the town hall (13th century–1693); parts of the city walls (14th–15th century); the Gothic weigh house (1528), now a museum; and many 16th- and 17th-century façades of houses. The town has valuable archives and in the Athenaeum library (the municipal library) are many manuscripts dating from the 10th century onward. There is a school of tropical agriculture. Famous for its tapestry weavers and pastry bakers (*Deventer koek*), Deventer also produces books, metal, meat and flour.

Deventer was founded in the 8th century, had its heyday at the end of the 10th and the beginning of the 11th centuries and in the late middle ages. About 1500 it was famous for its five annual fairs, for its trade office at Bergen in Norway and for being the most important Dutch printing centre. The famous Latin school was attended by Erasmus as a youth. In the 14th century Deventer was the birthplace of Gerhard Groote (*q.v.*) and his religious movement known as the Brethren of the Common Life (*q.v.*). (A. C. F. K.)

DEVERS, JACOB LOUCKS (1887–), one of the highest ranking U.S. army commanders in World War II, was born in York, Pa., Sept. 8, 1887. On graduation from the U.S. Military academy at West Point in 1909, he was commissioned second lieutenant of field artillery. He was commanding general of Ft. Bragg, N.C., and the 9th infantry division in 1940, becoming in 1941 chief of the armoured force. In 1943 he was appointed commanding general, European theatre of operations, and at the year's close became commander of the North African theatre of operations and deputy supreme Allied commander, Mediterranean theatre. In Sept. 1944 he took command of the 6th army group, made up of United States and French forces. These units cleared Alsace, crossed the Rhine and pushed through southern Germany to the Austrian and Italian borders. Devers headed the army ground forces before his retirement as a full general in 1949. In 1951 he was chief military adviser of the United Nations mission to India and Pakistan. (F. C. Pe.)

DEVIL (derived from Gr. *diabolos*, "slanderer," "accuser") is the generic name for a spirit of evil, especially the supreme spirit of evil, the foe of God and man, but also for minor evil spirits or demons. This article is concerned only with the devil as the chief of the fallen angels, the supreme spirit of evil, as the source of evil in dualist systems and as the chief evil power according to the Christian faith.

In the Bible.—There is little mention of the devil in the Old Testament, though his connection with the fall of man (in Gen. iii) is clear enough, and the scattered references to him all represent him as the tempter and tormentor, the deceiver. Later, pseudepigraphical Jewish literature offers a more developed demonology with some evidence of the influence of pagan literature. General Christian belief about the devil can be summarized as follows. Men and angels were created for the beatific vision, but neither were to possess it without previous testing. The angels were created as pure spirits, endowed with supernatural life, but some of them failed in their testing through some form of self-assertion. Christ speaks of the "prince of the devils" (Matt. ix, 34) and of the "devil and his angels" (Matt. xxv, 41) and it is usually held that one devil (Lucifer, Beelzebul or Satan; *qq.v.*) seduced the rest. (Lucifer, which occurs in Scripture only in Isa. xiv, 12, where the meaning is uncertain, is said to have been his name before the fall.) In the New Testament the power of the devil is frequently mentioned, and whatever may be meant by some of the references to this power over the world and mankind (*e.g.*, Luke iv, 6) it appears clearly that the devil is the adversary, the tempter of man. The primary effect of the redemption was the undoing of Adam's sin and the destruction of the power of the devil, but God permits the devil to tempt man not directly but through his nature, through his body.

There are at least two clear references in the New Testament to the fall of the devil: in II Peter ii, 4 ("God did not spare the angels when they sinned, but cast them into hell") and in Rev. xii, 7–9 ("War arose in heaven: Michael and his angels fighting against the dragon; and the dragon and his angels fought, but they were defeated . . . and the great dragon was thrown down, that ancient serpent who is called the Devil and Satan, the deceiver of the whole world"). From this passage it appears that the "great dragon," the devil, was the leader of the fallen angels as Michael was of those who did not fall.

In Early Christian Theology.—In the early church and during the whole patristic period, although teaching on the subject appears to have been fluid, considerable influence was exerted by the apocryphal scriptures, especially the book of Enoch, which, with the help of a faulty reading in the Greek version of the Hebrew Old Testament ("the angels of God took wives with the sons of men," Gen. vi, 2), gave rise to demonologies of the oddest kind. The view that the demons are the sons of the fallen angels and human mothers is to be found in Justin Martyr, Tertullian, Cyprian, etc., but the story is given in its clearest form in the pseudo-Clementine homilies. In the east, Basil and Athanasius, following Origen, asserted that the devil is a spiritual being fallen from heaven on account of his pride and reject the stories from Enoch; Augustine in the west also held that the devil fell through pride.

In Hagiology.—In addition to this early theological speculation account must also be taken of another class of Christian literature, the lives of the first hermits who went to the Egyptian desert in the 3rd/4th centuries. The life of Anthony, written shortly after his death in 355 or 366 by Athanasius, is a document of capital importance. Here is found, so to say, the embodiment of the theological speculation about the devil that was prevalent at the time; Anthony's life is one long struggle against the devil: "the decision he had taken to serve henceforth God alone was intolerable for the devil who is the enemy of all good." Anthony is tempted in every way imaginable; he was infested (the word is

Athanasius') with attacks in such a way that those who witnessed them in broad daylight were convinced that they were real hand-to-hand encounters. At night the devil conjured up obscene visions which Anthony repelled by prayer and acts of physical penance. "And it was thus," says Athanasius, "that he who believed himself equal with God was outplayed by the adolescent." The subject of the temptations of Anthony has frequently been used in literature and art and is well known, but such manifestations, though generally in a less excessive form, are a recurrent theme in hagiographical literature in all centuries and may be patterned to some degree in, for example, the lives of St. Benedict of Nursia, many medieval saints and even as late as the 19th century in the life of St. John Vianney (the Curé d'Ars). Many of these manifestations can of course be equated with poltergeist phenomena or psychological illness; while such matters are outside the scope of this article, what is relevant here is that these recorded cases, and a host of others, are clear evidence of the beliefs held at the times at which they occurred.

Middle Ages and After.—Medieval theology contains much speculation on the subject. The Dominican school (Albertus Magnus, Thomas Aquinas, 13th century) held that the devil's first sin, fixing him in evil, was one of pride; he had been created in a state of grace and not of beatitude and his sin was not in desiring equality with God but in seeking a natural beatitude obtained by his own powers. The Franciscan school (Duns Scotus, d. 1308), on the other hand, taught that the devil's sin was in the desire for equality with God. Francisco de Suárez in the 16th century endeavoured to reconcile these views by holding that the sin of the devil consisted in the desire of his own hypostatic union with the Word. In the Protestant tradition both Luther and Calvin with the doctrine of the "slave will" (*de servo arbitrio*) necessarily gave a large part to the devil in their theology, and in Luther particularly countless statements are to be found concerning the devil, his power, brutality and manifestations.

The whole question of the devil and of his place in the Christian scheme is fraught with difficulty. Modern liberal Protestantism tends to deny the necessity of belief in a personal devil, preferring to understand the biblical and other references to him as to a personification of the principle of evil, or to recognize that the mutual action of individual sinners on one another constitutes a kingdom of sin opposed to the kingdom of God. Catholics and other Protestants, on the other hand, hold that man is tempted not only by the world and the flesh but also by the devil and justify their belief from the Bible, the teaching of the Fathers of the Church and the constant tradition of the church.

This raises two important questions: Why does God allow, and therefore give power to, the devil to tempt men, and in what manner does the devil tempt? These questions have exercised theologians at all periods. According to James, temptation is inherent in free will, but God is not to be regarded as its author (James i, 13); Paul teaches that God does not allow it beyond what the soul can endure (I Cor. x, 13). Both John Chrysostom and Thomas Aquinas have answered the question on the assumption that if God were obliged to destroy all that occasions evil he would have to destroy nearly everything. Since, effectively, the devil is an occasion of sin, and we can overcome the traps that he lays for us, temptation can be for us an opportunity for glory as it provides the occasion to overcome an opponent superior in intelligence and power. Aquinas adds that to inhibit or abolish the influence of evil spiritual forces in human life would be a violent and capricious interference with the normal effects of the causes created by God, on a par with interference with the laws of nature.

> The influence of good and evil spirits upon us is as natural as is the influence of good and bad men; the existence of evil, indeed, raises questions which ultimately we cannot answer, but granted that problem, the permission of God to the devil to tempt us raises no particular difficulty, though it may perhaps sharpen or intensify to certain minds the general problem (B. Leeming, in *Satan*, p. 37; Sheed & Ward, Ltd. 1951).

It is usually held that the devil does not know the secret thoughts and intentions of men, save to the extent that they are revealed by some outward sign—since knowledge of the hearts of men is, according to Scripture and the Fathers, an attribute of God—and that temptation is effected by the devil's power to exert influence on the imagination, nerves and physical organism. The modern psychological approach regards sin as principally a psychological disorder, and holds that forms of temptation arising from the appetites are primarily natural instincts requiring some sort of satisfaction, while mental temptations are of a more serious order; the Christian moralist may obtain help from these analyses, since they can furnish him with a better estimation of the roots of moral action and a clearer determination of moral responsibility, but they do not affect the basic Christian concept of sin.

In Early Dualist Beliefs.—Although in orthodox Christianity down the centuries any form of dualism has been consistently and strongly opposed it was manifested very early in some of the sects which are to be found at the beginning of Christianity. It is possible that the "synagogue of satan" in Rev. ii, 9 is a reference to the first of these. The identification of the serpent with the devil led among some of these sects to his worship. The Ophites (from Gr. *ophis*, "serpent"), also called Naassians (from Hebrew *nahash* "serpent"), were a branch of the Gnostics of the 2nd century. They attached special importance to Satan as the tempter in view of their great respect for *gnosis*, the knowledge of good and evil which the serpent had enabled men to obtain. They held that the Creator had withheld this knowledge from the first man and that the serpent was a real liberator of mankind since he taught men to rebel against God. Some evidence of this teaching can be found in the Gnostic Marcion, but there is an obvious affinity between the Ophites and the Cainites who venerated as heroes all the Old Testament rebels against God such as Cain, Esau and the Sodomites. They worshiped Korah (one of Esau's sons) and also, and especially, Judas Iscariot for his freeing mankind from Jesus. (It is to the Cainites that the quotation above from Rev. ii, 9 possibly refers.)

In Manichaeism.—Persian dualism was brought into contact with Christian thought in the doctrine of Mani, and it is perhaps permissible to believe that the pessimistic views of Augustine regarding man's condition are due in some measure to this influence. In all the dualist sects there is a glorification of the devil because the essence of dualism consists in setting up the devil as God's rival, eternal and independent of him. Manichaeism was one of the principal forms of this dualism. In the "chapters of Mani" (*Kephalaia*) discovered in a Coptic translation in 1931, there are clear assertions on this point. Here the devil is "the king or prince of darkness" not in the biblical sense, but as a precosmic, uncreated, omnipotent power, the maker of the world and the equal with God. Inconsistently, however, Mani did not call him God and forbade his worship. Nevertheless, the prohibition was not always observed and sects influenced by Manichaeism—the Paulicians, Bogomils and Cathari (Albigensians)—seem to have contained secret groups known as Luciferians who worshiped the devil under the name of Satanaël (the God-Satan) or of Sammaël. This cult is mentioned by the 11th-century Byzantine writer Euthymius Zigabenus as prevalent among the Bulgarian Bogomils, who held that Satanaël seduced Eve and that he, not Adam, was Cain's begetter. (*See* also BOGOMILS; CATHARI; DUALISM; MANICHAEISM.)

Diabolism Within the Church.—Throughout the middle ages beliefs of this sort make a sporadic appearance side by side with orthodox Christianity only to be recurrently suppressed by the latter. In 1022, for example, some canons belonging to a chapter at Orléans were burned at the stake because, it was asserted, they worshiped the devil. Joachim of Flora (d. 1202) attributes similar practices to the Cathari and in 1236 the chronicler Matthew Paris cites Milan as a city in which the Luciferians found refuge. Konrad von Marburg, the first German inquisitor, was particularly active against the Luciferians and arousing hatred by his violent methods was killed, it was said, by those he had persecuted. Rome took a hand in the struggle against the Luciferians. A bull of Gregory IX in 1233 (*Vox in Rama*) contains a description of the initiatory rites of the Luciferians, though it requires to be borne in mind that the information was probably gathered from the German inquisitors who obtained much of their evidence by torture. The dissolution of the Knights Templar at the beginning of the

14th century on charges including diabolism is an example to the point here; some of the evidence, so far as it can be tested, seems to bear the stamp of authenticity and there appears to be a connection with the practices of the Luciferians, but on a final analysis these are matters that must be classed among the enigmas of history. After 1233, in any case, Gregory IX showed less severity in his treatment of the Luciferians.

Witchcraft and sorcery, of course, were closely connected with these matters and all through the middle ages and beyond were much in the forefront of men's minds as is shown by the many prosecutions. But the importance of witchcraft and sorcery within the context of this article lies in their claim to harness the devil, to make him act, to force him to further the projects of the sorcerer. There is no need to accept the validity of the sorcerers' claims, or of the charges brought against them by their ecclesiastical and other opponents, in order to appreciate the preoccupation with the idea of the devil during these centuries. Superstitions and theological divagations assumed extraordinary proportions and it is not difficult to detect a species of animism in some of the writings of the period. While the great theologians such as Albertus Magnus, Thomas Aquinas and Duns Scotus confined their speculations within the narrower limits of orthodox Christianity, popular preachers and witch hunters were not so guarded. Johann Nider (d. 1438) in his book *Formicarius* goes to great lengths in his exposition of the various superstitions of his time and his account of the witches' sabbath has been drawn upon by later writers. *Malleus maleficarum* (the "witches' hammer") by Jacob Sprenger (*c.* 1486; revised and expanded by Heinrich Institoris, 1489) contains similar lurid descriptions; it formed the handbook of antisatanism in Europe and ran through some 28 editions between 1486 and 1600; it was used by the Inquisition in its many trials of alleged witches and satanists.

With the advent of the 17th century and through the influence of Balthasar Bekker and the Jesuits Adam Tanner and his disciple Friedrich Spee, a more liberal attitude began to prevail in some countries, but elsewhere through the influence of Luther and Calvin popular belief in the pervasive and manifest power of the devil was developed to excess. (*See* also WITCHCRAFT.)

Exorcism.—Such divagations, despite their extravagant nature, should not distract attention from the constant Christian belief in the devil as the enemy of mankind and the source of evil. In the earlier centuries, and still among Roman Catholics, the rite of baptism contained exorcism (*q.v.*) and a renunciation of the devil and his works, and the renunciation is still contained in the Protestant formularies. And there is also a long Christian tradition in favour of the possibility of the possession (*q.v.*) of men and women by the devil from whom he is "cast out" by exorcism. In the Gospels Jesus casts out devils and gives his disciples powers to do so; and he distinguishes between healing the sick and casting out devils: "Heal the sick, raise the dead, cleanse lepers, cast out demons" (Matt. x, 8). Exorcism has been practised in all centuries, though the trend among Roman Catholics is to confine its use to certain rare and well-defined cases. Here again it must be recognized that many of the cases of possession in the past were in reality of psychopathological origin. Unbiased review of the complex problem of witchcraft, sorcery, possession and cognate phenomena, and appraisal of the extant evidence, would seem to show that almost all the cases indubitably were due to morbid and hysterical mental conditions provoked among the superstitious and ill-educated by a prevailing atmosphere of terror, mystery and suspicion. Outstanding figures such as Gilles de Rais (1404–40) and a few others no doubt believed in the reality of their communications with the spirit of evil and stopped short at no crime.

In Art and Literature.—It is natural that the devil is to be found down the centuries in art and literature. The fall of the damned depicted in the mosaics of the baptistery of Florence cathedral is a good example of medieval treatment of the theme. Hieronymus Bosch, with his fantastic creations of the ape of God, portrays the devil as the lord of disorder, of anticreation; Albrecht Dürer represents him as a pig, skulking behind death, following a man on horseback, ready to snatch his soul; Goya shows him as a goat, Delacroix reduces him to the absurdity of Mephistopheles. In medieval church carvings he often appears in the familiar form with horns and tail, a grotesque shape reflecting the ideas of the mystery plays. But it is to the east rather than to the west that the most telling examples of an early date are to be found. In popular Chinese art, in Iranian carvings, in Assyro-Babylonian remains the devil figures frequently, and it was from the latter that Judeo-Christian representations of him seem to be copied. There is a similarity between the bronze statuette in the Louvre (7th century B.C.) of the devil Pazuzu symbolized as the southwest wind, the bearer of fever and delirium, and the devil as he is represented in illuminated manuscripts and in the carvings of the churches of Europe.

Literature, reflecting the ideas prevailing at its epoch, portrays the devil in various guises. In the medieval mystery plays he is reduced to a comic figure, a buffoon; in Dante's *Divina commedia* he appears as an outcast from heaven. At the same time popular imagery has its part; the devils in hell are frightening though sometimes figures of fun in the medieval tradition. Principally however Dante's conception is based on Revelation and on orthodox theology, though sometimes in rudimentary form. The devil to whom Faust sells his soul is a familiar spirit called Mephistopheles (*q.v.*), whose character is strongly differentiated in the plays of Christopher Marlowe and Goethe, but in the 7th-century Greek legend of Theophilus of Adana, which is the earliest version of the story of an infernal pact, it is the devil himself whom the hero agrees to serve (*see* FAUST). Satan is a prominent character in *Paradise Lost*, where Milton seems at pains to reconcile his Christian belief with his humanist, Renaissance mentality and though he believes in the Bible narrative he alters it on occasion. *See* DEMON; SATAN; *see* also references under "Devil" in the Index volume.

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DE VILLIERS, JOHN HENRY DE VILLIERS, 1ST BARON (1842–1914), first chief justice of the Union of South Africa, who in this capacity modernized the Roman-Dutch law of Cape Colony, was born at Paarl, Cape Colony (Cape Province), on June 15, 1842. He was educated at the South African college, Cape Town and at Utrecht and Berlin universities.

In 1865 he was called to the bar by the Inner Temple and began practice in Cape Colony. Entering Cape politics in 1866, he was elected a member of the house of assembly, became attorney general of the colony in 1872 and two years later was appointed chief justice of the Cape. He was appointed president of the national convention in 1908 and in 1910 was raised to the peerage on becoming chief justice of the Union of South Africa. He died at Pretoria on Sept. 2, 1914.

DEVILS TOWER NATIONAL MONUMENT, first U.S. national monument, was established in 1906 pursuant to the Antiquities act of that year. Located near the Belle Fourche river in the northeast corner of Wyoming, the area of 1,346.91 ac. was set aside to preserve a remarkable natural rock tower of volcanic origin. The tower, with its flat top and fluted sides making it look not unlike a great petrified stump, is 865 ft. from base to summit, and stands on a rounded ridge which rises 415 ft. above the river. The top of the light gray and buff tower is inhabited by chipmunks and other rodents and there is a protected colony of prairie dogs near the river. It was first climbed in 1893.

Among several Indian legends explaining the origin of the tower one relates that seven little girls who were chased by bears sought refuge on a low rock. To save them the gods raised the rock beyond the reach of the bears, pushing the girls into the sky where they are still visible as stars, the Pleiades in the constellation Taurus. The bears left permanent claw marks, the fluting, on the tower. (T. A. LN.)

DE VINNE, THEODORE LOW (1828–1914), the most eminent U.S. printer during the later 19th century and the first decade of the 20th, was known as an authority on the history of typography and was the author of many scholarly books on the subject. Born at Stamford, Conn., on Dec. 25, 1828, he took the first steps toward learning his trade in 1843 in a printing office at

Fishkill, N.Y., but entered on his regular apprenticeship soon after in the office of the *Gazette* at Newburgh, N.Y. In 1847 he went to New York city and, after working in several offices, in 1849 entered the employ of Francis Hart, one of the leading printers in that city. From work as a job compositor, he graduated in 1850 into the position of foreman; nine years later, Hart made him a member of the firm. At that period the business of Francis Hart and Co. was tending more and more to book printing, a field to which De Vinne devoted most of his efforts from that time onward. About 1864 De Vinne began to write on printing, his earliest contributions dealing with the economic aspects of the business, but he soon turned to the aspects of typographic style and the history of the craft.

In 1873 the firm began to print *St. Nicholas* and soon after took on the *Century Magazine*, in printing the illustrations for which some new standards were established. The *Century Dictionary* was another job of importance produced under De Vinne's direction. Francis Hart died in 1877, and in 1883 the name of the firm was changed to Theodore L. De Vinne and Company. The De Vinne press earned a reputation as the outstanding printing plant of the country. De Vinne was one of the founders of the Grolier club and one of its most active members, printing most of the early books issued by that organization and writing or editing a number of them. He died on Feb. 16, 1914. As a printer De Vinne was a craftsman of high standards, but he could not be regarded as a great creative artist. His simplest books were his best.

De Vinne's most important contributions to typographic literature were *The Practice of Typography* (1900–04), a series of four manuals; *The Invention of Printing* (1876); *Christopher Plantin and the Plantin-Moretus Museum at Antwerp* (1888); and *Notable Printers of Italy during the Fifteenth Century* (1910).

(D. C. McM.)

DEVISE, in the strict terminology of Anglo-American law, is a disposition of real property by will, as distinguished from a legacy or bequest, the disposition of personal property by testament. Since the late 19th century the terms devise and legacy, as well as will and testament, have come to be used interchangeably. *See* LEGACY; WILL. (M. RN.)

DEVIZES, a market town and municipal borough in the Devizes parliamentary division of Wiltshire, Eng., 25 mi. N.W. of Salisbury by road. Pop. (1961) 8,497. Its castle was built on a tongue of land flanked by two deep ravines, behind which the town grew up on a stretch of exposed tableland. Its main streets, in which a few ancient timbered houses survive, radiate from the large market place, where stands a market cross with an inscription commemorating God's judgment on referring to a woman who was struck dead in 1753 after praying she might drop dead if she was guilty of withholding money in a transaction; the money was found clutched in her hand. The Kennet and Avon canal, now practically disused, has a chain of 29 locks; the canal and its banks have a rich fauna and flora. St. John's church (12th century), one of the most interesting in Wiltshire, is cruciform with a massive central tower and fine Norman chancel and contains several ancient monuments besides some beautiful carved stonework and oak ceilings. St. Mary's, a smaller church, is partly Norman but was rebuilt in the 15th century and restored in the 19th century. Roundway down, on the edge of which the town stands, stretches eastward and is the site of an ancient earthwork. The museum of the Wiltshire Archaeological society has a good representative collection of prehistoric finds and is also the depot of the Wiltshire regiment. There is a big corn, cattle and pig market. Devizes has bacon, cheese and tobacco factories, tileworks, engineering works and is the oldest manufacturer of snuff in the country. Assize courts are held at Devizes, which has its own commission of the peace and court of quarter sessions.

The construction at Devizes in the reign of Henry I of a castle of exceptional magnificence by Roger, bishop of Salisbury, at once made the town a political centre, and the name itself is possibly a corruption of the medieval Latin referring to the "castle at the boundaries" (*ad divisas*). After the disgrace of Roger in 1139 the castle was seized by King Stephen. It was dismantled after Cromwell took it in 1643. The town's first charter was granted in the reign of Matilda and was followed by charters of other monarchs. Devizes returned two members to parliament from 1295 until deprived of one member in 1867; its representation was merged in that of the county in 1885.

DEVOLUTION, WAR OF, the war of 1667–68 between France and Spain. Following the Anglo-Dutch War of 1664–67 and preceding the Franco-Dutch War of 1672–78, it is best considered in the context of the Dutch Wars (*q.v.*). Devolution was a local custom governing the inheritance of land in certain provinces of the Spanish Netherlands, by which daughters of a first marriage were preferred to sons of subsequent marriages; and Louis XIV of France began the war on the pretext that this custom should apply to sovereign territories also, so that his wife Marie Thérèse should succeed her father Philip IV of Spain (d. 1665) in the majority of the Spanish possessions in the Netherlands in preference to her younger half-brother, Charles II of Spain. The war was ended by the treaty of Aix-la-Chapelle; for its provisions *see* AIX-LA-CHAPELLE, CONGRESSES OF. (I. F. B.)

DEVON, EARLS OF. From the family of DE REDVERS (de Ripuariis, Reviers), earls of Devon from 1141, this title passed to that of Courtenay (*q.v.*), which held it until the death (1556), without issue, of Edward, the 11th Courtenay earl. The title then became dormant in the Courtenay family until a claim by a collateral branch was allowed by the house of lords (1831) and the earldom of Devon was restored to the peerage. The earlier earls of Devon were sometimes referred to as earls of Devonshire; but this variant is now solely used for the earldom and dukedom held by the Cavendish family.

DEVON, a county of England, part of the southwestern peninsula, with a northern and southern seacoast and including Lundy (*q.v.*) island, is bounded on the west by Cornwall and on the east by Somerset and Dorset. Its area, 2,612.7 sq.mi., is exceeded only by that of Yorkshire and Lincolnshire among the English counties.

Physical Features.—Devon has the boldest relief of the counties of southern England. Its coastline, with the contrast between rugged cliffs and deep winding estuaries, offers a great variety of colour and scene, but gives way almost everywhere to hilly country. The main physiographic feature is an extensive dissected platform—the mid-Devon plain—lying at about 430 ft. above sea level. In the south this plain is dominated by the rolling granite upland of Dartmoor, whose tors rise above 2,000 ft.; in the northeast it gives way to the hills of Exmoor.

The geology of the county is complex in detail but simple in outline. The oldest rocks are early or pre-Palaeozoic schists occurring in the extreme south between Start point and Bolt Tail. To the north lie folded sediments of Devonian Age which extend in a great syncline or trough outcropping south of Dartmoor and northeast of the Taw-Torridge estuary. These sandstones and shales are broken by massive limestones in the south, but in the Exmoor area only a few limestone bands are found. The centre of the Devonian syncline and about one-third of the county's area is occupied by intensely folded and faulted sandstones and shales of the Carboniferous Age, known as the Culm measures. These old rocks were influenced by the Armorican folding and, particularly in the south, by igneous activity. The great granite mass of Dartmoor there protrudes through the Devonian and Carboniferous sediments, with widespread evidence of metamorphism. East of these outcrops, and approximately along the line of the river Exe, New Red rocks of Permian and Triassic age cover the old sediments. These weather down to the rich red soils of the Tor bay and Exeter areas, so often quoted as typical of Devon, though they cover but a small proportion of the county. The little-disturbed Trias strata, whose boundary with the Permian is usually considered to be the Budleigh Salterton pebble bed, dips under Lias limestone and marls which are themselves covered by Cretaceous rocks in the southeast of the county. Outliers of Cretaceous material (*e.g.*, the Haldon hills) lie farther west. Between Seaton in Devon and Lyme Regis in Dorset the widely known landslip of 1839, caused by the erosion of the Greensand and the slipping of the Middle Chalk upon it, was made a national nature reserve in 1955. Oligocene clays, with interbedded lignites, occur between Newton

J. ALLAN CASH—RAPHO GUILLUMETTE

ANSTEY'S COVE, NEAR TORQUAY, DEVON, ENG.

Abbot and Bovey Tracey and in the Peters Marland area. These "ball clays," notably whiteware and stoneware, are extensively worked from both open pit and mine. The county was not directly affected by the Quaternary ice sheets, but much of the valley gravels and "head" date from that period and, with the drowned river valleys and raised beaches, demonstrate the different conditions then prevailing.

The wet uplands, Dartmoor and Exmoor, both designated as National parks, are the source of most of the Devon rivers. From Dartmoor the streams flow in a radial pattern to the south coast (the Teign, Dart, Avon, Yealm and Plym) and to the north coast (Taw, Okement), or to the Tamar (Lyd, Tavy) which flows south to Plymouth sound and forms over most of its length Devon's boundary with Cornwall. Most of Exmoor drains to the Exe (*q.v.*), which flows south through rich farming country, its wide basin forming another major physiographic unit. The remainder is drained by a series of short rivers, the principal one of which is the Lyn, falling steeply to the north. East of the Exe the land rises to the east Devon plateau, which, again, is deeply dissected by rivers (the Otter, Sid, Axe) flowing southward to the coast.

Climate.—The climate is generally mild but there are marked variations according to height above sea level and distance from the sea. The annual average rainfall varies from about 30 in. at the mouth of the Exe to over 80 in. at the centre of Dartmoor and exceeds 60 in. at the centre of Exmoor.

Along the coastal areas the temperature is equable due to the influence of the sea and the estuaries which penetrate up to 8 mi. inland. Away from the sea, and especially on higher ground, the daily range of temperature increases and winter weather grows more severe. On the coast the number of days with snow varies between 5 and 7½ a year, while on the high land of Dartmoor above 1,000 ft., it increases to about 25.

Soils.—The great variety of rocks give a number of different types of soils, many of which, because of the nature of the rocks and the heavy rainfall, are deficient in lime. This is especially true of the western part of the mid-Devon plain, where the Culm measures, themselves deficient in lime and subject to heavy rainfall, give rise to cold, heavy clays on the shaley horizons and shallow stony soils on the sandy layers. The highly folded and resistant rocks of north Devon result in upland tracts with soils of moderate fertility. These are deficient in lime except, as in the Combe Martin valley, where they are associated with local beds of limestone. Drainage is better than on the Culm measures. The varied character of rocks in south Devon, including limestone, volcanic and schistose rocks, afford a variety of soils correspondingly varied and on the whole superior to those of north Devon. In east Devon and along the strip from Hatherleigh to Crediton is the red soil derived from the red rocks laid down under the desert conditions of Permian times. It is a warm, fine, easily worked loamy soil, and the most valuable agricultural land in the county.

Vegetation and Animal Life.—About a quarter of the county is heathland, moorland and rough grazing, principally Dartmoor and Exmoor with secondary areas on the Culm measure moors and the plateau heath of east Devon. The remainder is now largely pasture land, though considerable deciduous woodland survives.

The county has an abundant wild life. The Dartmoor and Exmoor ponies are well known. Foxes are common, and rabbits are numerous in the Dartmoor area as well as badger and otter. Characteristic birds are the buzzard, raven, carrion crow, kestrel, stonechat, whinchat, dipper and gray wagtail. Common lizard and adder are frequent in heather and moorland areas. Roach, dace and bream, as well as salmon and trout are fished in the rivers, and bass and flatfish abound in the estuaries.

National Parks.—Part of the Exmoor National park and the whole of the Dartmoor National park lie within the boundary of the administrative county. Dartmoor covers 365 sq.mi. and its special features are rounded hills capped with "tors" (large blocks of bare granite) and "clitters" (heaps of granite boulders and stones). Exmoor covers 265 sq.mi., approximately 77 of which are within the Devon boundary. The heather, bracken and grass moorland is seamed with combes, or valleys providing shelter for a vigorous scrub and tree growth. The northern coastline is an outstanding feature with cliffs, woods, steep gorges such as Heddons Mouth, the Lyn valley and the bold promontory of Foreland point. (*See* DARTMOOR; EXMOOR.)

Antiquities and History.—Traces of Paleolithic man have been found in the limestone caves of south Devon around Tor bay and Plymouth sound, and in the gravel pits near Axminster. Kent's cavern, Torquay, is one of the two oldest known human dwellings in Britain. A few Neolithic remains include a house at Haldon. Bronze Age man turned to yet higher ground, particularly to Dartmoor. Here there are several thousand prehistoric monuments: hut circles of which the best known is Grimspound, barrows and stone rows, circles and cairns. There are several series of Bronze Age barrows in north and east Devon, particularly Farway. The Iron Age newcomers girdled Dartmoor and guarded the river routes inland with a series of earthworks or hill forts. Hembury fort, the largest, may have been the headquarters of the Dumnonii until Exeter was founded as the Roman frontier station (Isca Dumnoniorum) lying at the end of the Fosse way. From Exeter, Roman roads ran to Topsham (formerly the Roman and medieval port of Exeter), to Teignbridge and north of Dartmoor to the river Taw. Villas have been found in Seaton and Uffculme, and a Roman fort at Martinhoe.

The British Dumnonii, who gave their name to Devon, largely survived the Saxon conquest, which began in the late 7th century and was partly military in character and partly peaceful colonization of the lowland districts. Saxon and Briton together were subjects of Wessex and in the late 8th century Devon was recognized as a shire. It was included in the see of Sherborne (set up in 705) until 909 when it was made into a separate diocese of Crediton. In 1050 the see was moved to Exeter, a walled city, where it is still. There are a few Saxon remains: a crypt at Sidbury and a few decorated stone crosses. The many undated stone crosses on Dartmoor possibly mark trackways and medieval manor boundaries.

From 851 to 1003 the area suffered from Danish raids. In 1068 Exeter was taken by William I after its citizens refused him fealty. A castle was built there which in 1348 was granted for life to Edward, prince of Wales. There was skirmishing during the wars between Stephen and Matilda, in the Wars of the Roses and again during the Civil War. Local as opposed to national risings had little success, and Exeter withstood sieges by Perkin Warbeck in 1497 and by the western rebels of 1549. Raids on the coast occurred during most wars, but in the 15th and 16th centuries Devon pirates and privateers were probably doing even more damage to shipping.

Tin mining on Dartmoor was an important industry from the mid-12th to the early 17th century, and the miners formed a separate community with its own courts governed by the lord warden of the stannaries. Silver and lead mines were worked until the

16th century, iron ore from the 16th to the 19th and copper and manganese in the 18th and 19th centuries. The cloth industry came to the fore in the middle ages and remained a staple industry until the 19th century. The export of cloth and tin led to the rise of the ports, chief among them being Exeter, Plymouth, Barnstaple and Dartmouth. Devon sea fisheries (with those of Newfoundland from Tudor times) provided training and opportunity for the seaman of Elizabeth I's reign and later. Sir Francis Drake, Sir Walter Raleigh, Sir John Hawkins, Sir Richard Grenville and, in the 20th century, Capt. R. F. Scott of the Antarctic were among the many famous seamen and explorers born in Devon. The decay of the woolen and mining and other local industries, such as paper and lacemaking, resulted in a drift from the county from the 19th century onward. This drift was partly halted by the growth of the seaside towns and the tourist industry, which began in the late 18th century.

Devon was represented at the council of 1258 and in parliament in 1290. From 1295 Devon and four boroughs were continuously represented, and other regular and casual boroughs were added until there were 26 Devonshire members. In 1832 this was reduced to 22, by 1918 to 11, and in 1954 to 10.

During World War II the South Hams district was used as a battle-training ground by U.S. forces which necessitated the evacuation of many villages and farms. Plymouth was a major embarkation port for the Normandy invasion.

Architecture.—Rougemont castle, Exeter, the remains of which are preserved, dominated Norman Devon both structurally and administratively. The keeps of Gidleigh, Lydford and Okehampton date from the 12th and 13th centuries. Exeter cathedral is the outstanding example of medieval architecture, built in the late 13th-century plan; and Ottery St. Mary (*q.v.*) is an almost untouched early 14th-century church. Most of the medieval, Tudor and Jacobean buildings are in local stone, with limestone quarried at Beer much used for finer carving in the south. This variety of stone adds interest to the churches which date mostly from the 14th century in Perpendicular style. Tudor and later structural additions are usually aisles and are generally of the same height as the nave with timber wagon roofs. Richly decorated rood screens, the earliest in stone and later in wood, are an outstanding feature of the churches. Monastic remains are scanty: in Exeter chiefly the Benedictine priory of St. Nicholas, in the Mint, and the 13th-century priory of St. Katherine's, at Polsloe; Tavistock (*q.v.*) abbey (founded 961); and the 13th-century Cistercian abbey of Buckland. Buckfast abbey, near Buckfastleigh (*q.v.*), founded as a Cistercian house in 1137, was acquired by French Benedictines in 1882 and on the ruined site they rebuilt the abbey and its church, which was consecrated in 1932.

Among many fine houses are Weare Giffard and Bradley manors, both of the 15th century; Dartington hall, since 1925 used as a centre for rural economics and education, Powderham castle, Compton castle and Wortham manor, all medieval houses with important later additions, the last two being fortified. Traditional country buildings are in colour-washed cob with thick walls and thatched roofs. The late 18th and early 19th centuries are characterized by planned street architecture in Plymouth and Exeter and the terraces and crescents of the new seaside towns such as Torquay, Teignmouth and Ilfracombe. Princetown gaol, on the bleakest part of Dartmoor, became a convict prison in 1850.

Properties administered by the National trust include Buckland abbey, Bradley manor, Compton castle, Holne woods, Watersmeet, Kipling Tors near Westward Ho!, Arlington court, Hayes Barton, and many other fine properties.

Population and Administration.—In 1961 the resident civil population was 204,279 for Plymouth, 80,215 for Exeter and 538,412 for the administrative county. The main concentrations of population in the county are in the Plymouth fringe area, in the Tor Bay area, in the lower Exe valley and in the Taw-Torridge estuary area. Both the northern and southern coastal strips tend to be more densely populated than inland where generally there is a pattern of rural settlement, market town, village, hamlet and farm, which has persisted over many hundreds of years.

The 1961 resident civil population figures show that the five largest towns in the county are Torquay (53,915); Paignton (30,289); Exmouth (19,740); Newton Abbot (18,066); and Barnstaple (15,907) (*qq.v.*). Bideford, Brixham, Sidmouth, Teignmouth and Tiverton (*qq.v.*) are in excess of 10,000, while Dartmouth, Dawlish, Ilfracombe, Tavistock, Totnes (*qq.v.*) and Northam all have populations of between 5,000 and 10,000. The high average age of residents is an indication of the popularity of Devon with retired people.

The county is divided into the administrative county of Devon and two county boroughs, Plymouth, well known as a naval base, and Exeter (*qq.v.*), the cathedral city and administrative and business centre. The administrative county, the largest local authority in area in England and Wales, is subdivided into 10 municipal boroughs, 20 urban districts and 17 rural districts.

The Economy.—Devon's rural economy is based on livestock. Out of about 1,150,000 ac. of crops and grass, about 900,000 are in grass and less than 20,000 are used for the main cash crops of wheat, potatoes and sugar beet. Furthermore, much of the 360,000 ac. of moorland provides rough grazing and is linked to the economy of the peripheral farms.

There are two indigenous breeds of cattle. The North Devon, or Red Ruby, is the smaller of the two and is an excellent beef animal. The large South Devon or South Ham is used as a dual purpose animal for high quality milk as well as for beef. Dairy farming is found in most parts of the county, particularly in east Devon and near the south coast towns, but beef cattle are important, especially in the north and west and in areas associated with the Dartmoor and Exmoor grazings. Exmoor and its fringing lands are pre-eminently stock raising localities, many of the large sheep flocks there being the native Exmoor Horn or the Devon Closewool. There are other native breeds of sheep—the Devon Longwool in west Devon, the South Devon in the south and two Dartmoor breeds, now less numerous on the main moorland than the hardy Scottish Blackface Highland.

The countryside has a pattern of small fields and hedgerow banks much more suited to a pastoral economy than to mechanized tillage. The tillage acreage is limited chiefly by the climate. The heavy rainfall and high winds often militate against an easy grain harvest. Cereals become of significance only where the rainfall is less than 40 in. per annum, particularly in the lower Exe basin and the South Hams. A high proportion of the cereals is grown for animal feeds. Pigs and poultry are numerous, but are generally regarded as ancillary to the main farm enterprise. The growing of early vegetables and fruit (*e.g.*, strawberries in the Tamar valley and at Combe Martin, and flowers in the Dawlish-Teignmouth area) is important. The acreage of orchards is steadily declining and although Devonshire "Clotted" cream is still made on many farms, the other famed produce, cider, is mainly made in factories.

The total area of woodlands suitable for economic management accounts for only 5.4% of the land. In the early 1960s, the Forestry commission held about 24,000 ac. and a further 24,000 ac. in private ownership was being worked under a plan of operation approved by the Forestry commission.

Apart from the importance of the naval dockyard to Plymouth, the chief employment in the coastal towns is provided by the tourist trade. Estimates suggest a peak holiday population of about 250,000 persons, and probably 2,000,000 are accommodated during the year. The variety of the enterprise is considerable, but except for some minor centres round Dartmoor, and scattered fishing interests, the industry has little direct effect on rural Devon. Torquay, Paignton and Brixham, Exmouth, Sidmouth, Dawlish, Teignmouth and Dartmouth are the main south coast resorts, and Ilfracombe the only sizable one of the north coast. The small picturesque towns of Salcombe, Seaton, Lynton and Lynmouth (*q.v.*), Woolacombe and such villages as Beer, Newton Ferrers and Clovelly (*q.v.*), do much to make the county a favourite tourist area. Exeter, Barnstaple and Bideford are inland holiday centres and Plymouth is a seaside resort as well as a naval base. At Dartmouth is the Britannia Royal Naval college and also the headquarters of the Royal Dart Yacht club.

Sea fishing is less important than in the past and practically

all the county's fishing industry is centred on Brixham and Plymouth. The Marine Biological laboratory at Plymouth was established in 1855. Salmon fishing is both commercial and recreational.

Almost every town has some factory or works where skills have been handed down over many generations. Shipbuilding at Brixham, on the Dart, Teign and Torridge, and the complex industry associated with the Devonport dockyard are typical; also gloving in Torrington and the wool industries of Axminster, Buckfastleigh and Ashburton, the textile enterprises of Tiverton and the papermaking works of the Culm and lower Exe valleys. Plymouth and Exeter are the main industrial centres. At Tiverton, Barnstaple, Newton Abbot and Axminster the proportion of the population employed in factories is above the county average. However, none of these towns can be described as industrial as nearly all the individual enterprises are small. The dairy industry is important, and vehicle and machine maintenance and repair enterprises, from village smith to the large Newton Abbot railway works, illustrate the emphasis on the manufacturing processes and distribution of dairy products in the county's economy. Of all employees in the county, 66% work in the "services" group of trades and professions, as compared with a national proportion of 52%. This reflects the size of the tourist industry and Devon's function as a residential area for retired people. These factors support such industries as printing, enterprises associated with the building industry (*e.g.*, woodworking and the making of bricks and concrete products) and gas and electricity undertakings.

Ball clays and china clays (kaolin) from southwest Dartmoor are now the chief mineral export. Ball clays, dispatched by rail or ship from Teignmouth and Fremington, are the basis of some local industry and are used mainly in ceramics. China clay is used particularly as a filler in paper, rubber and paints. Devon's production of china clay, exceeded 110,000 tons annually in the early 1960s.

Ground limestone for agriculture is sent to Cornwall and the Channel Isles, small quantities of polished "Devon marble" are exported, and there is a coastal trade in industrial limestone. Igneous stone is transported for railway ballast and monumental purposes.

The county road and railway network focuses on Exeter. From the east the Leeds-Exeter trunk road and the British railways Western Region main line enter from Taunton, and the London-Plymouth trunk road and Southern Region main line enter from Honiton. From Exeter the Western Region line follows the coast to Newton Abbot, thence to Plymouth and Cornwall, with a branch to Tor bay. The Southern Region line strikes north from Exeter, one branch going round Dartmoor to Plymouth and the other serving Barnstaple, Ilfracombe and Bideford. The road pattern is similar. There are civil airports at Exeter and Plymouth, and air traffic is also handled at the Chivenor field in north Devon. Inland waterways are of little significance, and the only canal working is the Exeter ship canal. Bideford, Fremington, Exmouth, Teignmouth and Plymouth are worthy of note as ports, but the fine harbour of Dartmouth has lost trade through the decrease of the business of ships' coaling, and the main traffic on the Dart to Totnes is now pleasure boats.

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DEVONIAN SYSTEM. The Devonian system of rocks includes those that originated during the Devonian period of time, or roughly the interval from 285,000,000 to 320,000,000 years ago. In practice both time and rocks are defined with reference to distinctive fossils, which differ from those of the previously deposited Silurian rocks below, and the more recent Lower Carboniferous, or Mississippian, above. The Devonian is a middle division of the Paleozoic era (*q.v.*), as indicated in the accompanying geologic time chart.

In addition to the cross references to related articles given throughout this article, for related information *see* GEOLOGY; PALEOBOTANY; PALEONTOLOGY; SEDIMENTARY ROCKS; and FOSSIL. For further information on both ancient and modern forms of life mentioned in this article the reader is referred to the separate articles on the various phyla, as BRACHIOPODA; MOLLUSK, etc.

The main divisions of this article are:

I. The Devonian System and Period
  1. Physical Events and Features
  2. Climate and Ecology
  3. Devonian Rocks
II. Devonian Life
  1. Vertebrates
  2. Plants
  3. Invertebrates and Associated Fossils
  4. Biogeography and Migration Routes
III. Regional Summary
  1. Great Britain
  2. Ardennes and North Rhineland
  3. Central and Southern Europe
  4. U.S.S.R.
  5. Asia
  6. Australia, New Zealand and Approaches
  7. South America
  8. Antarctica and South Africa
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I. THE DEVONIAN SYSTEM AND PERIOD

Devonian sediments contain the earliest really abundant remains of land plants and of fishes, although both originated long before and have changed drastically since. These fossils, those of the continuously evolving marine invertebrates, and the sediments tell us that the Devonian climates were mild and apparently not markedly zoned latitudinally, that there was land with bodies of fresh water and primitive vegetation in the far North Atlantic, and that the sea spread widely over present continents.

During the Devonian period the first four-footed vertebrates arose from the fishes, and the conquest of the lands began. Mountain building, accompanied by granitic intrusion and volcanism, played an important part in modeling the Devonian scene and in providing sediments to fill the subsiding areas.

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	1,000 Years
	CENOZOIC ERA		
Quaternary	Recent	Modern man	11
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	70,000
	MESOZOIC ERA		
Cretaceous		Extinction of dinosaurs	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	160,000
Triassic		Appearance of dinosaurs	200,000
	PALEOZOIC ERA		
Permian		Reptiles developed, conifers abundant	235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
Ordovician		First primitive fishes	400,000
Cambrian		Marine invertebrates	500,000
	PRE-CAMBRIAN TIME		
		Few fossils	3,500,000–4,000,000

Devonian rocks are important petroleum reservoirs and host rocks for various metallic mineral deposits of later origin. The tin that brought the Romans to Cornwall and Devon was in lodes in Devonian rocks. Many of the Upper Devonian black shales

contain as much as 0.01% primary uranium, and hence are possible ore reserves.

Cement rock, glass sand, refractory brick, building stone and abrasives are common Devonian industrial resources.

Some of the world's most storied landscapes result from the erosion and weathering of Devonian rocks. This has produced the best north Rhineland scenery, including the Lorelei and Wagner's Grosser Feldberg. Other examples are found in the Ardennes, Brest harbour and the higher parts of Brittany, Cape Town's Table mountain, the Catskills, the scenic tip of the Gaspé Peninsula in Quebec, the Ramparts of the Mackenzie river, Moray firth and the hillier parts of the Scottish central lowlands, and the historic and lovely south coast of Devonshire, in southwest England, where the name comes from.

Identification of rocks from any other part of the world as Devonian (or a specific part of it) is based on comparison of the fossils they contain against those of the type marine section in Devonshire, or on relationship to or correlation with other rocks so dated. The absolute age in years is only crudely estimated by extrapolation from rare radiogenically dated control points, whose determined ages are believed to be within about 10% of true values, but whose stratigraphic position is only approximately known. Geologists, therefore, do not ordinarily think or talk of Devonian or other rocks in terms of years, but in terms of named subdivisions based on the physical characteristics of the rocks and the fossils found in them. The correlation table shows the principal Devonian subdivisions for selected regions. The map indicates the distribution of land and sea in the Devonian world, somewhat distorted by emphasis on fossiliferous marine deposits and very different from similar maps for brief intervals of Devonian time.

Historically, recognition of the Devonian deposits as a system was delayed by absence of Devonian rocks with marine fossils from areas where the stratigraphically adjacent systems were most intensively studied. As early as the 18th century, deposits called the Old Red Sandstone were known in England north of Bristol and in Scotland; but lacking marine fossils these deposits could be interpreted as equivalent to some part of the previously described Lower Carboniferous (Mississippian) system above or the Silurian system below. The first inkling of an intermediate system came from William Lonsdale's studies of south Devon fossils (corals intermediate between those of Silurian and Carboniferous rocks) in the late 1830's. Shortly thereafter (April 24, 1838; published 1840), Roderick Impey Murchison and Adam Sedgwick, on the verge of the same conclusion from geologic mapping, went before the Geological Society of London to baptize the new system—with full credit to the help of Lonsdale. Later, by general consent, the richly fossiliferous Devonian sequence of the Ardennes and west Rhine was accepted as the standard for comparison, in place of the more strongly metamorphosed and structurally complicated Devonshire succession.

1. Physical Events and Features.—Great events altered the earth during Devonian time. Mountain building convulsions (the Caledonian orogeny), probably beginning before the end of the Silurian period, squeezed the thick older Paleozoic deposits of northwestern Europe into a northeast-southwest curving folded belt, eradicated the troughs in which they had accumulated, and erected the highlands from which the sediments for the Old Red Sandstone were eroded. New subsiding belts (geosynclines) and rising borderlands were created. The sea, which had been restricted during Late Silurian and Early Devonian, spread widely with advancing time. At one time or another, and to varying depths, it seems to have covered large parts of all continents as shown on the distribution map.

Only between Greenland and Scandinavia does there appear to have been extensive land where there now is sea—the Old Red continent, sometimes called the North Atlantic continent or Eria. Physical characteristics of the continental sediments of east Greenland imply derivation from high or rapidly rising land to the east, and those of both Greenland and Europe contain similar nonmarine or fresh water fishes and land plants. Evidence such as this, and the close affinities between bottom-living marine faunas on opposite sides of the Atlantic, has also been interpreted as indicating the drifting apart of a once united supercontinent into the pieces now given separate names—but this is a highly controversial hypothesis.

There are also records of important warping of the earth's crust and changing of seaways outside of Europe during Devonian time. The so-called Acadian disturbance, for instance, created highlands along the eastern border of central North America and folded the Devonian and older rocks of the northern Appalachian and Acadian region. Eastern Australia underwent several strong paroxysms of mountain building that produced discordances within and beneath Devonian rocks and erected the Kanimbla Mountains. In north Africa, the Urals and the Andes, thick detrital Devonian sections indicate adjacent elevated or rising tracts. Deep seated axial intrusion of granitic and other plutonic rocks accompanied the rising mountain belts that bordered the subsiding sedimentary troughs or geosynclines. Concurrent volcanism shed its wastes alike on terrestrial slopes and basins and into the seas, where they were mixed and interbedded with more normal detrital and organic sediments.

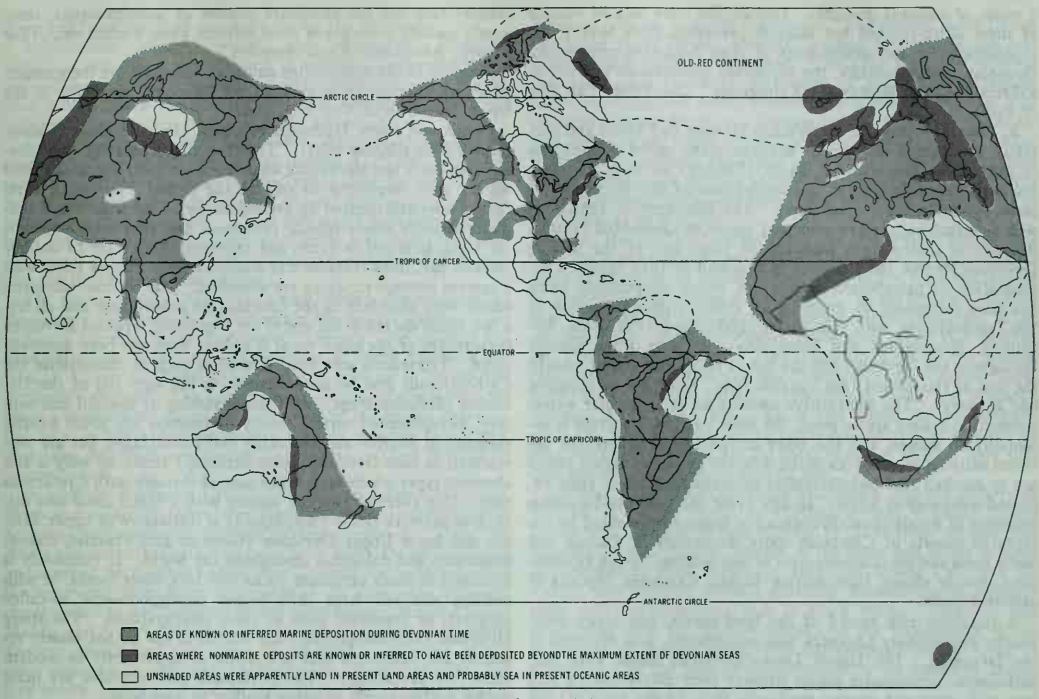
Late Devonian time saw the first crustal movements of the Hercynian, or Variscan, and Appalachian orogenies, pulses of which recurred through the rest of the Paleozoic era and eventually created mountains from the sediments of subsiding belts throughout the world.

2. Climate and Ecology.—The rising mountains of Devonian time doubtless interfered with wind circulation and created some climatic diversification, especially of rainfall. Extensive seaways, however, provided a heat transfer system that had strongly equalizing thermal effects. A generally warm climate throughout the world is suggested by the wide development of thick Devonian limestones and dolomites with an abundance of reefs formed by corals and stromatoporoids or stony Hydrozoa, as well as by hordes of shelly bottom-living organisms that show strong similarities over wide ranges of latitude.

Principal ecologic variations were presumably interrelated with physical and chemical changes due to increasing depth at sea or altitude on land, or special geographic configuration. Reef-building organisms flourished in clear circulating waters at shelf edges, or in shoals not exposed to floods of sediment. In the shelf seas were deposited calcium carbonate sands of biologic origin and terrestrial detritus, together with remains of associated molluscan and brachiopod faunas; terrestrial detritus predominating where circulation was restricted, as behind some reef belts. In the deeper sedimentary basins or troughs were soft oxygen-poor muds (commonly with sandy or calcareous interlayered beds), in which free-swimming cephalopods (ammonoids) and floating pteropods are the principal forms of life preserved. Some ammonoids are also found associated with the reef deposits and on the back-reef shelves. Local mass transport of sediments down the slopes of basins led to the mixing of sediments and remains of organisms from different depths, and the creation of a distinctive complex of sedimentary features. On land, the poor sorting, red colour, fossil content and textural characteristics of the Old Red Sandstones and similar deposits imply formation principally in intermontane basins, deltas or estuaries in a warm climate of marked seasonal rainfall. If the inference is correct, such conditions existed in many parts of the northern hemisphere, and from Greenland to Antarctica.

3. Devonian Rocks.—Particular kinds of rock and biologic associations, called facies, result from the interplay of variation of source, history of deposition or emplacement, and environmental factors. In the Devonian, as in other systems, different rock or biologic facies may be equivalent in time, and the same or similar rock or biologic facies may recur at different times. The concept of facies as associations of particular kinds of rocks is equally applicable to sedimentary, metamorphic or igneous rocks. Among Devonian sediments the reef limestones and the Old Red Sandstone are common facies types, but there are many others.

An especially distinctive facies of Upper Devonian and Devonian-Carboniferous transition deposits consists of fissile black shales bearing fossil records of spores and conodonts or small



MAP SHOWING DISTRIBUTION OF DEVONIAN SEAS AND LANDS

toothlike objects, at places accompanied by chert or novaculite. This is prevalent in the central U.S., where representatives are the Chattanooga, Ohio and Woodford shales. It may also be represented in the lower Amazon basin of Brazil, and elsewhere. Beside distinctive conodonts, as *Palmatolepis*, and megaspores of plants, such shales frequently contain silicified logs of primitive conifer-like wood, remains of tiny conical floating pteropods, inarticulate Brachiopoda (*q.v.*) and the bones of fishes. It is clear that there were no high or rising lands near the sites of deposition of such sediments, yet they commonly overlap older deposits at their margins as though approaching land. The fossils point toward free connections with the open sea, but the specific depth and other environmental conditions of the black shale deposition are debatable.

II. DEVONIAN LIFE

The Devonian is sometimes called the age of fishes because of the relative abundance and variety of fossil fishes found in the Old Red Sandstone and in some marine deposits. It was once supposed also that the higher plants first arose in Devonian time, because no ancestral forms had been found in older rocks. Both of these circumstances are fortuitous; actually the invertebrates are the numerically dominant Devonian fossils, and their evolutionary sequence is the reference standard for Devonian correlation.

1. Vertebrates.—Hundreds of species and all classes of fishes, from a few inches to several feet long, are known from the Devonian, commonly from finds in fresh water or estuarine deposits or associated with black shales of marine origin. In North America alone over 100 genera are recognized, with two or three times as many in Upper Devonian deposits as in Middle or Lower.

Late in the period the first four-footed vertebrates arose from the lobe-finned crossopterygian fishes, which have persisted to modern times in waters of moderate depth off Madagascar where the living coelacanth (*q.v.*) has been found. The first vertebrates to emerge from the seas were labyrinthodont amphibians, of which nine Devonian species were recorded up to the second half of the 20th century. It is a delicate and not too important point whether some of these fishlike amphibians are not really amphibianlike fish; the dispute merely fortifies the indicated evolutionary connection. (*See* AMPHIBIA: *Evolution.*)

Despite their conspicuousness in some deposits, the Devonian vertebrates were far from the earliest of their line. The oldest vertebrate fossils known are fragments of bony armour from relatives of the jawless hagfishes and lampreys, found in Middle Ordovician deposits in the American Rockies. Four of the five orders of these jawless fish (Agnatha) are recorded from both Silurian and Devonian deposits, but none are known to have survived the Devonian. (*See* CYCLOSTOME.)

A second class of fishlike vertebrates related to the sharks, the placoderms, with armoured heads and soft bodies, is almost limited to the Devonian. Only one of the six orders of these bizarre creatures, the acanthodians, has significant records in either older or younger rocks. Numerous and distinctively Devonian mollusk-crushing varieties do appear at the top of the Silurian, however, and one is recorded from the Lower Carboniferous. Real jaws were present, although only the lower one was movable. These were probably the first vertebrate predators. With the arrival of the sharklike fishes or Chondrichthyes (selachians) who left their first known records in the Middle Devonian, the last major step in fish evolution was achieved. Jaw articulation was now entirely free. (*See* CHONDRICHTHYES.)

Meanwhile fishes with bony internal skeletons, the class Osteichthyes, had become abundant in Middle Devonian freshwater deposits. Among this group, the lobe-finned crossopterygians and the lungfishes (Dipnoi) held the upper hand through the rest of Devonian time, while the subsequently dominant ray-finned fishes were greatly subordinate. The development of internal nostrils in both Dipnoi and crossopterygians, and of lungs in the former, indicate adaptations to air breathing, probably as

a result of seasonal droughts. Despite the later lack of success of these sharp-toothed but sluggish predators, both have living representatives, and descendants of their backward minnowlike Devonian contemporaries, the ray-finned paleoniscids evolved in a direct line to paddlefishes and sturgeons. (*See* FISH: *The Rise of Fishes.*)

2. Plants.—Although Sir William Dawson had found and correctly interpreted the simple vascular plant called *Psilophyton* in the Lower Devonian of Gaspé (Canada) as early as 1859, botanists generally ignored the implications of this discovery for plant evolution until much later. The discovery of similar as well as structurally more advanced plants in undoubted Silurian deposits in southeastern Australia in 1908, and of the Middle Devonian Rhynie chert deposit in Scotland in 1917 caused a re-evaluation of paleobotanical data. A broad morphologic unity has been recognized by grouping all vascular plants together as the Tracheophyta, with four major subdivisions (Psilopsida, Lycopsida, Sphenopsida and Pteropsida), the first three present throughout the Devonian and the last (Pteropsida) arising toward the end of this period (*see* PALEOBOTANY: *Geologic Distribution and Ecology*). The competitive advantages of a vascular water-conducting system are so great, the basic vascular structure is essentially so simple, and the other morphological differences between early representatives of the different groups of higher plants are so marked that paleobotanists increasingly suspect their repeated independent origin. In any event the long pre-Devonian existence of woody plant diversification seems corroborated by the repeated reports of Cambrian spore discoveries in Estonia and north India and the announcement of leaf bearing, though asporangiate, woody shoots from marine Middle Cambrian deposits in eastern Siberia.

A relatively rich record of the land plants, and many noteworthy evolutionary advances, are, nevertheless, first recorded in the Devonian. The known Lower Devonian floras were low, herbaceous, semiaquatic plants without clear differentiation into true root, stem and crown—similar to those of the Silurian, and resembling living club mosses. A much higher degree of differentiation is observed among Middle Devonian plants, which include several of the principal races of the woody plants and even a few treelike gymnosperms. A fossil forest of a fernlike plant, *Aneurophyton,* in eastern New York has yielded trunks several feet in diameter and leaves six feet long. Forests were well established by Late Devonian time, made up of the predecessors of the Carboniferous coal-swamp forests. Indeed, thin Devonian coal seams are found at a few places. Trunks up to five feet in diameter of the great cordaite gymnosperm, *Callixylon,* were floated out to sea, and silicified logs are common in marine and near shore Upper Devonian deposits all over the eastern U.S. and in the Donetz basin of southwest Russia.

The lower plants are known from the occasional remains of red and brown algae, siphonaceous green algae, dextrally spiraled stoneworts (Charophyta), and various composite algal structures, all marine. Identifiable smaller algae obtained from chert in the uppermost Lower Devonian Onondaga beds of New York state include greens (desmids and Ulotrichaceae) and blue-greens (Chroococcaceae). (*See* ALGAE.) A variety of well preserved fresh-water fungi and algae have been obtained from the Rhynie chert of Aberdeenshire.

3. Invertebrates and Associated Fossils.—Devonian marine invertebrate faunas are dominated by brachiopods and corals, with large numbers also of bivalve mollusks (pelecypods) and of stony Hydrozoa (stromatoporoids) locally. Shell-bearing cephalopods with complicated internal partitions, the nautiluslike ammonites, became common in the Upper Devonian—the beginning of a long line of distinctive, short-lived, widely-distributed species of superior value as time indicators. Conodonts are frequently common where other fossil evidence is rare or missing, and hence are also of special interest in rock correlation. Unicellular (or noncellular) organisms (Protozoa) are represented by a few Foraminifera and many Radiolaria. Tracks and trails, burrows, markings made by drifting objects, unclassified fossils, and unidentified objects resembling fossils, are common in Devonian rocks as in others—they are the crossword puzzles of paleontologists, commonly spelling messages of great interest when worked out. (*See* FOSSIL; ANNELIDA: *Fossil Annelids.*)

Simplest of the many-celled animals (Metazoa) are the sponges, which were numerous in parts of the Devonian, especially in the Upper Devonian of New York state.

Corals and stony Hydrozoa represent the cnidarians (coelenterates with stinging cells). Together and separately they constructed reefs and thicketlike associations in clear Devonian shelf waters from beginning to end of the period. Devonian coral faunas are characterized by predominance of fasciculate and simple tetracorals whose tubular calcareous skeletons included vertical septa arranged in fours and numerous horizontal to oblique internal partitions (tabulae and dissepiments). Simple cones with a cystose internal structure are abundant. The colonial tabulates, which were abundant in the Silurian, are subordinate and all but a few forms die out at the end of the Devonian; reported Devonian occurrences of the chain coral *Halysites* have not been authenticated. Tetracorals with axial structures such as characterize the Carboniferous first became common at the very top of the Devonian (Strunian stage), with the dwindling of colonial and solitary, dissepimented forms. Stony hydrozoans are about equally common in Silurian and Devonian reef assemblages, but are represented in post-Devonian (post-Strunian) strata by only a few aberrant types which apparently carried through until Cretaceous time. One aberrant twiglike variety with a radial canal and distinctive network tissue (*Amphipora*) is distinctive of upper Middle and lower Upper Devonian (Givetian and Frasnian stages) limestones and dolomites throughout the world. It commonly is abundant in black carbonate rocks that lack other fossils, or with nothing else but large thick-hinged pelecypods—the so-called spaghetti or vermicelli beds of some stratigraphers. The stony Hydrozoa (stromatoporoids) are related to but do not closely resemble the millepores that contribute so importantly to modern reefs (*see* HYDROZOA). The tetracorals and tabulates are quite unlike modern corals of either shallow or deep water.

Polyzoa or Bryozoa (*q.v.*) (moss animals) are abundant throughout the Devonian. Stony types (trepostomes) were common, but apparently diminishing, while the lacy varieties (fenestellids) forged ahead.

Devonian brachiopods show bursts of evolution among the loop and spire bearers (terebratuloids and spiriferoids), continued abundance and expansion of rhynchonellids, and the beginning of expansion of the spiny productoids. Dalmanelloids and strophomenoids were somewhat more abundant than in later times, but the true orthoids dwindled out early in the period. The many short-ranged loop-bearing terebratuloid genera are especially helpful in Lower Devonian correlation; the wide-hinged spiriferoids throughout the system.

Marine clams (Lamellibranchiata) and snails (Gastropoda) increased greatly during the Devonian, the former locally outnumbering the brachiopods in near-shore facies. The oldest records of fresh-water clams (*Archanodon*) are also Devonian. The great Ordovician-Silurian surge of nautiloid cephalopod evolution continued the decline in the Devonian that had begun in the Silurian. Their cousins, the ammonoids, evolved to fill the predatory niches vacated by the nautiloids, and to take their place as index fossils. Devonian ammonoid septa and sutures were simpler than later forms, a feature sometimes recognized by calling them goniatites.

Trilobites, strongly reminiscent of their Silurian ancestors, are common in the Lower Devonian, a spiny variety reaching a length of two feet. They dwindle in number and diversity during the rest of Devonian time, foreshadowing their extinction in the Permian. Minute bivalved Crustacea, the ostracods, are abundant, and apparently planktonic species have been found particularly useful in correlation in Europe. Branchiopod Crustacea are fairly common and occasionally nonmarine (*Estheria*). Giant arachnid-like arthropods, the Eurypterida (*q.v.*), lived mainly in fresh-water bodies and estuaries; where they perhaps preyed on the early fishes and their smaller fellow invertebrates. Ancestral spiders which are found in the Rhynie chert presumably evolved

from unknown arachnid ancestors during the Silurian.

Echinoderms, except cystoids, were advancing. Blastoids, echinoids and starfishes increased in numbers and variety, and crinoids became locally abundant. Single bladed types of graptolites died out with the Silurian, and only occasional net-formed (dendroid) graptolites are found in the Devonian.

4. Biogeography and Migration Routes.—Although the faunas and floras of the Old Red facies seem much alike the world over, some of the Devonian marine faunas show marked division into mainly southern hemisphere (austral) and mainly northern hemisphere (boreal) types. These two major provinces seem to have been most clearly defined in later Early Devonian time, when the boreal fauna was also most clearly divisible into European and North American subprovinces.

The austral Lower Devonian is particularly characterized by sandy and silty sequences containing the brachiopod *Australocoelia* in South America, South Africa and Tasmania. An unusual and apparently rare brachiopod, *Scaphiocoelia,* of South American and African Lower or Middle Devonian beds appears to be another distinctive element. The boreal Lower Devonian commonly displays a sedimentary facies similar to that of the austral province, but only in North America does it contain possible faunal ties, especially the brachiopod genus *Leptocoelia,* a close relative of *Australocoelia.*

In addition to general circum-antarctic connections, therefore, there was evidently some later Early Devonian communication between North America and the austral provinces. There are strong ties between North American later Early Devonian faunas and those of the Reefton beds in New Zealand, for instance; while the somewhat older Baton river beds of the same area are more closely allied to the European faunal subprovince. Related boreal Middle and Upper Devonian faunas can be traced clear across Europe, Siberia and the orient to Australia; and some of the same elements (*Amphipora, Pachyphyllum, Stringocephalus*) got into North America. Possible connections can be seen even on the highly generalized distribution map. North America seems to have been a sort of mixing pot, with at least temporary connections to Europe, to Siberia and to the southern hemisphere. In Middle and Late Devonian time its internal seaways probably connected with both Europe and Siberia through far northern channels. During parts of Lower Devonian time there was probably communication between Europe and New England, and from Tennessee to South America.

III. REGIONAL SUMMARY

The composite and highly generalized distribution map shows where Devonian deposits of different ages and broadly different types might have been laid down on the present land areas. Beside those here indicated, nonmarine sediments also will be found to interfinger with the marine deposits along the margins of the ancient seaways mapped; and the sediments of subsiding basins may be widely overlapped by shelf-sea deposits.

The map and the correlation table together, however, provide a framework of data on the distribution of Devonian rocks and seas that gives a general idea of the local complexities and supplements the discussion that follows.

1. Great Britain.—The type sequence of the Devonian system in south Devon consists of 1,000 ft. or so of Middle and Upper Devonian limestones and some interbedded shales, resting on an unknown thickness of impure sandstones and clayey beds of Early Devonian Age. In north Devon the sequence is about 13,000 ft. thick and consists of sombre graywackes, slates, shales, sandstones, volcanic sediments and occasional discontinuous limestones. The lower part (Foreland grits), of which the base is unknown, consists of red sandstones and conglomerates with land plants. The top beds are in depositional sequence with overlying Lower Carboniferous strata. The Devonian sections of both north and south Devon contain distinctive marine fossils in common with the west Rhineland and Ardennes sections, which have been accepted as correlation standards.

The north Devon sequence is replaced northward across the Bristol channel by the Old Red facies, with the base of which the Foreland grits are probably continuous. The detrital north Devon and lower south Devon sediments contain land plants, fish and shallow water types of brachiopods, corals and mollusks; whereas the post-Lower Devonian limestones of south Devon include coral-stromatoporoid reefs. Faunal and sedimentary facies hold the same natural geographic relationships as in the Ardennes region, only slightly foreshortened by structural compression. Thus similar reef limestones and shales occur from Ireland to the Rhine between near shore shelf or shallow basin sediments to the north and a deep basin shale-sandstone facies with open sea elements to the south, as in Brittany.

Wales, the Scottish Lowlands, and the area around Moray firth were the sites of major Devonian continental basins into which as much as 40,000 ft. of mainly red detritus poured from the erosion of surrounding mountains and volcanoes. It was buried so rapidly that much of the ferruginous colouring matter remained in an oxidized state. Robert Jameson mistakenly called this detritus the Old Red Sandstone in 1808, thinking it to be the British equivalent of Abraham Gottlob Werner's "Aelter rother Sandstein" in the Permian system. The mistake stuck, and Werner's Permian deposits eventually got a new name, the Rotliegende, while Old Red was extended to Devonian continental deposits all over the world. Fishes are the local basis for relative time subdivision and correlation of the Old Red.

Between the Old Red, of continental origin, and the underlying Silurian, of marine origin, in England are the so-called Downtonian beds, which were long referred to the Silurian because they contained marine fossils. Studies of the fishes and plants in these and correlative beds eventually suggested strong Devonian affinities, and mapping showed generally disconformable relationships with the underlying beds in south Wales. Finally it was established from the marine fossils that the Downtonian is the equivalent of certain strata (the Mondrepuits clayey rocks or argillites) near the base of the Devonian in the standard Ardennes section.

2. Ardennes and North Rhineland.—Thanks to the efforts of five generations of Belgian and French paleontologists and stratigraphers the world's best known Devonian sequence is the wonderfully complete and fossiliferous marine section of the Dinant basin and adjacent parts of Belgium and France. The 18,000 ft. or so of shale, siltstone, sandstone and limestone comprising this sequence is easily accessible for study in artificial and natural cuts, including sawed quarry surfaces that transect entire coral and stromatoporoid reefs of Middle Devonian Givetian and Upper Devonian Frasnian age several yards thick. Moderate folding has repeated parts of the section so that lateral changes of facies may be studied.

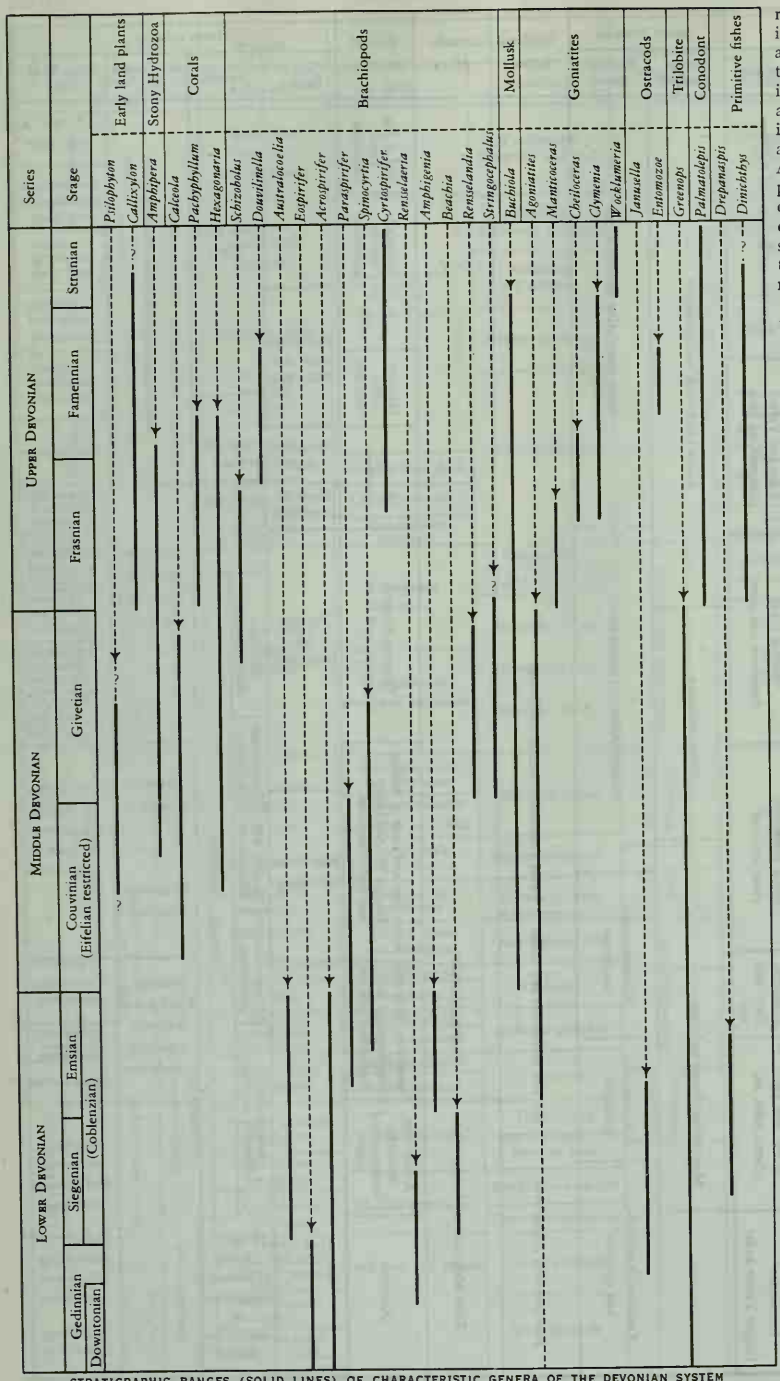
This Ardennes sequence is strikingly similar to that of south Devon when distance and deformation are taken into account. The Ardennes reefs and detrital limestones have been studied particularly by M. Lecompte who finds that they change laterally to and are interbedded with shales, and attain maximum dimensions of over 800 ft. thickness and more than one-half mi. in length. They began to grow in early Middle Devonian time at the shoaling edge of an open basin to the south. Thereafter, the reefs formed intermittent local barriers to circulation in the shelf seas that stretched northward behind them to the border of the Old Red continent. Their shelf equivalents are red and green silty shales and patches of dolomite, relatively thin, with basal beds increasingly younger northward. The pile of siltstones, sandstones and silty shales below the oldest reefs suggest that the latter appeared late because they were unable to gain a foothold until the supply of debris was reduced by erosional lowering of the source area. They were eventually killed off by a flood of mud in the Dinant basin in late Frasnian and Famennian time. This mud became a shale, which grades northward to the near-shore Condroz sandstones in the Namur basin.

Continuing eastward into the Rhenish Slate mountains (Rheinisches Schiefergebirge) of north Rhineland, is a roughly similar but changing suite of rocks. The Eifel section, farthest west, has almost the same thickness as the Ardennes section and is also richly fossiliferous. Its lowest beds are continental in origin,

Series	Stage	Britain: North Devon	Britain: South Devon	Belgium: Ardennes	Germany: Eifel	Germany: Sauerland	Bohemian massif		U.S.S.R.: Moscow basin	U.S.S.R.: Altai foothills
Upper Devonian	Strunian	Lower Pilton slates	?	Etroeungt limestone and sandstone		Wocklumeria limestone and shale			Malerka-Muraevna limestone	Podonyinsky limestone, sandstone and slate
	Famennian	Baggy and Marwood beds	Plymouth or Great Devon limestones with associated and laterally equivalent shales and sandstones	Condroz sandstone and shale	Sandstones and shales of Hohes Venn	Dasburg limestone and shale			Dankov-Lebedjansk dolomite	
						Hemberg red siltstone				Jarnovsky limestone, sandstone and clay
		Pickwell Down sandstone		Famenne shale		Nehden sandstone			Elezk limestone and clay	
	Frasnian	Morte slates		Matagne olive shale		Adorf limestone				Kaigiusky limestone and shale
				Frasnes reef limestone and shale	Budesheimer shale				Eflanov marl, clay and limestone	Sergeivsky sandstone and conglomerate
					Ooser limestone				Varanezsch clay and limestone	Petropavlowsky beds
				Fromelennes shale and limestone	Wallesheimer dolomite				red beds	
Middle Devonian	Givetian	Ilfracombe limestone and shale with Stringocephalus and Cyrtospirifer		Givet reef limestone and shale	Schönecker dolomite	Roteisenstein	Srbsko shale and quartzite	h	Semiluk limestone and clay	Iarsky clay and sand
						Hauptgrünstein			Schtschigrg clay and conglomerate	Safonovsky limestone and tuff
						Finnentrop beds				
					Fleringer calc. shale and limestone	Tentaculite beds			Stary-Oskol clay and marl	Kerlegeschky limestone and tuff
	Couvinian (Eifelian restricted)			Couvin shales and reef limestones	Freilinger shale and limestone	Bänderschiefer				Akarakinsky tuff, sand and slate
					Rommersheimer limestone and shale	Selscheid shales	Hlubočep limestone			Mamontovskiesloi beds
		Haugnan grits with fish and plant fragments			Geeser shale and limestone	Mühlenberg beds	Daleje shale	g		Schandinsky limestone
				Bure shale limestone and siltstone	Nohner calc. sandstone	Hobräcker beds				Salairsky limestone
			Staddon grits		Laucher shale and limestone	Cultrijugatus zone	Bráník limestones			Nadkryovsky limestone
Lower Devonian	Emsian			Hierges siltstone and shale	Heisdorfer ss	Oberems				
					Wetteldorfer ss					
				Winenne sandstone and shale	Wiltzer shale	Koblenz quartzite				
	Siegenian (Coblenzian)	Lynton slates and grits	Meadfoot slates with limestone beds		Ems sandstone					
				Vireux shale and siltstone	Klerfer sandstone	Unterems				
					Stadtfelder bed		Konĕprus limestone	f		
				Pengny siltstone and shale	Ruhrberger beds	Ulmen beds				
						Herdorf beds				
				Houffalize silty shale						
	Gedinnian	Foreland grits with Psilophyton	Dartmouth beds (variegated argillaceous)		Monschauer beds	Rauhflaser-horizont				Krekovsky limestone
				Anor arkose and shale		Tonschiefer-horizont				
	Downtonian			St. Hubert sandstone and shale	red beds and arkose	Bunte Ebbesch				
				Oignies spotted shale						
				Mondrepuits argillite						
				Haybes sandstone and cg.	?	Silberger shale				
				Fepin conglomerate		?				

DEVONIAN CORRELATION TABLE SHOWING GENERAL SUBDIVISIONS AND LOCAL SEQUENCES

Southwest China	Australia		South America		Falkland Islands	South Africa	Central Morocco	North America			
East and central Yunnan	North-west	Southeast	Lower Amazon	Bolivian Andes				Canada Slave L.	Nevada	N. Central U.S.	New York State
Sinospirifer triplisinosus limestone		Lambian sandstones and argillites	Curuá black shale and limestone ?	? fissile shale, slate and sandstone			Sidi el Haj Tahri limestone		Pilot shale (part)	Huron, Antrim and Ellsworth black shales	? Knapp cg. and shale
	Productella limestone						Goniodymenia limestone				Conewango conglomerate and shale
	Sporadoceras beds						Aricha shale	Hay River shale and limestone			Conneaut sandstone and shale
Sintsouen beds	Cheiloceras beds	Eden and Yalwal lavas and red beds					Manticoceras limestone				Canadaway shale and sandstone
Laofongtsun beds	Manticoceras beds						Alveolites limestone	Simpson shale	Devil's Gate limestone (and shale)		Chemung sandstone and shale
				?				Slave Pt. limestone			Naples shale
Lunan beds	Amphipora limestone	Moore Creek limestone and chert		Sicasica shales and sandstones	?		Tiliouine-Slimane limestone and shale	Presque Isle limestone		Traverse group of limestones and shales	Genesee black shale and sandstone
Kwahsinshan limestone			Erere sandstone						Bay State dolomite mem.		Tully limestone, shale and sandstone
Tahili beds											Moscow shale and limestone
Tungshan limestone											Ludlowville shale and limestone
Sieul beds		Sulcor limestone, chert and tuff					limestones and shale of Sefout, Dechta Ait Abdallah, and Sidi Rhezouani		Woodpecker limestone m.		Skaneateles shale and sandstone
								Pine Point limestone	Sentinel Mt. dolomite m.	Delaware limestone	Marcellus shale sandstone and limestone
			?	Huamampampa sandstone						Columbus limestone	
Lunghashan sandstone ?		Nemingha limestone, chert and tuff	Maecurú sandstone and shale		Fox Bay sandstones and shales	Bokkeveld series ?	limestone, shale and sandstone of Sidi Daoud to Christian		Oxyoke Canyon sandstone m.	Detroit River group dolomite limestone sandstone	Onondaga limestone
		Lower Tamworth cherts, tuffs, etc.		Icla shale and sandstone					Beacon Peak dolomite member		Schoharie shale and sandstone
											Esopus shale
					Port Stephens sandstones?	Table Mountain sandstones	Acrospirifer Sieberella limestone and shale				Oriskany sandstone and Glenerie limestone
		Cave Hill and Loyola limestones (Upper Yering beds)		Cordillera Real shale and quartzite			Quartzites		Upper "Lone Mountain" limestones of Antelope Valley		Helderberg shales and limestones (including Manlius Is.)



STRATIGRAPHIC RANGES (SOLID LINES) OF CHARACTERISTIC GENERA OF THE DEVONIAN SYSTEM

rather than marine, however, and it also differs in the greater amount of calcareous shale and the reduction of reef limestones in beds of Givetian and Frasnian age. It is, nevertheless, richer in well-preserved brachiopods and other shelly fossils than the Ardennes section. Natural exposures are poor, but in the early days trenches and quarries were dug especially to collect the fossils, and they became well known through the descriptions of German paleontologists.

The Sauerland sequence, in the northeastern Slate mountains attains thicknesses of 25,000 to 30,000 ft., and is much sandier than equivalent beds of the Eifel or Harz. It includes relatively deepwater deposits with floating types of minute bivalved crustacians and conical gastropods (ostracods and pteropods) in the upper part; but reefs of colonial tetracorals and stromatoporoids are found in Givetian to Frasnian equivalents locally. These reef limestones are the Massenkalks of German geologists, good sites for quarries and hilltop cathedrals. The lower beds are mainly sandstones, slates and metamorphosed silty shales with occasional zones that are rich in brachiopods and other shelly fauna indicative of relatively shallow water. These retain a generally similar nature from Sauerland westward to the gorge of the Rhine, where a bluff and river shallows of Emsian sandstone produced the legend of the Lorelei.

Probably parts of the area of the Slate mountains tended to be high in Devonian time as some do today. This would account for complications in the depth facies of the sediments in this area. Evidences of contemporaneous volcanism suggest that parts of the area were volcanic islands.

3. Central and Southern Europe.—Eastward across Europe from the north Rhineland Slate mountains the lowest and highest Devonian formations drop out, and the remaining Lower and lower Middle Devonian becomes increasingly calcareous. In the Harz region the beds are calcareous shales and shaly limestones, and at Prague they are pure limestones that have yielded myriads of well preserved brachiopods and trilobites for the museums of the world. The Upper Devonian is missing here, presumably because of non-

deposition due to emergence of the Bohemian positive area, as foreshadowed by the shallow water deposits of Givetian Age that comprise the Srbsko beds. Preponderantly calcareous Devonian sequences in Europe are sometimes referred to as the Bohemian facies, in contrast to the Rhine or Rhenish facies—calcareous sedimentation in contrast to sandy sedimentation. The intermediate facies of the Harz Mountains is then called Hercynian.

Actually the calcareous Devonian in Europe is mainly an Alpine (or Tethyan) type deposit. In the Carnic Alps, for instance, a possibly complete Devonian sequence is represented by fossiliferous limestone. Lower and Middle Devonian beds are commonly reef rock, locally dolomitic, while the Upper Devonian begins with a brachiopod facies and ends in a sandy basinal facies, with ammonoids. These deposits were formed in the Tethyan seaway, which occupied the present site of the Alps and south Asian mountain ranges. Broadly similar deposits occur generally in the Mediterranean region.

Elsewhere in Europe, Devonian rocks occur in the Vosges, Montagne Noire, and Massif Central of France; the Pyrenees, Catalonia and other parts of Spain; in several of the larger Mediterranean islands; and in Rumania. A good and fossiliferous section, with representatives of all series is found in the Holy Cross mountains (Gory Swietokryzskie) near Kielce, in Poland, and outcrops of Old Red and Downtonian deposits are known in the gorges of the Dniester river drainage in western Podolia, now a part of Russia.

4. U.S.S.R.—A shallow but subsiding gulf of the European epicontinental sea spread northeast beyond Moscow, where a maximum of about 4,000 feet of limestone, marl, clay and some dolomite at the centre and south grades laterally into thinner sandstones with fossil fish, fossil plants, and generally strong Old Red affinities. In the vicinity of Moscow this sequence is known from borehole records only, but it rises southward to expose a thin edge of marine Upper Devonian limestones between Kursk and Varanezsch.

A Devonian subsiding trough ran the length of the Urals (Uralian geosyncline), to merge with the Tethyan channel to western Europe, and to spill eastward as the Siberian epicontinental sea, eventually crossing China to Australia and connecting with Alaska. Geological knowledge of the Urals and Siberia was increased by investigations after the middle 1920's, and especially after 1945. Thus, the Altai foothill section (Kuznetsk coal basin, south central Siberia) given on the correlation table incorporates extensive revisions of older work introduced by G. N. Kartseva and V. B. Tsyrlina in 1956.

The Ural sections are shales, marls and limestones, of great thickness, representing all major divisions of the period above the Lower Devonian Siegenian. The same sedimentary trough stretched the length of the Novaya Zemlya arctic islands and northwestward, probably to connect with the Cordilleran geosyncline in North America. Central Siberian sections, reaching to the Lena delta area, show Middle and Upper Devonian limestones and shales, commonly rich in shelly faunas and corals. These deposits are apparently not very thick. From Tomsk almost to Kamchatka they grade shoreward into a variety of volcanic deposits, and to red and green clays, marls and sandstones of Old Red facies with fossil fishes. The distinctive Uralian and Siberian brachiopod, the spiriferoid genus *Theodossia*, characteristic of Givetian and Upper Devonian deposits, gets into central North American deposits, presumably via the arctic.

5. Asia.—Yünnan province (southwest China) has a thick and nearly complete marine sequence of Middle and Upper Devonian rocks somewhat reminiscent of that in Siberia. The Lower Devonian is represented only by a thin nonmarine sandstone. Devonian sections, generally poorly represented in the lower part, are also known from Kwangsi, Szechwan, Kweichow, and Hunan in China and from Indochina and at places throughout the high mountain ranges leading west to Iran and the Bosporus. In the Kitakami mountains of northern Japan all series of the Devonian are represented by fossiliferous marine volcanic sediments, some with land plants.

6. Australia, New Zealand and Approaches.—The only known Devonian between Malay and Australia is found in central Netherlands New Guinea. These strata contain a Frasnian marine fauna.

In the Kimberly embayment of western Australia, however, the Devonian section reaches a thickness of 10,000 ft. or more. It consists of clastic debris from the erosion of rising adjacent lands and limestones of post-Couvinian (Middle Devonian) Age, with a marine fauna allied to that of Europe. Interbedded with the marine sediments are extensive volcanic deposits.

The eastern mountain ranges of Australia display thick Devonian sequences in Tasmania, Victoria, New South Wales and Queensland, all including both marine and continental deposits with a strong to predominating volcanic element. A composite section ranges from about 10,000 to 16,000 ft. thick, but no complete section is known at any one place. The Upper Devonian is widespread, but outcrops of the Lower and Middle parts are scattered and restricted. The locally rich marine faunas resemble those of Europe. In Tasmania the brachiopod *Australocoelia* provides a southern hemisphere flavour. Radiolarian cherts are abundant, perhaps because of local enrichment of the water in silica as a result of volcanism. Although radiolarian cherts are sometimes considered to indicate deep water deposition, these are associated locally with shallow water limestones containing reef building tetracorals, the stony hydrozoan *Amphipora*, and the large stringocephalid brachiopod *Bornhardtina*.

The Devonian record in New Zealand is limited to the two sequences previously mentioned under *Biogeography and Migration Routes*, the Reefton beds of Siegenian to Emsian Age, and the apparently somewhat older Baton river beds, containing the brachiopod *Eospirifer*.

7. South America.—A Devonian sedimentary trough extended the length of western South America from Venezuela to the Falkland Islands. Apparently separate subsiding basins also existed in Brazil, Paraguay and Uruguay. The best known section is in Bolivia, where shales and sandstones below the Middle Devonian Sicasica beds represent the Lower and perhaps lower Middle Devonian. The Andean Sicasica series of shales and sandstones contains Middle Devonian fossils, especially the trilobite *Dipleura dekayi*. It is overlain by shales and sandstones of possible Late Devonian Age. Partial equivalents of the Sicasica beds, with faunal affinities to the North American Middle Devonian occur in Colombia (Floresta beds), Venezuela (Río Cachiri beds), and Brazil. Curuà black shale beds (Pará, Brazil), containing the brachiopod *Schizobolus concentricus*, probably transgress the boundary from Middle to Upper Devonian.

8. Antarctica and South Africa.—The terrestrial Beacon sandstone and shale of Victoria Land, eastern Antarctica contains Upper Devonian fish in the lower shales at Granite Harbor, and post-Devonian plants above. These deposits attain a thickness of 5,500 ft. but it is not known how much of this is Devonian.

South Africa exposes a thick clastic section with a few marine fossils between Cape Town and the Cape of Good Hope. Brachiopods in it, including *Australocoelia*, indicate affinities with South American and Tasmanian Lower Devonian.

9. North Africa.—Devonian seas covered the western third of north Africa, from the Gold Coast (Ghana) to the central Sahara. Nearly complete sequences 6,500 ft. or so thick accumulated in a northwestern trough that subsided markedly, from shallow beginnings, in Middle and Late Devonian time. This trough ran northeastward through central Morocco to the northwestern Sahara. South and east of an intermittently high axis in western Algeria, the sea was shallow and deposition irregular. Land northwestward beyond the subsiding trough toward Gibraltar is heralded by nearshore sands with plant remains in that direction. Limestone deposition and reef formation prevailed in clear shoal waters at the southern margin. Above the Lower Devonian, ammonoids and other open sea species are found both in the trough sediments and, episodically, in the shelf areas, indicating local deepening or good communication channels from shallow to deep water. In central Morocco is an apparently complete fossiliferous marine sequence mainly of limestone and shale, with quartzite at the base.

10. North America.—A broad and mainly shallow seaway brought an arctic fauna down through the Cordilleran region of western Canada and the western U.S. This seaway at times had east-west connections across the northern and southern U.S. (and into Mexico) that permitted mixing of eastern and western faunal elements. For the most part, however, the eastern epicontinental seas seem to have had separate connections with the ocean. Faunal affinities of the eastern deposits are closer with the German Eifel succession than with the coral rich Ardennes. The fossil record shows that even if the larvae of reef corals were brought to the area they could not ordinarily survive in the turbid waters of the eastern seas except during parts of the Early Devonian and much shorter intervals of the Middle. On the other hand, corals and stromatoporoids, with reef associated brachiopods, were able to spread through the relatively shallow seas of Canada and the western U.S., because adjacent lands were generally low and waters clear. Strikingly different faunas are found in Alaska and northern California, with affinities to Siberia and the Urals.

The Devonian system in the central Appalachians and New York state is particularly important as one of the world's classic reference sequences. The Lower Devonian is mainly shallow-water (platform) limestones and shales with sandstone in the middle part. In New England and the northern Appalachians, however, the largest part of the section is siliceous detritus, some in the upper part (Gaspé sandstone) with plants. The Middle Devonian of New York state forms a great wedgelike succession of beds, thinning westward. On the east, in the Catskill mountains, it is represented by thick red and green sandstones and conglomerates containing fishes, the remains of an *Aneurophyton* forest, freshwater pelecypods, and large Eurypterida (*q.v.*). Westward toward the centre of the state the beds interfinger with marine sands and shales, and at the western New York border black shales occupy most of the section. Further westward these grade into marls, limestones, and dolomites containing the great coral plantations of a former platform sea in southwestern Ontario, Michigan, Wisconsin and Indiana. A similar facies development occurs east to west throughout the Appalachians far southwestward from New York. The Upper Devonian of eastern New York and the Appalachian region is almost wholly of Old Red facies in the eastern part and finer sandstones and silty shales to the west. In Ohio the sandstones pass into black shales. In the midwest and the south the black shales are collectively known as Chattanooga shale, locally including parts of Early Carboniferous Age.

In Iowa and Missouri the Middle Devonian is mainly limestone and dolomite; the Upper Devonian consists of limestones and marls, commonly containing corals and, in the lower half, the ammonoid goniatite *Manticoceras*. A red-bed facies with fishes and plants occurs locally. In Wyoming and Utah, channel fillings in pre-Devonian beds have yielded fishes resembling those of the lower Old Red, but possibly pre-Devonian. In the far west and central Canada carbonate rocks (limestones and dolomites) predominate, with some sandstone and shale, as much as 3,000 to 6,500 ft. thick. Faunas show affinities with both eastern U.S. and Europe.

See also references under "Devonian System" in the Index volume.

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DEVONPORT, a seaport town on the north coast of Tasmania, Austr., lies on both sides of the Mersey estuary 82 mi. N.W. of Launceston by rail. Pop. (1954) 10,597. The town developed from the villages of Torquay on the east and Formby on the west bank. The district is mainly agricultural with secondary industries (food processing, textiles, milk products); the chief exports are potatoes, cement and timber. The excellent harbour has sheltered wharfage on the west bank. Devonport is linked by ferry services with Melbourne (210 mi. N.N.W.) on the Australian mainland and by air services with Melbourne and Launceston.

DEVONSHIRE, EARLS AND DUKES OF. From 1618 the Devonshire title has been held by the Cavendish family, one of the most powerful of the great Whig families. Previously it was held by CHARLES BLOUNT (1563–1606), 8th Lord Mountjoy, who as lord deputy of Ireland (1600–03) combated the earl of Tyrone's rebellion. He was created earl of Devonshire in 1603, but the title died with him. In the Cavendish line the 1st earl of Devonshire was WILLIAM (1552–1626), second son of Sir William Cavendish (d. 1557) and of Bess of Hardwicke (afterward countess of Shrewsbury). He was given the title by James I in 1618 and was succeeded by his son WILLIAM (1590–1628), 2nd earl, and grandson WILLIAM (1617–84), 3rd earl.

The 3rd earl's eldest son and successor, WILLIAM (1641–1707), 4th earl and 1st duke of Devonshire, was born on Jan. 25, 1641. He entered parliament in 1661 and soon showed himself a determined and daring opponent of the general policy of the court. He was one of the committee appointed to draw up articles of impeachment against the earl of Danby in 1678. In 1679 he was re-elected member of parliament for Derby and made a privy councilor by Charles II. He withdrew from the board with his friend Lord William Russell when the duke of York (afterward James II) was recalled to the court (1680). He carried up to the house of lords the articles of impeachment against Lord Chief Justice William Scroggs, and when the king declared his resolution not to sign the bill for excluding the duke of York from the succession, he moved in the house of commons that a bill might be brought in for the association of all his majesty's Protestant subjects. He appeared in defense of Lord Russell at his trial, and after Russell's condemnation offered to exchange clothes with him in the prison, remain in his place and so allow him to effect his escape. Cavendish succeeded to the earldom in Nov. 1684. He opposed the government under James II with the same consistency and high spirit that he had displayed during the previous reign. An imprudent quarrel at court was punished by a fine of £30,000 which he could not pay and he was in prison for some time. After his discharge the earl occupied himself with the building of his great house at Chatsworth (*q.v.*). The revolution of 1688 again brought him into prominence. He was one of the seven who signed the original paper inviting William of Orange to England and was the first nobleman who appeared in arms to receive him on landing. He received the order of the Garter and was made lord high steward of the new court. In 1690 he accom-

panied King William on his visit to the Netherlands. He was created marquess of Hartington and duke of Devonshire in 1694.

The 1st duke had married in 1662 a daughter of James, duke of Ormonde, and was succeeded by his eldest son, WILLIAM (*c.* 1673–1729), 2nd duke, whose son WILLIAM (1698–1755), 3rd duke, was viceroy of Ireland from 1737 to 1744. The 3rd duke's son WILLIAM (1720–64), 4th duke, married the daughter and heiress of Richard Boyle, earl of Burlington and Cork, who brought Lismore castle and the Irish estates into the family. From Nov. 1756 to July 1757 he was prime minister, mainly in order that William Pitt, who would not then serve under the duke of Newcastle, should be in power. His son WILLIAM (1748–1811), 5th duke, was the husband of the beautiful Georgiana Spencer (1757–1806) and of the intellectual Elizabeth Foster (1757–1824), both of whom Gainsborough painted. The 5th duke's son WILLIAM (1790–1858), 6th duke, died unmarried. He was the patron and friend of Sir Joseph Paxton. The title passed in 1858 to his cousin WILLIAM (1808–91), 2nd earl of Burlington, as 7th duke.

The 8th duke is noticed separately (*see* DEVONSHIRE, SPENCER COMPTON CAVENDISH, 8th Duke of). He died without issue, and his successor as 9th duke was his nephew VICTOR CHRISTIAN WILLIAM CAVENDISH (1868–1938), who was financial secretary to the treasury (1903–05), civil lord of the admiralty (1915–16), governor general of Canada (1916–21) and colonial secretary (1922–24). In 1892 he married a daughter of the marquess of Lansdowne. One of his daughters married Harold Macmillan who became prime minister in 1957. The 9th duke was succeeded by his son EDWARD WILLIAM SPENCER CAVENDISH (1895–1950), 10th duke, who held his father's seat in parliament for West Derbyshire (1923–38) and served as a parliamentary undersecretary from 1936 to 1945. His second son, ANDREW ROBERT BURTON CAVENDISH (1920–), 11th duke, became parliamentary undersecretary to the commonwealth relations office in 1960.

DEVONSHIRE, SPENCER COMPTON CAVENDISH, 8TH DUKE OF (1833–1908), British statesman who became leader of the Liberal Unionist party in 1886, was born at Holker hall, Lancashire, on July 23, 1833. He was the son of the 7th duke (then earl of Burlington) and his wife, Lady Blanche Howard (sister of the earl of Carlisle). Educated at home and at Trinity college, Cambridge, he was returned to parliament as Palmerstonian member for North Lancashire in 1857. At the opening of the new parliament of 1859 the marquess of Hartington, as he had then become, was chosen by Lord Palmerston to move the amendment to the address which overthrew the government of Lord Derby. In 1862 he visited the United States, meeting both Lincoln and Jefferson Davis, and in 1863 he became first a lord of the admiralty and then undersecretary for war in Lord Palmerston's government. In Feb. 1866 he entered Lord John Russell's cabinet as war secretary. He retired with his colleagues in July and used his comparative leisure to visit Germany and to meet Bismarck. He lost his seat in 1868, but became M.P. for Radnor early the next year. He entered Gladstone's first cabinet as postmaster general, an office which he exchanged against his own inclination, in Jan. 1871, for that of secretary for Ireland. When Gladstone temporarily withdrew from the leadership of the Liberal party in Jan. 1875, Lord Hartington reluctantly accepted the position of Liberal leader in the house of commons. He was a moderate critic of Disraeli's foreign policy in the near east, but emphatically condemned the conduct of Indian affairs which led up to the Afghan War of 1878. After the Conservative defeat in the general election of 1880, the queen sent for him as leader of the opposition, but Hartington had to decline her request to form a government, in view of Gladstone's position in the party. Hartington joined the new Gladstone government as secretary of state for India, from which office, in Dec. 1882, he passed to the war office. All through the life of this cabinet he led its conservative wing, especially on Irish matters. Gladstone's attempt to conciliate him through his younger brother Lord Frederick Cavendish (1836–82), who was made Irish secretary on May 4, 1882, resulted in the tragedy of Cavendish's murder two days later in Phoenix park, Dublin.

Hartington shared the responsibility for sending Gen. C. G. Gordon (*q.v.*) to evacuate the Sudan, but he repeatedly warned the cabinet of the urgency of the Wolseley relief expedition and threatened resignation when a decision was delayed. In June 1885 he resigned along with his colleagues, and in December was elected for the Rossendale division of Lancashire, created by the new Reform bill. Immediately afterward Gladstone's proposal of Home Rule for Ireland forced on Hartington the great political decision of his life. His refusal to follow his leader in this course inevitably made him the chief of the new Liberal Unionist party. In the house of commons he successfully moved the rejection of Gladstone's bill on the second reading. This led to the dissolution of parliament, and in the general election Gladstone was decisively defeated.

In the new parliament Hartington held a position much resembling that which Sir Robert Peel had occupied after 1846—the leader of a small, compact party, the standing and ability of whose members were out of all proportion to their numbers, a man much esteemed and trusted in the country, yet in his own opinion forbidden to think of office. Lord Salisbury's offers to serve under him as prime minister, after the general election of 1886 and again in Jan. 1887, after Lord Randolph Churchill's resignation, were declined and Hartington continued to discharge the delicate duties of the leader of a middle party. It was not until 1895, when the differences between Conservatives and Liberal Unionists had become attenuated by changed circumstances and by the habit of acting together, that the duke of Devonshire, as he had become in 1891, entered Lord Salisbury's third ministry as lord president of the council, an office which carried the responsibility for education. He also presided over the cabinet committee on defense. In 1892 he succeeded his father as chancellor of the University of Cambridge. In that year he married the widow of the 7th duke of Manchester.

He continued to hold his office till Oct. 3, 1903, when he resigned on account of differences with A. J. Balfour over the latter's attitude toward free trade (*see* BALFOUR, ARTHUR JAMES BALFOUR, 1ST EARL). He necessarily became the leader of the Free Trade Unionists who were neither Balfourites nor Chamberlainites, and his weight was thrown into the scale against any association of Unionism with the constructive policy of tariff reform, which he identified with sheer protection. A struggle at once began within the Liberal Unionist organization between those who followed the duke and those who followed Chamberlain; the latter were in the majority, and the duke resigned his chairmanship of the Liberal Unionist association (May 1904), and became president of the new organizations, the Unionist Free Food league and the Unionist Free Trade club.

In the autumn of 1907 his health gave way and he wintered in Egypt. He died on his way home, at Cannes, on March 24, 1908.

The duke's reputation as the last of the great Whigs rested as much on personal character as on political ability. His strong sense of duty was shown no less in his administration of his estates and care for the library and art treasures at Chatsworth than in his public life. A typical country gentleman, his own keenest personal pleasure was in racing and he owned several famous horses. As an orator he was remarkable more for clarity and cogency than brilliance. He owed much of his success to "the transparent honesty and simplicity . . . quiet and inflexible courage . . . and absolute disinterestedness" which, as Balfour said after his death, won "the respect and confidence of men of every shade of opinion."

See B. Holland, *Life of the 8th Duke of Devonshire*, 2 vol. (1911). (M. R. D. F.)

DE VOTO, BERNARD AUGUSTINE (1897–1955), U.S. novelist, journalist, historian and critic, best known for his works on American literature and the history of the western frontier, was born in Ogden, Utah, on Jan. 11, 1897. He attended the University of Utah and Harvard university (B.A., 1920), and taught at Northwestern university (1922–27) and Harvard (1929–36) before becoming editor of the *Saturday Review of Literature*. After two years he resigned and returned to Cambridge, Mass., where he lived during the remainder of his life. Although he wrote a number of novels, his essays in the "Easy Chair" depart-

ment for *Harper's Magazine* perhaps brought him his largest popular audience. His ability to combine sound scholarship and a vigorous, outspoken style made him one of the most widely read critics and historians of his day. He died in New York city on Nov. 13, 1955.

Among the works De Voto wrote or edited are: *Mark Twain's America* (1932); (ed.) *Mark Twain in Eruption* (1940); *Mark Twain at Work* (1942); *Across the Wide Missouri* (Pulitzer prize, 1948); *The World of Fiction* (1950); *The Hour* (1951); *The Course of Empire* (1952); and (ed.) *The Journals of Lewis and Clark* (1953).

See G. Mattingly, *Bernard De Voto: A Preliminary Appraisal* (1938); and the obituary in *New England Quarterly* (Dec. 1955).

DEVRIENT, the name of a family of German actors.

1. Ludwig Devrient (1784–1832) was born in Berlin on Dec. 15, 1784. He served his apprenticeship with a provincial company in Thuringia and then joined the court theatre in Dessau, where he developed his talent for character parts. After the death of A. W. Iffland he was called to Berlin, where he was a member of the royal court theatre from 1814 to his death on Dec. 30, 1832. He counted among his most famous roles Franz Moor in Schiller's *Die Räuber,* Richard III, Shylock and Falstaff.

Three of Ludwig Devrient's nephews, Carl August, Eduard Philipp and Emil Devrient, made important contributions to the history of the German stage:

2. Carl August Devrient (1797–1872) began his career in Brunswick (1819). From 1821 to 1835 he acted in Dresden, marrying there the singer Wilhelmine Schröder-Devrient. Karlsruhe (1835–39) was the steppingstone for Hanover, whose playgoers acclaimed him for his portrayals of King Lear, Shylock and King Philip (in Schiller's *Don Carlos*). He died in Hanover on Aug. 3, 1872.

3. His brother Eduard Philipp Devrient (1801–1877) started as an opera singer in Berlin. From 1844 until 1852 he was an actor and a stage director in Dresden, from where he was called to Karlsruhe. There he reorganized the grand duke's theatre and finished his *Geschichte der deutschen Schauspielkunst* (1848–74), a work that still has to be consulted for its information on acting.

4. Emil Devrient (1803–1872) faced his first audience in Brunswick (1821). Via Bremen, Leipzig and Hamburg he reached Dresden (1831), where he remained associated with the court theatre until his retirement in 1868. His Hamlet was favourably received in London (1852 and 1853).

5. Otto Devrient (1838–1894) was coached as an actor by his father, Eduard Devrient. His early engagements included Karlsruhe (1856–58), Stuttgart (1858–60), Berlin (1860–61) and Leipzig (1862). In 1863 he returned to Karlsruhe to assume the duties of a stage director, and ten years later was called to Weimar. There he played Mephistopheles in his own production of Goethe's *Faust,* parts i and ii. Subsequently he served as stage director in Mannheim, Frankfurt, Oldenburg and Berlin. After his retirement to Jena he emerged occasionally for guest appearances as an actor. He died in Stettin on June 23, 1894. (A. M. N.)

DE VRIES, HUGO (1848–1935), Dutch botanist and geneticist best known for his studies on mutation, introduced the experimental method in the study of plant evolution. De Vries was one of the three investigators (the others being E. Tschermak von Seysenegg and K. E. Correns) who, in 1900, independently rediscovered and confirmed G. J. Mendel's laws of heredity. He was born at Haarlem, Neth., on Feb. 16, 1848. Educated at Leiden, Heidelberg and Würzburg, he became a professor at the University of Amsterdam in 1878. His attention was drawn to plant evolution by the discovery of new forms among a display of *Oenothera lamarckiana* (an evening primrose) growing as a garden escape in a waste meadow. This suggested to De Vries that evolution might be studied by a new, experimental method rather than by the old method of observation and inference. This new method may be regarded as his greatest contribution to science and resulted in a new epoch in the history of evolution. He discovered in his cultures of *O. lamarckiana* new forms appearing among the hosts of ordinary forms, and the name "mutation" was given to this method of producing new species and varieties, which he showed to arise suddenly, as distinct from Charles Darwin's variation of species through natural selection. He visited the United States to investigate the behaviour of *O. lamarckiana* in its natural environment. After his retirement in 1918 from the University of Amsterdam De Vries lived in Lunteren, where he continued his experimental work in producing new forms through many generations of culture. He died on May 21, 1935. His best-known works are *Intracellular Pangenesis* (1889); *The Mutation Theory* (Ger. ed., 1900–03; Eng. trans., 1910–11); and *Plant Breeding* (1907; Ger. trans., 1908).

DEW, a deposit of waterdrops formed at night by the condensation of water vapour from the air onto the surface of objects freely exposed to the sky. It forms on clear nights when the air is calm or, preferably, when the wind is light. If the temperature of the surface is below the freezing point of water, the deposit takes the shape of hoarfrost. Dew forms on clear nights because on such nights freely exposed surfaces lose heat to the sky by radiation. Unless this loss is offset by an efficient conduction of heat from the interior of the object, the surface will cool. Most objects, including grass blades, leaves and petals, are much better radiators than air and, as a result, are usually colder at night than the air. The cold surface cools the air in its vicinity and if the air is sufficiently humid, it may cool below its dew point (*q.v.*). Water vapour will then condense out of the air onto the surface.

The formation of dew is sustained by the diffusion of water vapour. Regarding the vertical diffusion of water vapour over soils carrying vegetation, there are two possible situations. First, there is the downward movement of water vapour from the atmosphere, occurring when the water vapour content of the air increases with height. Second, there is the upward movement of water vapour, occurring when the soil surface temperature is higher than that of the leaves. Accordingly, dew may be classified: (1) as formed when water vapour diffuses downward in the air, and (2) as formed from water vapour diffusing from the underlying soil surface. The name "dewfall" is proper to (1). Dew arising from (2) may be called "distillation." (J. L. Monteith, *Quart. J. R. Met. Soc.,* no. 83, London, 1957.)

There have been various attempts to measure dew. Among the various instruments are R. Leick's porous gypsum plates and S. Duvdevani's dew gauge consisting of a wooden slab treated with paint. To determine the amount of dew, Leick's plates are weighed while Duvdevani's gauge involves the use of an optical dew scale. Other investigators (*e.g.,* J. M. Craddock, E. G. Jennings and J. L. Monteith) developed recording dew balances whose surface and exposure conform with the surrounding surface as far as possible. It is by means of such dew balances that one can best observe the phenomenon of distillation: on occasions no gain in weight or even some loss in weight may be recorded though dew had formed on the leaves. Clearly, this dew must be attributed to the diffusion of water vapour from part of the weighed system to another; *i.e.,* from soil to leaves.

The amounts of dew formed on plants are not well known. It would appear that during dew nights the amounts vary from very small quantities to about $\frac{1}{50}$ in. G. Hofmann (*Die Thermodynamik der Taubildung,* Bad Kissingen, 1955), estimated that the maximum possible amount is about $\frac{3}{100}$ in. for a ten-hour night, but such amounts would occur only under exceptional circumstances. Total annual dew precipitation may lie between about one-half inch in cold climates and in nearly arid warm climates, to about three inches in semihumid warm climates. Since dew produced by distillation from the soil cannot be regarded as a gain of moisture, not the whole of the annual dew may be significant from a hydrological point of view. Even so, in semiarid regions the net gain may be a substantial fraction of the rainfall. From the biological viewpoint, the usefulness of dew is sometimes doubtful as dew may stimulate the growth of fungi harmful to plants.

In ancient times it was believed that dewdrops fell from the sky. Aristotle in his *Meteorologica* suggested that dew or hoarfrost was formed by the condensation of water vapour which had evaporated from the surface by day. Louis-Constant Prévost (*Recherches Physico-Mécanique sur la Chaleur,* 1792) was probably the first to connect dew with radiation losses from the surface.

However, the first thorough investigation of dew was made by Charles Wells, physician to St. Thomas's hospital, London. He showed (*An Essay on Dew and Several Appearances Connected With It*, London, 1814) that dew was the result of cooling of the air at night. He also pointed out that although dew tended to form on windless nights, "a slight agitation of the air . . . when the air is pregnant with moisture . . . will render greater the quantity of dew"—the first statement appreciating the effect of slight turbulence on dew. In 1885 John Aitken (*Trans. Roy. Soc. Edinb.*, no. 33) published the results of his studies which demonstrated, among other things, that trays of turf at times lost weight when dew formed on the blades. He interpreted this as the result of vapour diffusion from the soil. Aitken also made a distinction between dewdrops proper and drops formed by guttation; *i.e.*, the exudation of water from leaves under the action of root pressure.

(JA. N.)

DEWAN: *see* DIWAN.

DEWAR, SIR JAMES (1842–1923), British chemist and physicist, remembered for his studies of low-temperature phenomena and for his invention of the vacuum flask (*q.v.*) which bears his name. He was born at Kincardine-on-Forth, Scot., on Sept. 20, 1842. He was educated at Dollar academy, Dollar, Clackmannanshire, and Edinburgh university. In 1875 he was elected Jacksonian professor of natural experimental philosophy at Cambridge, and in 1877 he succeeded J. H. Gladstone as Fullerian professor of chemistry in the Royal institution, London.

Dewar's scientific work covers a wide field. His earlier papers deal with organic chemistry, with measurement of high temperatures, with electrophotometry and the chemistry of the electric arc. With J. A. Fleming, of University college, London, he investigated the specific inductive capacity of substances at very low temperatures. His work on the liquefaction of the so-called permanent gases (*see* LOW-TEMPERATURE PHYSICS), and his researches at temperatures approaching absolute zero are well known. His interest in this branch of inquiry dates back at least as far as 1874, when he discussed the "Latent Heat of Liquid Gases" before the British association. By 1891 Dewar had constructed a machine for producing liquid oxygen in quantity. He made use of this liquid for some low-temperature experiments on meteorites, and in 1891 showed that both liquid oxygen and ozone are magnetic. He introduced the use of liquefied gases as aids in studies at very low temperatures.

About 1892 the idea occurred to him of using vacuum-jacketed vessels for the storage of liquid gases, and so efficient did this device prove in preventing the influx of external heat that it was found possible to preserve the liquids for comparatively long periods; this apparatus, which he designed, is known as the "Dewar flask" and is invaluable for low-temperature work. The principle has been used extensively in the common Thermos bottle or vacuum flask. He next experimented with a high-pressure hydrogen jet by which low temperatures were realized through the Joule-Thomson effect (*see* THERMODYNAMICS), and the successful results thus obtained led him to build at the Royal institution the large refrigerating machine by which hydrogen was first liquefied in 1898 and solidified in 1899. He investigated the gas-absorbing powers of charcoal cooled to low temperatures, and applied them to the production of high vacua and to gas analysis.

He was president of the Chemical society in 1897 and of the British association in 1902, served on the Balfour commission on London water supply (1893–94) and, as a member of the committee on explosives (1888–91), invented cordite jointly with Sir Frederick Abel. He was awarded the Rumford medal of the Royal society in 1894; and the Smithsonian institution, the French Academy of Sciences, the Italian Society of Sciences and the Royal Society of Arts honoured his work. He was knighted in 1904, and died on March 27, 1923.

DEWAS, a town and district in Madhya Pradesh, India. The town (pop. [1951] 27,879), is 22 mi. N.N.E. of Indore on the main Bombay-Agra road. It was formerly the joint capital of Dewas Senior and Junior states. It lies at the foot of the conical (300-ft.-high) Chamunda hill with a shrine, Devivasini, on top. Two miles south stands a steep, highly eroded group of hills, with peaks rising 400–500 ft. above the general level. The town, a municipality, contains cotton-spinning and weaving mills and an agricultural college and a teacher's training college affiliated to Vikram university.

DEWAS DISTRICT (area 2,706 sq.mi.; pop. [1961] 447,090) comprises the main part of the former Dewas Senior state with much additional territory. Dewas was founded by two Ponwar Maratha brothers who came into Malwa with Baji Rao in 1728. From 1841 the senior and junior branches of their family ruled their own portions independently. The lands of both were intimately entangled: Dewas Senior's main tract lay north and south of Dewas town; that of Dewas Junior centred on Sarangpur, 50 mi. N.E. Both states were merged in Madhya Bharat on June 15, 1948. Madhya Bharat became part of Madhya Pradesh state on Nov. 1, 1956. (S. M. A.)

DEWBERRY (TRAILING BLACKBERRY), of the genus *Rubus* (family Rosaceae), is the name given to any blackberry so lacking woody fibre in the stems that it trails along the ground. In the eastern and southern area of the United States several trailing native species of *Rubus*, especially *R. flagellaris*, *R. baileyanus*, *R. hispidus*, *R. enslenii* and *R. trivialis*, produce excellent fruits and some varieties, especially Lucretia, are cultivated. *See* BLACKBERRY. (G. M. D.; X.)

D'EWES, SIR SIMONDS (1602–1650), English antiquarian whose collection of documents, together with his personal diaries, are a mine of historical information, was born in Coxden, Dorsetshire, on Dec. 18, 1602. He was educated at St. John's college, Cambridge, and the Middle Temple, London. Knighted in 1626, he was sheriff of Suffolk in 1639 and 1640, when he was prosecuted in the Star Chamber for his failure to collect ship money. A moderate Puritan, he was elected for Sudbury to the Long parliament, and in its early years took an active part in debate, offering his vast historical knowledge to the house. Created a baronet in 1641, he later turned royalist and was expelled in Pride's purge of 1648. He died on April 8, 1650, at Stow Langtoft hall, Suffolk.

Though an avid collector of historical materials, D'Ewes published nothing but a tract called the *Primitive Practise for Preserving Truth* (1645). His *Journals of all the Parliaments During the Reign of Queen Elizabeth* is the basic source for the years 1584–1601, as the commons journal for this period has disappeared. It was published by his nephew, Paul Bowes, in 1682. His *Autobiography and Correspondence* was published by J. O. Halliwell-Phillips in 1845. *The Journals of Sir Simonds D'Ewes* covering the Long parliament began to be published in 1923; Nov. 1640—March 1641, ed. by W. Notestein (1923) and Nov. 1641—Jan. 1642, ed. by W. H. Coates (1942). (RD. C. G.)

DE WETTE, WILHELM MARTIN LEBERECHT (1780–1849), German theologian, described by Julius Wellhausen as "the epoch-making opener of the historical criticism of the Pentateuch," was born on Jan. 12, 1780, at Ulla, near Weimar. He was educated at Weimar and at Jena, and held chairs in theology at Heidelberg (1807), Berlin (1810) and Basel (1822). He was dismissed from his post at Berlin in 1819, nominally because of a letter of consolation he wrote to the mother of the murderer of August von Kotzebue, but in fact because of his radical rationalism. De Wette died on June 16, 1849.

His most important works are *Beiträge zur Einleitung in das Alte Testament*, 2 vol. (1806); *Kommentar über die Psalmen* (1811); *Über Religion und Theologie* (1815); *Lehrbuch der christlichen Dogmatik* (1813–16); *Lehrbuch der historisch-kritischen Einleitung in die Bibel* (O.T., 1817; N.T., 1826); *Christliche Sittenlehre* (1819–21); *Das Wesen des Christlichen Glaubens* (1846). De Wette also edited *Briefe, Sendschreiben und Bedenken Luthers*, 5 vol. (1825–28), and wrote a drama, *Die Entsagung* (1823).

DEWEY, DAVIS RICH (1858–1942), U.S. economist and statistician, was for nearly 30 years (1911–1940) managing editor of the influential *American Economic Review*. He was born in Burlington, Vt., April 7, 1858, and was educated there and at Johns Hopkins university. For many years he was professor of economics and statistics at the Massachusetts Institute of Technology. His principal work is a *Financial History of the United States*

(1902). He died in Cambridge, Mass., Dec. 13, 1942.

(Fk. L. K.)

DEWEY, GEORGE (1837–1917), U.S. naval commander who defeated the Spanish fleet at the battle of Manila bay, was born at Montpelier, Vt., on Dec. 26, 1837. He studied at Norwich university, then at Norwich, Vt., and graduated from the United States Naval academy, Annapolis, Md., in 1858. He was commissioned lieutenant in April 1861.

In the Civil War Dewey served on the steam sloop "Mississippi" (1861–63) during Adm. David Farragut's passage of the forts below New Orleans, La., in April 1862 and at Port Hudson, La., in March 1863; he took part in the fighting below Donaldsonville, La., in July 1863. In 1864–65 he served on the steam gunboat "Agawam" with the North Atlantic blockading squadron and took part in the attacks on Fort Fisher in Dec. 1864 and Jan. 1865. He became a commander in 1872, captain in 1884 and commodore in 1896.

In Nov. 1897 he was assigned, at his own request, to sea service, and sent to Asiatic waters. In April 1898, while with his fleet at Hong Kong, he was notified by cable that war had begun between the United States and Spain, and was ordered to "capture or destroy the Spanish fleet" then in Philippine waters.

Arriving off the island of Luzon in the Philippine islands on the night of April 30, Dewey entered Manila bay about midnight. The Spanish fleet, consisting of about 10 ships under Admiral Montojo, was anchored near the village and arsenal of Cavite at the southern end of the bay. Dewey, with six ships in line at intervals of about 400 yd., opened fire shortly before 6:00 A.M. of May 1. After passing the Spanish anchorage twice, the U.S. forces withdrew about 7:35 A.M.

At 11:16 A.M. the action was resumed against the remaining Spanish ships and the shore batteries around Cavite. The victory, won without the loss of a single U.S. seaman, was complete. All the Spanish ships had been sunk or destroyed and Cavite had been captured. (*See* SPANISH-AMERICAN WAR.)

Congress, in a joint resolution, tendered its thanks to Commodore Dewey, and to the officers and men under his command, and authorized "the secretary of the navy to present a sword of honor to Commodore George Dewey, and cause to be struck bronze medals commemorating the battle of Manila bay, and to distribute such medals to the officers and men of the ships of the Asiatic squadron of the United States." He was promoted rear admiral on May 10, 1898, and on March 3, 1899, was named admiral of the navy, a title created for him by congress on March 2, 1899, and the highest rank ever held by a U.S. naval officer.

On Aug. 18, 1898, Dewey's squadron assisted in the capture of Manila and after remaining in the Philippines under orders from his government to maintain control he returned home, arriving in New York city, where, on Sept. 30, 1899, he received a great ovation. He was a member (1899) of the Schurman Philippine commission, and in 1901 acted as president of the Schley court of inquiry.

By special provision Admiral Dewey was not retired, but continued in the service up to his death, being president of the general board of the navy for the last seven years of his life. To the end of his life he continued to urge the building of large battleships, citing their superiority in the battle of Jutland. In 1913 he published his *Autobiography*. He died in Washington, D.C., on Jan. 16, 1917, and was buried in the Arlington National cemetery. His body was transferred March 28, 1925, to the crypt of the Bethlehem chapel of the National Episcopal cathedral in Washington.

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DEWEY, JOHN (1859–1952), U.S. philosopher, psychologist and educator, was born in Burlington, Vt., on Oct. 20, 1859. He graduated from the University of Vermont in 1879 and taught school for two years in Pennsylvania and in rural Vermont. In 1884 he received the Ph.D. degree from Johns Hopkins university. He taught philosophy at the University of Minnesota in 1888–89 and at the University of Michigan from 1889 to 1894. In 1894 he went to The University of Chicago, where he became head of the combined departments of philosophy, psychology and pedagogy. There he established in 1896 The University of Chicago's Laboratory school, which he directed until 1904. At that time he went to Columbia university as professor of philosophy and remained there until his retirement in 1930.

Dewey was president of the American Psychological association, of the American Philosophical association and of the American Association of University Professors, which he had helped to organize. He was lecturer in philosophy and education at the University of Peking in 1919 and again in 1931. He visited Turkey at the request of the Turkish government and prepared a report on the reorganization of the national schools of that country in 1924. Later he visited Japan, Mexico and the U.S.S.R. to study the practices, problems and possibilities of education in those countries.

Dewey's work in psychology and philosophy was largely centred in his major interest, educational reform. In 1944 he wrote that "There is probably no better way to realize what philosophy is about when it is living, not antiquarian, than to ask ourselves what criteria and what aims and ideals should control our educational policies and undertakings." ("Challenge of Liberal Thought," *Fortune*, Aug. 1944.) These criteria, aims and ideals he drew in large part from psychology, specifically the psychology of learning. The task of the Laboratory school he directed at The University of Chicago was, he said, "the problem of viewing the education of the child in the light of the principles of mental activity and processes of growth made known by modern psychology." (John Dewey, *School and Society*, University of Chicago Press, 1899; p. 88, 2nd ed., 1915.)

The terms "activity," "process" and "growth" were central and controlling in his analysis of the psychology of learning. As he saw it, thought and learning is a process of inquiry starting from doubt or uncertainty and spurred by the desire to resolve practical frictions or to relieve strain and tension. Education must therefore begin with experience, indeed at its best it is ever-enlarging experience, which has as its aim growth and the achievement of maturity.

A second basis of educational reform, as Dewey saw it, required an analysis of contemporary society, its aims and needs. He found two aspects of modern society of basic importance to education: first, that society is in the process of momentous change of which the Industrial Revolution is one of the chief marks; second, that the great advances of modern society are results of modern science. "Ultimately and philosophically," he said, "science is the organ of general social progress." (John Dewey, *Democracy and Education*, p. 270, The Macmillan Company, New York, 1916.)

As educational reformer, Dewey therefore sought to relate education to the students' interests, to free it from "recapitulation" of human experience or "retrospection" of human thought. "The idea of education advanced in these chapters is formally summed up in the idea of continuous reconstruction of experience." (John Dewey, *Democracy and Education*, p. 93, The Macmillan Company, New York, 1916.) Given the advancing society of our time, he declared, we must "make each one of our schools an embryonic community life, active with types of occupations that reflect the life of the larger society and permeated with the spirit of art, history, and science." (John Dewey, *The School and Society*, Chicago: The University of Chicago Press, 16th Impression, 1949, p. 27.)

Dewey's ideas and proposals strongly affected United States education and thought about education. Aspects of his views were seized upon by the "progressive movement" in education, which stressed the student-centred rather than the subject-centred school, education through activity rather than formal learning, and vocational or occupational education rather than the mastery of traditional subjects. The movement did not, however, draw upon the full range of Dewey's thought. As early as 1897 Dewey wrote regarding the "child study movement" that "the features of child study against which criticism has been justly directed are the results partly of the exaggeration incident to all large

movements in their inception, partly of the misdirected gyrations of those camp followers . . . hanging about education as about all progressive forces . . . and partly of the unwise zeal of those who lacking in stability are blown about by every new wind of doctrine and lose the just perspective." By 1938, when Dewey was asked to discuss conflicting theories and practices of "traditional" and "progressive" education, he was moved to sharp criticism of educators who sought merely to interest or amuse students, disregarded organized subject matter in favour of mere activity on the part of students, and were content with mere vocational training.

The philosophy on which Dewey's views of education rest has been labeled pragmatism. Dewey himself seems to favour the term instrumentalism or experimentalism. William James's *Principles of Psychology* early stimulated Dewey's rethinking of logic and ethics by directing his attention to the practical function of ideas and concepts, but Dewey and the "Chicago school" of instrumentalists went further than James had gone in that they conceived of ideas as instruments for transforming the uneasiness which is connected with the experience of having a problem into the satisfaction of some resolution or clarification of it.

His model of inquiry was scientific investigation. It has been pointed out that the basis of Dewey's reconstruction of philosophy is the analysis of experiment. As he saw it, the experimental methods of science provided the most promising approach to all problems, social and ethical as well as scientific in the narrow sense of "scientific." He consequently rejected the idea of a "fixed and immutable" moral law derivable from the consideration of the essential nature of man, insisting that such a view forces us to go "to the past for instruction," thus becoming authoritarian, and obliges us, moreover, to hold "that one method obtains in natural science and another, radically different, in moral questions," thus creating disunity in the intellectual life of our time and denying the promise which he believed empirical and scientific methods can hold even in the field of ethics. (John Dewey, *Problems of Men*, pp. 150–155. Philosophical Library, Inc., New York, 1946.)

Dewey developed from these views a philosophical ground for democracy and liberalism. He conceived of democracy not merely or primarily as a form of government, but rather as a mode or method of association, one which provides the members of a democratic society opportunity, maximum experimentation and growth. The good society was one which provided the conditions for ever enlarging the experience of all its members. Society faces three possibilities in times of change. It may drift and thus "perpetuate the present confusion and possibly increase it." It may be intelligently conservative, attempting to maintain "the old order intact against the impact of new forces." Or it may "select newer scientific, technological, and cultural forces that are producing change in the old order; it may estimate the direction in which they are moving and their outcome if given freer play, and see what can be done to make the schools their allies." (*Social Frontier*, Urbana, Ill., May 1937.)

Attacks on Dewey's philosophy and his educational program have centred on his preoccupation with process and growth, his insistence on the experimental or scientific approach to social, ethical and philosophical problems, and his consequent denial of ethical absolutes. Opponents of his views have charged him with valuing activity and experience for their own sakes and with failing to provide, and in effect undermining, any qualitative criteria with respect to experience.

Full analysis of the meaning Dewey gives to such terms as "science" and "experimental" and of the extent to which such ideas as "growth" and "freedom" are more than relative terms in his system of thought might uncover substantial areas of agreement between Dewey and his critics. In the absence of such developments, however, Dewey's followers and their opponents have served to bring into focus some of the most troublesome and some of the most urgent problems of our time.

Dewey's publications include *Psychology* (1887); "The Reflex Arc Concept in Psychology," *Psychological Review* (1896); *The School and Society* (1899); *The Child and the Curriculum* (1902); *Ethics*, with James Tufts (1908); *How We Think* (1910); *Democracy and Education* (1916); *Reconstruction in Philosophy* (1920); *Human Nature and Conduct* (1922); *Experience and Nature* (1925); *The Public and its Problems* (1927); *The Quest for Certainty* (1929); *Art as Experience* (1934); *Logic, The Theory of Inquiry* (1938); *Freedom and Culture* (1939); *Problems of Men* (1946).

See also references under "Dewey, John" in the Index volume.

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DEWEY, MELVIL (1851–1931), U.S. librarian who devised the Dewey Decimal system of classification for library cataloguing and probably more than any other single person was responsible for the sound development of library science in the U.S., was born at Adams Center, N.Y., on Dec. 10, 1851. He graduated in 1874 from Amherst college, Mass., and became acting librarian there. In 1877 he moved to Boston, there founding, with R. R. Bowker and Frederick Leypoldt, and editing the *Library Journal*. He was also one of the founders of the American Library association. In 1883 he became librarian of Columbia college, New York city, and there founded the school of library economy, the first institution established for the instruction of librarians.

This school, which was very successful, was re-established in Albany, N.Y., as the State Library school under his direction; from 1889 to 1906 he was director of the New York State library, from 1889 to 1900 secretary of the University of the State of New York and from 1904 to 1906 state director of libraries. He completely reorganized the state library, making it one of the most efficient in the U.S., and established the system of traveling libraries and picture collections. Dewey's decimal system of classification, first proposed in 1876, is extensively used (*see* CATALOGUING, LIBRARY). He died Dec. 26, 1931.

DEWEY, THOMAS EDMUND (1902–), U.S. lawyer who was twice nominated for the presidency by the Republican party, was born in Owosso, Mich., March 24, 1902. He graduated from the University of Michigan, received his law degree from Columbia university in 1925 and was admitted to the New York bar the following year. He became chief assistant to the U.S. attorney for the southern district of New York in 1931, and, except for brief intervals, remained in public life thereafter until 1955. He gained national attention as special prosecutor in an investigation of organized crime in New York, 1935–37, by obtaining 72 convictions in 73 prosecutions. Elected district attorney of New York county in 1937, he was unsuccessful as Republican party candidate for governor of New York in 1938 but won this office in three successive elections—1942, 1946 and 1950. He gained as governor a reputation for political moderation and administrative efficiency. He was an unsuccessful candidate for the Republican presidential nomination in 1940 (when Wendell Willkie was nominated) but became the party nominee in 1944 and again in 1948. In losing to Pres. Franklin D. Roosevelt in 1944, Dewey received slightly over 22,000,000 popular votes and 99 electoral votes. Although his victory was widely predicted in 1948, Dewey lost to Pres. Harry S. Truman; his popular vote fell slightly below 22,000,000 but his electoral vote increased to 189. In 1952, after traveling in the far east, he published an account of his experiences, *Journey to the Far Pacific*. Dewey, as a leader of the eastern Republicans, played an important role in the 1952 Republican national convention in bringing about the nomination of Dwight D. Eisenhower for president. At the conclusion of his third term as governor of New York in 1955, Dewey re-entered private law practice. (C. F. McI.)

DEWING, THOMAS WILMER (1851–1938), U.S. painter, one of the leaders of a group called the Ten American Painters, was born in Boston, Mass., on May 4, 1851. He studied in Paris at the Académie Julian under Boulanger and Lefebvre and also received training in Munich. Despite this academic beginning he turned to a more atmospheric style and, together with men like Childe Hassam and J. Alden Weir, became devoted to the cause of Impressionism. In 1887 he was elected as an associate

of the National Academy and the following year became a full academician. He died in New York city on Nov. 6, 1938.

Dewing was especially fond of depicting young women in a sort of evening dress which became more of a classical garment than a modish gown. These enigmatic figures devoid of emotion were painted with subtle colour and the utmost taste and refinement. What was important to him was not the subject itself but his inner vision of the subject. He often placed his figures on fragile chairs in a sparsely furnished room where the very emptiness added to the restrained poetic mood. (F. A. Sw.)

DE WINT, PETER (1784–1849), English landscape and architectural painter of Dutch extraction who was one of the chief English water colourists of the early 19th century. Born at Stone, Staffordshire, on Jan. 21, 1784, he studied (1802–06) under the engraver John Raphael Smith and in 1809 entered the Royal Academy. In 1811 he became a member of the Society of Painters in Water-Colours, where he exhibited for many years, as well as at the academy. He died in London on Jan. 30, 1849.

DEW POINT, the temperature at which the atmosphere is saturated with water vapour, when it is cooled without changing its pressure or vapour content. A given volume of air containing much water vapour has a higher dew point than the same volume of drier air; thus the dew point gives an indication of the humidity. In meteorology the dew point is applied, for example, in predicting the height of the base of certain types of clouds, including summer cumulus. *See* also HUMIDITY, ATMOSPHERIC.

DEWSBURY, a market town, county and parliamentary borough of the West Riding of Yorkshire, Eng., on the Calder river, 9 mi. S.S.W. of Leeds by road. Pop. (1961) 52,942. The parish church of All Saints, mostly rebuilt in the 18th century, retains Anglo-Saxon carvings. Dewsbury, which was mentioned in Domesday Book, had a woolen industry in the 13th century, but there was no great expansion until the Industrial Revolution when the town became the natural centre of a heavy woolen district. The chief industries are mungo and shoddy manufacture (for which large-scale rag selling by public auction is carried on), blanket weaving, coal mining and engineering. Dewsbury was incorporated in 1862 and became a county borough in 1913.

There is a tradition that Paulinus, the first archbishop of York, preached in A.D. 627 at Dewsbury, which had in Saxon times a parish over 400 sq.mi. in area. Another tradition holds that Robin Hood died and was buried in the extensive park at Kirklees where are the remains of a 12th-century Cistercian convent.

DEXIPPUS, PUBLIUS HERENNIUS (*c.* A.D. 210–d. after 270), Roman historian and Athenian statesman, is one of the principal authorities for the history of the mid-3rd century A.D. The 9th-century encyclopaedia called the *Bibliotheca* by Photius, patriarch of Constantinople, credits him with three major works, a history of events after the death of Alexander the Great, a *Scythian War*, and an annalistic chronicle from legendary times to 270 A.D. Though none of these survives, numerous fragments have been recognized in the compilations of later historians.

Several Athenian inscriptions attest the high birth and public offices (*archon, basileus,* etc.) of Dexippus, his father and children. He himself relates (fragment 28) how, when the frontiers of the Roman empire suddenly and catastrophically collapsed, he rallied about 2,000 of his fellow citizens to repel a barbarian attack on Athens, probably about 267 A.D.

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DEXTRIN or DEXTRINE, a class of substances prepared by the incomplete hydrolysis of starch or by the heating of dry starch. Dextrins are used chiefly as adhesives and as sizing agents for textiles and paper. *See* STARCH.

DEY (a corruption of the Turkish word meaning "maternal uncle"), an honorary title used in the North African possessions of the Ottoman empire, applied in a heroic sense to Turkish corsair leaders and janizary officers. There were deys in Tunis (until replaced by the hereditary beys in 1705), in Algeria (until 1830) and in Tripoli. In practice the dey was absolute, though he flouted the wishes of his troops at his peril. He was cut off from his family to prevent succession claims. (A. D. A.)

DEYSSEL, LODEWIJK VAN (real name KAREL JOAN LODEWIJK ALBERDINGK THIJM) (1864–1952), leading Dutch writer and critic of the late 19th and early 20th centuries, was born in Amsterdam, Sept. 22, 1864, son of J. A. Alberdingk Thijm (who promoted a Catholic cultural revival in the Netherlands). He joined the largely agnostic individualistic group associated with the magazine *De Nieuwe Gids* ("The New Guide"). His passionate critical writings were published as *Verzamelde Opstellen* ("Collected Essays," 11 vol., 1894–1911). He began writing as an admirer of Émile Zola and published a naturalistic novel himself, *Een Liefde* ("A Love Affair," 1889). Later he abandoned naturalism and wrote highly personal impressionistic prose. A sensitive artist with great powers of observation and a keen eye for detail, he was a powerful influence on Dutch literature, both as an original and as a critical writer, for many years. His "proseverses" were clever, somewhat overwrought verbal experiments. His collected works appeared in 6 vol. (1922–24). When, with his friend Willem Kloos (1859–1938), he was awarded an honorary doctorate in Amsterdam in 1935, he had already outlived his own importance. He died at Haarlem, Jan. 26, 1952.

See F. Jansonius, *Lodewijk van Deyssel* (1951). (GD. W. HS.)

DEZFUL (DIZFUL), a city in the province of Khuzistan, Iran, is situated on the high left bank of the Dez (or Diz), a tributary of the Karun river, 10 mi. from the edge of the foothills of the Zagros mountains and 650 ft. above sea level. Pop. (1956) 52,153, mainly Persians and Lurs and some Arabs. The name, meaning "Dez bridge," is derived from the imposing 450-yd.-long bridge which spans the river there, originally erected, according to tradition, by the Sassanid king Shahpur II. The climate is oppressively hot in summer. Underground chambers are therefore largely used, which are easily cut into the dry conglomerate.

Dezful is the most important regional centre of the northern Khuzistan plain and the principal winter market of the nomad population of Luristan. Extensive dry farming areas are situated north and east of the city, while about 75,000 ac. of irrigated land lie to the south on both sides of the river. Dezful is connected by roads through Khoramabad with the highland and southward with Ahvaz by two roads, one through Shushtar, and the other west of the river through Andimeshk and Shush, the ancient Susa (*q.v.*). Andimeshk (pop. [1956] 7,324) is the station on the Transiranian railway on the other side of the river, 6 mi. N. of Dezful. It was once called Salehabad. It is there that most of the modern development of the region is taking place (railway yards, a headquarters of the Khuzistan Development service, a large military camp and an airfield). The great Dez dam (started in 1960) 20 mi. upstream was designed to provide abundant power and to increase the possibilities of irrigation by regulating the water supply. (H. Bo.)

DEZHNEV, SEMEN IVANOV (*c.* 1605–73), Russian explorer and the first man known to have sailed through the Bering strait, was born in Velikiy Ustyug, north Russia. He served as a cossack in Siberia, where he traveled much in the north between 1638 and 1670. In 1648 he sailed from the Kolyma eastward, rounded the northeast tip of Asia (now called Cape Dezhnev) and reached the Anadyr. He thus proved the separation of Asia and America, but his report lay buried in the archives at Yakutsk until the historian G. F. Müller found it in 1736, so the discovery was not known about until nearly a century had passed, and after Vitus Bering (*q.v.*) and others had explored the area. (T. E. A.)

DHAHRAN (AZ ZAHRAN), the administrative centre of the American oil industry in Al Hasa province of Saudi Arabia, is located in the Dammam oil field, 230 mi. N.E. of Riyadh. It was the scene of the original discovery of oil in Saudi Arabia in the 1930s. Dhahran has well-laid-out modern buildings, gardens and recreation grounds within a barbed-wire fence, as well as a model Arab village for the local employees and their families. Out of a total payroll of about 18,000 in the late 1950s about 13,000 were Arabians, nearly 2,700 were U.S. citizens and there were approximately 2,000 Indians and Pakistanis and some others. Dhahran has a large modern airport with accommodation for the working

personnel and a hotel for visitors. (H. St. J. B. P.)

DHANBAD, a town and district in Bihar state, India. The town, headquarters of the district, is 168 mi. from Calcutta on the Eastern railway and 5 mi. S. of the Grand Trunk road near the eastern edge of the Jharia coal field. Pop. (1951) 34,077. It is a comparatively new and open town surrounded by artificial lakes and is the home of the Indian School of Mines and Applied Geology affiliated with Bihar university.

Dhanbad District, to which a part of Manbhum was added in 1956, is the smallest among the districts of Bihar. Pop. (1961) 1,158,363. Area 1,114 sq.mi. The district consists of an undulating erosion plain, 500–900 ft. above sea level, and is dotted with irrigation tanks and a few patches of wood. The Damodar (*q.v.*) runs east-west through the centre of the district. The chief crops are rice, maize and oilseeds and some lac. Dhanbad, containing the whole of the Jharia and part of the Raniganj coal fields, leads the districts of India in coal production. The Sindri fertilizer factory is on the Damodar 16 mi. S. of Dhanbad. The Maithon and Panchet dams of the Damodar valley project fall in this district. (E. Ah.)

DHAR, a town and district in Madhya Pradesh, India. The town is 35 mi. W.S.W. of Indore, with which it has road connections. Pop. (1951) 23,652. It is picturesquely situated among lakes and trees surrounded by barren hills, on the northern slopes of the Vindhyas, commanding one of the gaps leading to the Narmeda valley. The Lat Musjid, or Pillar mosque, was built by Dilawar Khan Ghori in 1405 out of the remains of Jain temples. Its name derives from an iron pillar (13th century) bearing a later inscription recording the seven days' visit of the Mogul emperor Akbar in 1598. The pillar, which was 43 ft. high, is overthrown and broken. The Kamal Maula is an enclosure containing four tombs, the most notable being that of Sheikh Kamal (Maulvi Kamal ud-Din), a follower of the famous 13th-century saint Nizam-ud-Din Auliya. The mosque known as Raja Bhoja's school was built from Hindu remains in the 14th or 15th century; its name is derived from the slabs, covered with inscriptions giving rules of Sanskrit grammar, with which it is paved. On a small hill north of the town stands the fort, a pile of red sandstone, said to have been built by Mohammed Tughluq of Delhi in the 14th century. It contains the raja's palace.

The town became famous as the capital of the Paramara chiefs of Malwa when Vairisinha II transferred his headquarters from Ujjain at the close of the 9th century. Under the celebrated Raja Bhoja (1018–60) it was a great centre of learning. It was conquered by the Muslims at the beginning of the 14th century. In the time of Akbar, Dhar fell under the dominion of the Moguls, in whose hands it remained until 1730, when it was conquered by the Marathas.

Dhar District, with an area of 3,150 sq.mi., includes the ruins of Mandu (*q.v.*) or Mandogarh, the Muslim capital of Malwa (12 mi. S. of Dhar town). The population of the district was 643,601 in 1961.

The princely state of Dhar included a number of Rajput and Bhil feudatories and was divided into two main tracts in the Narmeda valley, separated by 30 mi. of Indore territory. Pop. (1941) 253,210. Area 1,798 sq.mi. The rulers were Ponwar Marathas, whose founder, Anand Rao Ponwar, claimed descent from the Paramara clan of Rajputs who ruled Malwa from the 9th to the 13th century from their capital at Dhar. In 1742 Anand Rao received Dhar as a fief from Baji Rao, the Maratha peshwa. Later the state was subject to a series of spoliations by the neighbouring rulers Sindhia and Holkar; by a treaty of 1819 Dhar passed under British protection. Dhar was controlled through the Malwa subagency of the Central India agency. When India became independent it was merged into Madhya Bharat (June 15, 1948) and, with the accession of additional territory, made into a district. Madhya Bharat was merged into Madhya Pradesh on Nov. 1, 1956. (S. M. A.)

DHARWAR, a town and district in Mysore, India. The town, the headquarters of the district, was incorporated in 1961 with Hubli, 13 mi. S.E., and lies 290 mi. S.S.E. of Bombay on the Southern railway. Pop. (1961), 77,235. It is the seat of Karnatak university and has a broadcasting station of All India Radio. It contains an agricultural college and farm, an engineering institute, an art school, three colleges and training colleges for men and women. There are a Borstal school, a temporary detention home for juveniles and a mental hospital. Dharwar was fortified in the 16th century by the 'Adil Shahi kings of Bijapur (*q.v.*); its original name, Daravada, means a gateway town.

Dharwar District has an area of 5,303 sq.mi. Pop. (1961) 1,950,540. In the north and northeast are plains of black soil, favourable to cotton growing; in the south and west are ranges of low hills with flat fertile valleys between them. The whole district lies on the western edge of the Deccan plateau and is drained by the Gangawali, which flows westward into the Indian ocean, and the Malprabha, a tributary of the Krishna which flows eastward across the plateau into the Bay of Bengal. The principal products are millets, pulses, cotton and timber. The centres of cotton trade are Hubli and Gadag.

In the Malprabha basin interesting collections of Stone Age tools have been made. From the 7th century the district was ruled by the Chalukyas, Rashtrakutas and kings of Vijayanagar, and later by the sultans of Bijapur and the Marathas. A feudatory family of the Kadambas ruled at Hangal from the 11th to the 13th centuries. Buddhist remains have been discovered at Dambal and Kolivad, and Jainism flourished during the middle ages when Gadag, Kolivad, Lakkundi and Lakshmeshwar were centres of literature and art. A college for grammar and exegesis was founded in A.D. 1012 at Kotumachigi from a state endowment. On the final overthrow of the peshwas, in 1817, Dharwar was incorporated within the territory of the East India company.

(V. V. B.; P. B. D.; M. S. H.)

DHENKANAL, a town and headquarters of Dhenkanal district in Orissa state, India, lies about 40 mi. N.W. of Cuttack, with which it is connected by rail. Pop. (1951) 10,352. It is called after a medieval chieftain of the Savara tribe named Dhenka, who is still remembered. The raja's palace is situated on the brow of a hill surrounded by double moats. Dhenkanal college was founded in 1959.

Dhenkanal District was formed after the merger of the princely states with Orissa in 1948. Area 4,181 sq.mi. Pop. (1961) 1,030,632. Density 247 per square mile. In most parts the district is covered with thick forest and hills, with many streams. It is intersected by two main rivers, the Mahanadi and the Brahmani. The chief occupation of the people is agriculture, aided by tank irrigation. Textiles, wickerwork, stonecutting and the manufacture of brass utensils are the principal cottage industries. The coal fields at Talcher yield about 350,000 tons per year and are connected with Cuttack by a branch of the South Eastern railway. Angul, 38 mi. W.N.W. of Dhenkanal, has a science college, a basic training college and the state police training institute. The large village of Bhuban, 23 mi. N.E. of Dhenkanal, is famous for brass utensils. At Bhimakanda and Saranga are found reclining images of Vishnu (9th century A.D.) measuring 41 ft. 6 in. and 32 ft. long respectively. Saptasajya (Vishnuism), Kapilas (Saivism) and Joranda (Mahima cult) are religious centres. (Ma. M.)

DHOLE, the "red dog" of Asia, *Cuon* species, distinguished from the true dogs (*Canis*) by one molar less in the lower jaw. A reddish brown in colour, the dhole is larger than a jackal and hunts in large packs. It is reported to kill animals as large as the buffalo and tiger, but deer are most hunted. *Cuon* is found from India north to Siberia and east to Sumatra and Java.

DHOW: *see* Boat.

DHULIA is a town and headquarters of Dhulia (formerly West Khandesh) district, formerly of Bombay state and from May 1, 1960, of the state of Maharashtra, India. Pop. (1961) 98,342. It lies on the southern bank of the Panjhra river, 35 mi. N. of Chalisgaon with which it is connected by a branch line of the Central railway. Until the 19th century Dhulia was an insignificant village; thereafter its progress appears to have been steady. With the development of trade in cotton and linseed in the 20th century, the town acquired commercial importance. Coarse cotton and woolen cloth and turbans are manufactured for local

use and there are cotton presses and ginning mills. (*See* also JALGAON AND DHULIA.) (M. R. P.)

DHULIP SINGH (1837–1893), Sikh maharaja of Lahore from 1843 to 1849, was born in Feb. 1837, acknowledged by Ranjit Singh and proclaimed maharaja on Sept. 18, 1843, under the regency of his mother the rani Jindan. After the first Sikh War (1845–46) he was recognized by the British as maharaja of the reduced Sikh kingdom, and by the articles of agreement of Dec. 16, 1846, was made the ward of the government of India, whose resident at Lahore, aided by a council of regency, ruled in his name. In 1848 an anti-British outbreak at Multan and another in Hazara, which was provoked by the violence and suspicions of the commissioner, Capt. (later Sir) James Abbott, were allowed to develop into widespread Sikh risings which led to the second Sikh War (1848–49). The war ended in the defeat of the Sikhs at the battle of Gujrat on Feb. 21, 1849, and although Lord Gough, the British commander in chief, was acting in the name of the maharaja and the council of regency, the maharaja was deposed and his kingdom annexed in March of that year. He was given a pension, became a Christian and chose to live in England where he became *persona grata* in society. In 1882 he appealed for a larger pension, and when this was refused went abroad, abjuring Christianity. He died in Paris on Oct. 22, 1893.

See E. Bell, *The Annexation of the Punjaub and the Maharajah Duleep Singh* (1882); J. G. A. Baird (ed.), *Private Letters of the Marquess of Dalhousie* (1910). (J. B. HA.)

DIABASE or DOLERITE. Diabase is the American term; dolerite is the British term. Diabase is a fine- to medium-grained, dark gray to black intrusive igneous rock of basaltic composition. It is extremely hard and tough and is commonly quarried, under the name of trap, for crushed stone. Although not popular it makes an excellent monumental stone and is one of the dark coloured rocks commercially known as "black granite." About one-third to two-thirds of the rock is calcium-rich plagioclase feldspar (*q.v.*), whereas the remainder is mostly pyroxene (*q.v.*).

Chemically and mineralogically diabase closely resembles the volcanic rock basalt but is somewhat coarser and rarely contains glass. In diabase poorly formed pyroxene crystals wrap around or mold against long, rectangular plagioclase crystals to give it the characteristic texture known as diabasic or ophitic. The larger pyroxene grains may completely enclose plagioclase; but, as the quantity of the latter increases, pyroxene appears more interstitial.

Generally considered an intrusive rock, diabase is wide spread and occurs in dikes, sills, sheets, and other relatively small shallow bodies. It is largely on the basis of its intrusive character that diabase is distinguished from basalt. In fact, many specimens from thick basalt flows have all the characteristics of diabase. With increase in grain size diabase may pass into gabbro (*q.v.*).

Crystallization.—Under the microscope plagioclase crystals (usually labradorite) are commonly seen to consist of concentric shells of differing composition. Outermost shells are usually more sodic (sodium-rich) and cores more calcic (calcium-rich). Augite, frequently titanium-rich, is the common and early formed pyroxene; but orthopyroxene, not usually abundant, may also form early. Pigeonite may form later contemporaneously with much augite, but the crystallization period of augite may outlast that of any other pyroxene. Within each variety of pyroxene early formed crystals are enriched in magnesium; whereas later ones are richer in iron. Olivine is uncommonly a major constituent, but like pyroxene shows magnesium enrichment in the earlier crystals. Small patches of micropegmatite (an intergrowth of quartz and alkali feldspar) in some diabases represent the last portions to crystallize. Other minor constituents of diabase include biotite, hornblende, magnetite, apatite, and feldspathoid.

Certain flat tabular masses (thick sheets or sills) of diabase, like that forming the Palisades of the Hudson near New York city, show concentrations of heavy minerals (olivine, pyroxene) in their lower portions. These concentrations are commonly believed to have developed by settling of early formed crystals in molten diabase (*see* SILL). For further discussion of processes of crystallization *see* PETROLOGY.

Alteration.—Diabase may show varying degrees of alteration in which plagioclase is converted to saussurite; pyroxene to hornblende, actinolite, or chlorite; and olivine to serpentine and magnetite. In the British usage such altered rock is known as diabase. Some diabase masses have been subdivided by systematic fractures into rectangular blocks. Subsequent alteration and weathering along these fractures have disintegrated and rounded off block corners and edges (spheroidal weathering) leaving regularly spaced spherelike masses of fresh diabase enveloped by shells of progressively more altered and disintegrated material.

Chemical Analysis.—An average chemical analysis (in weight per cent) of diabase is as follows: silica (SiO_2), 50.48; alumina (Al_2O_3), 15.34; ferric iron oxide (Fe_2O_3), 3.84; ferrous iron oxide (FeO), 7.78; magnesia (MgO), 5.79; lime (CaO), 8.94; soda (Na_2O), 3.07; potash (K_2O), 0.97; water (H_2O), 1.89; and titania (TiO_2), 1.45. (C. A. CN.)

DIABELLI, ANTON (1781–1858), Austrian publisher and composer known for his waltz or *Ländler* on which Beethoven wrote his 33 Variations for piano (Op. 120), was born on Sept. 6, 1781, at Mattsee, near Salzburg. He was intended for the priesthood and was educated at the monastery of Raitenhaslach where his studies were supervised by Michael Haydn. On the secularization of the Bavarian monasteries in 1803 he went to Vienna where his piano pieces were widely played and where he became known as a teacher of the piano and the guitar. In 1818 he founded a publishing firm with Peter Cappi which six years later he took over entirely. He published works by Schubert, Czerny and Beethoven, and in 1851 issued the first thematic catalogue of the works of Schubert. Known for his sure instinct in publishing matters, he was called by Beethoven "Diabolus Diabelli." His own works include operettas and church music, piano works and numerous light pieces for the flute, guitar and other instruments. He died in Vienna on April 7, 1858.

See H. Rietsch, *Diabellis "Vaterländischer Künstlerverein"* (1906).

DIABETES INSIPIDUS is a disease characterized by the excretion of large volumes of urine of a low specific gravity accompanied by an abnormally great thirst, probably secondary to the excessive urine excretion. It is caused by destruction of the neural lobe of the pituitary gland or by lesions in the nervous connections between the hypothalamus and that lobe. The condition can be alleviated but not cured by the administration of posterior pituitary extract. *See* also HYPOTHALAMUS; METABOLISM, DISEASES OF; PITUITARY GLAND. (F. L. A.)

DIABETES MELLITUS is a condition in which the body is unable to metabolize sugars and other food materials efficiently. This disease is commonly termed "diabetes" and it appears when there is a relative but not necessarily an absolute deficiency of insulin in the body (*see* METABOLISM, DISEASES OF: *Endocrine Disturbances*). The first suggestion that the pancreas is necessary for the complete utilization of carbohydrates in the animal body was made by Johann Conrad Brunner in 1682. The relationship of the pancreas to diabetes was first suggested in 1788 by Cawley, an English physician. In 1889 J. von Mering and O. Minkowski showed that the complete removal of the pancreas from dogs resulted in a condition that is practically identical with diabetes mellitus in man. Although scores of investigators attempted to secure an antidiabetic substance from the pancreas, this substance, called insulin, was not proved to be present until 1921 (*see* INSULIN). In some cases the diabetic condition may be the direct result of a decrease in the formation and secretion of insulin by the pancreas, while in others the defect may be primarily the result of an altered activity of other glands.

Diabetes is a common disease. There are clear references to it in the ancient literature of Egypt, China and India. No age group is exempt, but most patients are over 40 at the onset of the disease and there are more female than male patients at this age. Obese persons are more liable to develop diabetes than are persons of normal weight. About 25% of all diabetics have relatives who are diabetics; hereditary predisposition toward the disease is well established. Estimates of the occurrence vary from 1.5 to 2%

of the population; about half of these cases are believed to occur in persons who are unaware that they have the disease.

Signs and Symptoms.—The untreated diabetic patient suffers from extreme thirst, hunger, weakness and loss of weight. He excretes abnormally large quantities of urine of high specific gravity (1.030 to 1.050, compared with a normal 1.015 to 1.020); his urine contains sugar and other substances not usually present. He is very susceptible to infection, and the infection when established is difficult to eliminate.

The diabetic condition is suspected when a patient complains of one or more of these signs or symptoms. A person may be a mild diabetic for a long time before he is aware of his condition. Diabetes as a rule advances comparatively slowly except in the young, in whom it often progresses so rapidly that the patient develops an acidosis, vomits and lapses into coma within a few days of what is apparently an acute onset of the disease. The routine analysis of the urine as a part of the physical examinations given to persons applying for life insurance or entering the armed forces has resulted in the early diagnosis of many cases of previously unsuspected diabetes. The prognosis of the early case is, of course, much better than that of the advanced, since treatment can be instituted earlier in the course of the disease. The amount of sugar in the blood under certain standard conditions is a valuable indication of the severity of the disease. The presence in the urine of the so-called ketone bodies (acetone, aceto-acetic acid and β-hydroxybutyric acid), which appear in the urine as a result of the excessive breakdown of fats, is a warning that acidosis and coma are imminent. The presence of these substances in the body can sometimes be suspected from the odour that acetone imparts to the breath.

The most characteristic finding is that of sugar in the urine, though it alone is not diagnostic of the diabetic condition. The amount of sugar thus excreted may be small or very great, depending upon the severity of the disease and upon the amount of sugar or starchy food eaten by the patient. Because the diabetic person does not use sugar as readily as a normal person, sugar accumulates in the blood to higher levels than normal and the excess is excreted in the urine. The metabolism of fats is increased to such an extent that the ketone bodies, which are the intermediary products of fat metabolism, are not completely oxidized as in the normal person, and these substances also accumulate in the blood and are excreted in the urine. Two of these ketone bodies are acids and are excreted in combination with alkali, which is thus removed from the body; the removal of alkali produces a condition of acidosis that may lead to coma.

The complications of inadequately treated diabetes are many and serious. Vision may become impaired. Skin affections of all kinds may occur and prove very intractable. Boils, carbuncles and gangrene are all apt to occur as life advances. There is especial danger of gangrene of the toes and feet. Diabetics are especially liable to tuberculosis. Digestive troubles, kidney diseases and diseases of the heart and particularly arteriosclerosis commonly occur. But the most serious complication of all is diabetic coma. The onset of this condition is often insidious but may be indicated by loss of appetite, a rapid fall in the quantity both of urine and of sugar in the urine, and by either constipation or diarrhea. At first the condition is rather that of collapse than of true coma, though later the patient is completely comatose. He suffers from a peculiar kind of dyspnea (difficult breathing) and the breath and skin have a sweet ethereal odour. In the pre-insulin days coma was the major cause of death in diabetics, but today this condition never appears in well-treated patients.

Treatment.—Patients suffering from diabetes mellitus are treated by dietetic measures and, if the condition is of moderate or severe intensity, by the administration of insulin. In certain cases in adults, successful treatment may consist of diet and hypoglycemic sulfonylureas given orally. Before the discovery of insulin the lives of many patients with severe diabetes were prolonged by the drastically restricted diets introduced as treatment by Frederick Madison Allen and by Elliott P. Joslin.

Several important principles underlie the dietetic treatment of the disease. The diet must supply sufficient calories to keep the patient's weight at the proper level. Protein, preferably as lean meat, eggs and milk, must not be reduced below a certain minimum value. If the dietary intake of protein is unduly reduced, the proteins in the tissues of the patient's body are drawn upon. Excess sugar is excreted in the urine, and the amount of sugar so excreted can readily be determined by chemical analysis.

The diabetic diet should resemble a normal diet as closely as possible. It is much more satisfactory for the patient to obtain the essentials of his diet from among common foods than to be largely dependent upon specially prepared diabetic foods. The diabetic diet need not be monotonous.

Insulin, which is distributed as a sterile, slightly acid solution, is injected hypodermically. There is no substitute for insulin. The amount necessary depends upon the severity of the disease, upon the quantity and nature of the diet, and upon the activity of the individual. In general, enough insulin is given to reduce the concentration of sugar in the blood to the level of a normal person. It is given every day, usually before breakfast; supplementary amounts sometimes are given later in the day.

If the diet is unbalanced with respect to the relative amounts of proteins, fats and carbohydrates, or if there is a serious lack of insulin, a diabetic may pass into coma. The treatment of coma before insulin was available was to put the patient to bed, supply fluids, heat and stimulants, and give sugar by mouth or by vein. These general measures are in large part still necessary. Insulin has proved a specific remedy in the treatment of this condition, and when it is given early enough and in large doses, the results have been very successful.

A very serious condition called hypoglycemia may be produced in a diabetic patient by an overdose of insulin or by insufficient or delayed food intake, excessive physical exertion, nervous tension, diarrhea, menstruation or infection. Whatever the cause, the result is a lowered concentration of sugar in the blood. Insulin shock, which results from insulin overdosage, can be avoided if the physician carefully balances diet against dosage of insulin, and if the patient closely follows the diet and learns to recognize the premonitory symptoms of the beginning of a hypoglycemic reaction. These early symptoms include sudden hunger, fatigue, a peculiar restlessness often described by the patient as a feeling of "inward trembling," pallor or flushing of the face and an increased pulse rate, a particularly valuable sign in children. If the overdose of insulin is large and corrective measures are not taken, the patient may show profuse perspiration, tremor, emotional disturbances, collapse and unconsciousness. The treatment of mild or moderate degrees of hypoglycemia consists of the administration of carbohydrate in any convenient form such as ordinary sugar or candy or diluted corn syrup. In severe cases a sterile solution of glucose is given intravenously by a physician.

Insulin Adjuvants.—Hundreds of plant extracts and pure chemicals have been suggested as substitutes for or adjuvants of insulin. A very large proportion of the few agents that have proved effective are liver poisons that decrease the output of sugar from this organ. The orally administered hypoglycemic sulfonamides, however, earned a place in therapeutics on the basis of tests completed in the late 1950s. There is evidence that they liberate some insulin from the patient's pancreas; they probably have other actions that in the early 1960s were still unknown. These drugs are useful in the treatment of mild cases in adult obese diabetics; they are not effective in children or in patients with ketosis. In some patients, the sulfonamides lose their effectiveness and must be replaced by insulin. In cases that can be treated effectively by dietary restrictions alone, neither insulin nor the oral drugs should be used.

Prognosis.—Before insulin became available, fewer than 20% of patients suffering from severe diabetes lived more than ten years. Children, who usually have the disease in a severe form, seldom lived for more than a year. As knowledge about the disease and its treatment accumulated, the life expectancy of a diabetic patient in the early 1960s was much nearer that of the general population. Diabetic women who follow a carefully prepared dietary regime while receiving insulin and other necessary treatment can bear healthy babies. Most persons who have diabetes

can keep well and lead successful and useful lives, but constant and intelligent attention to the details of treatment by both patient and physician are necessary.

See BIOCHEMISTRY: *Carbohydrate Metabolism;* BANTING, SIR FREDERICK GRANT; *see* also references under "Diabetes Mellitus" in the Index. (C. H. B.; E. T. W.)

DIADOCHI (Gr. *diadochoi*) means "successors" and is the name given to the Macedonian generals who fought for the empire of Alexander the Great after his death in 323 B.C. The name includes Antigonus I and his son Demetrius I; Antipater and his son Cassander (*qq.v.*); Seleucus (*see* SELEUCID DYNASTY); Ptolemy (*see* PTOLEMIES); Eumenes and Lysimachus (*qq.v.*). The kingdoms into which the Macedonian empire was divided under these rulers are known as Hellenistic. The chief were Asia Minor and Syria under the Seleucid dynasty, Egypt under the Ptolemies, Macedonia under the successors of Antigonus II and Pergamum under the Attalid dynasty (*q.v.*). Gradually these were merged in the Roman empire. *See* also MACEDONIA, KINGDOM OF.

DIAGENESIS, the geologic process by which, after deposition, a sediment may be materially altered or modified. These modifications may occur before burial at the common boundary, or interface, between sea water and the sediment, after burial but before consolidation or after consolidation either at normal temperatures and pressures or at elevated temperatures and pressures. The term diagenesis is applied to those changes which take place in a newly deposited sediment, prior to its consolidation, either at or below the sediment-water interface. Changes in the sediment produced by higher temperatures and pressures are properly called metamorphic. There is some uncertainty where diagenesis leaves off and metamorphism (*q.v.*) begins. Some writers would restrict diagenesis to reactions taking place on the sea floor and would use the term epigenesis for those changes which occur after consolidation and uplift but prior to the advent of truly metamorphic conditions. The changes or processes operating on a sediment clearly overlap and form a continuum so that it is commonly difficult, from a study of the results alone, to be sure in which stage a particular feature was produced.

Diagenetic changes are brought about mainly by chemical reaction of the solid particles of the sediment with the surrounding fluid, either the superjacent medium from which the sediment was deposited or the fluids trapped in the intergranular voids or pores of the sediment. The processes, solution and reprecipitation and exchange of ions between solid and liquid, alter the physical properties and the chemical or mineralogic composition of the sediment. Included among the changes are compaction, which is largely physical and results in decrease of porosity of the rock; cementation, usually by the precipitation of interstitial cement; recrystallization (such as conversion of aragonite to calcite); replacement (such as the conversion of precipitated calcium carbonate to dolomite, the double carbonate of calcium and magnesium); selective solution of some components; and the regeneration and growth of others.

Among the many products of diagenetic action are the authigenic minerals (those formed on the spot) that grew in the sediment after deposition. These may occur as secondary overgrowths on pre-existing detrital grains or as crystals without detrital cores. The quartz and feldspars of some sandstones commonly show authigenic overgrowth; both may occur also in limestones as small authigenic euhedral crystals; *i.e.,* having well-formed faces. Some concretions, most glauconite, much dolomite, the chlorite and clay mica of shales and some cherts have been attributed in part to diagenesis. *See* also SEDIMENTARY ROCKS. (F. J. P.)

DIAGHILEV (DIAGHILEFF), **SERGEI PAVLOVICH** (1872–1929), Russian ballet, art and music impresario, whose ballet company introduced modern ballet to the western world in 1909 and from then until his death exerted enormous influence on dancing, painting and music. He was born in Novgorod province on March 19, 1872, and studied law in St. Petersburg, where he founded the magazine *Mir Iskusstva* ("The World of Art"). While serving as assistant to Prince Sergei Volkonsky, director of the imperial theatres, Diaghilev edited the 1899–1900 edition of the theatre annals; he resigned the position in 1901. An exhibition of Russian historical portraits that Diaghilev organized in St. Petersburg in 1905 led the following year to an exposition of Russian art in Paris. In 1907, he presented Chaliapin and other Russian musicians in Paris concerts, and in 1908 he produced *Boris Godounov* there.

After 1908 Diaghilev devoted himself exclusively to ballet. The first performance of the Diaghilev Ballet Russe took place at the Théâtre du Châtelet, Paris, May 18, 1909. It introduced Vaslav Nijinsky, Anna Pavlova, Tamara Karsavina and Adolph Bolm to the western world. The choreographic genius of Michel Fokine was revealed in his *Pavillon d'Armide* and *Prince Igor.* The vital, exhilarating art of the Russian dancers was a revelation to western eyes and marked the beginning of a great renaissance of the ballet.

Diaghilev had an uncanny ability to recognize incipient talent. His collaborators included the composers Stravinsky, Ravel, Prokofiev, Poulenc and Milhaud, the choreographers Fokine, Nijinsky, Massine and Balanchine and the painters Bakst, Picasso, Benois, Matisse, Derain and Chirico.

In successive seasons, Diaghilev produced such impressive works as *Les Sylphides, Petrouchka, Scheherazade, L'Oiseau de Feu, L'Après-midi d'un Faune, La Boutique Fantasque* and *Le Tricorne.* In 1921 he revived the great Tschaikovsky ballet *The Sleeping Beauty* in the original choreography by Marius Petipa. Later he experimented with new trends in music, décor and choreography.

Although the Diaghilev company disbanded after its founder died in Venice on Aug. 19, 1929, its influence on 20th-century ballet can hardly be overestimated.

See also BALLET: *the Diaghilev Ballet.*

See Arnold L. Haskell and Walter Nouvel, *Diaghileff, His Artistic and Private Life* (1935); S. L. Grigoriev, *The Diaghilev Ballet, 1909–1929* (1953). (LN. ME.)

DIAGNOSIS. Man, because of his physical and mental ills, has from time immemorial turned to the physician for aid. In the past a certain mystery or magic was associated with medical diagnosis. The modern physician, however, proceeds in a logical, rational manner, avoiding the supernatural but calling for aid not only upon medicine but also upon chemistry, physics and bacteriology. While many who are ill recover without treatment, thanks to what the ancients called the *vis medicatrix naturae,* the healing power of nature, the first step toward successful treatment is a correct diagnosis.

In making a diagnosis the physician consciously or subconsciously follows certain definite procedures in logic. First, he recognizes the problem that the patient presents; second, he collects data that more clearly outline the problem; third, he thinks over the facts and the possible solutions; fourth, he reasons out the implications of the suggested solutions; and, lastly, he compares the actual facts with the suggestions to see if there is an identity between the facts established and the suggested solutions. These facts are obtained from the anamnesis, or history, from the psychical and physical examination and from laboratory tests and the data obtained from the employment of instruments of precision, such as the X-ray, the electrocardiograph, the electroencephalograph and similar instruments.

These are the methods of diagnosis whether the disease is to be treated by medical or by surgical procedure. The methods of medical and surgical diagnosis are one and the same; only the methods of treatment vary.

Patient's History.—The importance of a careful history has been recognized from the earliest times. Rufus of Ephesus, who practised during the reign of Trajan (*c.* A.D. 100), wrote a work, *On the Interrogation of Patients,* that still ranks as one of the classics of medical literature.

In the history, the influence of heredity is often of great importance since certain physical characteristics of individuals are transmitted from one generation to another. The thin, gracile, sthenic type is more prone to develop certain diseases than is the heavy, muscular, phlegmatic individual who, in turn, is more likely to suffer from certain other diseases. High blood pressure and diabetes mellitus show a marked tendency to appear in suc-

cessive generations of the same family. Cancer and tuberculosis show a marked hereditary tendency. Nervous and mental diseases are particularly prone to appear in certain families. Some diseases of the nervous system are always hereditary, familial or congenital. Friedreich's disease and Huntington's chorea are hereditary; Wilson's disease is familial; meningocele, spina bifida and many cases of hydrocephalus are congenital. Psychoneuroses show a marked familial tendency, as do certain psychoses, notably manic-depressive psychosis.

Not only the family history but also the past history of the patient himself should be noted carefully. Certain diseases of childhood may give the clue that indicates the correct diagnosis. For instance, the history of enlarged glands of the neck, or even of scrofula, during childhood suggests that the cough from which the adult patient suffers is caused by pulmonary tuberculosis.

The patient's occupation and habits, moreover, may offer clues to diagnosis. Certain occupations present definite health hazards. Those who work in an atmosphere of dust, as do coal miners, metalworkers, stonemasons and woodworkers, inhale dust particles that lodge in the lungs and may later produce severe pulmonary disease. Workers in chemical plants may suffer from acute or chronic poisoning, and painters are prone to develop lead poisoning unless proper precautions are observed. Nursery workers who spray plants with solutions of arsenic, mercury and other poisonous ingredients are subject to hazards from these poisons. It is also important to know where the patient has lived or still lives. Malaria, for example, is very common in the Mediterranean area but very rare in Labrador.

The excessive use of alcohol and tobacco has long been recognized as a cause of disease. Chronic alcoholism causes certain types of psychoses. Cirrhosis of the liver is closely associated with the overuse of alcohol, as the old designation "gin-drinker's liver" indicates. More than one-half of the cases of cirrhosis of the liver in the United States are seen in alcoholics. The excessive use of tobacco plays its role in the production of disease, particularly of the vascular system. Tobacco causes, in many individuals, a constriction of the capillaries of the skin with a lowering of skin temperature, while other individuals develop cardiac irregularities from excessive smoking. Excessive cigarette smoking may be a major factor in the causation of lung cancer.

The patient's eating habits, his favourite foods and foods that agree or disagree with him suggest possible diagnoses. The patient with hyperacidity of the stomach cannot eat pickles, while the man with too little acidity enjoys them. The patient's psychological background and environment may play a deciding role in the causation of a disease. An environment of fear, or repression, or hostility may produce physiological as well as mental abnormalities.

History of the Illness.—Next, the physician investigates the history of the patient's illness. He asks if the symptoms are general or local; if they are local, he asks where they are localized. Since the local symptom is most commonly pain, the physician wishes to know where it is located, whether it is constant or occasional, whether it is sharp or dull, and whether it remains localized or travels to another region. In many diseases, such as angina pectoris, duodenal ulcer, intermittent claudication and tabes dorsalis, an accurate description of the pain, including its location, duration, periodicity and the conditions under which it appears or disappears, is often sufficient to indicate the diagnosis. The duration (chronicity) of the disease is always investigated. Some diseases are acute, some are chronic, some tend to regress spontaneously and others never regress with or without assistance. Lobar pneumonia is an acute disease in which either recovery or death occurs in a few days. A patient who has been ill a month or longer is not suffering from uncomplicated lobar pneumonia. Conversely, diabetes mellitus is a chronic disease in which complete recovery rarely if ever occurs. A patient who has had sugar in the urine but later finds that it has completely disappeared probably does not have diabetes.

History taking is an art of great value. Some physicians estimated that the history itself contributes 50% to the correct diagnosis; others raise the percentage as high as 75. Hippocrates, the father of medicine, compiled case histories so accurately that more than 2,000 years later the correct diagnosis can be made from them.

Physical Examination.—After he obtains the history of the patient and of the disease, the physician next proceeds to examine the patient, making use of his trained senses of sight, touch, hearing and smell. In this physical examination he employs four methods: (1) inspection; (2) palpation; (3) percussion; and (4) auscultation.

Inspection.—This is the oldest of these methods. Inspection alone may be sufficient to diagnose diseases that cause alterations in the patient's appearance; such diseases are acromegaly, which produces marked enlargement of the jaws, nose and frontal bone, and leprosy, which often causes thickening of the tissues of the face so that the patient's face resembles that of a lion—the leonine facies. The expression of the face is characteristic of certain diseases. In Parkinson's disease the face is often singularly devoid of expression, or masklike, the so-called Parkinsonian mask. In paralysis of the facial nerve, Bell's palsy, the patient is unable to close his eye, smile or show his teeth on the affected side. The gait of the patient may be characteristic of a certain disease, such as tabes dorsalis, hemiplegia or Parkinson's disease.

The eyes may be protruded or sunken; the pupils may be irregular, not of the same size in each eye or may not constrict when exposed to light. All of these abnormalities have special significance. Inspection of the blood vessels of the neck may reveal irregularities in the beat of the heart so characteristic as to indicate the diagnosis. Inspection of the chest may reveal a marked difference in size and inequality of respiratory movements on the two sides, and the apex beat of the heart reveals by its position whether the heart is enlarged and by its character whether the heart is irregular. An enlarged stomach, liver or spleen or a tumour in the abdomen are often readily seen on careful inspection.

The ancients devoted a great deal of attention to the pulse and wrote many tomes on the subject. Paul of Aegina, who practised during the 7th century A.D., distinguished 62 varieties of pulse. While the modern physician thinks that many of these varieties were figments of the imagination, he has found that certain diseases are almost invariably associated with a certain type of pulse and that certain heart diseases have pulses that are slow or fast, small or bounding, regular or irregular.

Palpation.—By palpation, the physician confirms what is seen on inspection. Firmness or softness, or irregularity in outline or of the surface, of an enlarged organ may not be apparent on inspection alone. Pain may be elicited on pressure, and edema of the ankles, which may have been suspected on inspection, is confirmed when pressure with the finger produces a pitting that persists.

Palpation may reveal tenderness over the gall bladder in gall bladder disease; tenderness on pressure over the appendix is diagnostic of appendicitis unless the symptoms and the other findings disagree with this diagnosis. Palpation is of great value in the diagnosis of suspected fractures because it can reveal abnormal motility of the bones or crepitation. After palpation the physician proceeds to percussion.

Percussion.—Percussion, or tapping with the fingers, was discovered by Leopold Auenbrugger and described in his *Inventum novum*, one of the classics of medical science, published in 1761. Auenbrugger, the son of an innkeeper in Graz, learned as a boy to tell how much wine was in a cask by tapping on the end. As a physician he discovered he could tell which side of the chest contained fluid by tapping on it and that he could determine the size of the heart, the presence of fluid, pneumonia and other disease conditions by this method.

Percussion of the chest reveals whether the lungs contain air or are consolidated, and whether pneumonia or pulmonary tuberculosis should be suspected, as well as whether fluid in the chest or thickening of the pleura or air in the chest may be present. Percussion is important in determining the position and the size

of the heart, liver, spleen and stomach. Its value is greatly enhanced by auscultation.

Auscultation.—Auscultation, or listening, was discovered by René Théophile Hyacinthe Laënnec, a pupil of Jean Nicolas Corvisart, who introduced percussion into medical practice in France. Laënnec, according to his biographers, was watching a group of children playing on a beam in the courtyard of the Louvre. One youngster scratched the beam with a pin, and the others, while pressing their ears against the beam, yelled every time he scratched. Laënnec, who made the observation while on his way to see a patient, had an inspiration. On reaching the patient's house, he took a sheet of paper, rolled it into a cylinder and applied one end to his ear and the other end to the patient's chest. To his delight he heard the heart sounds perfectly, and at that moment the stethoscope was discovered. He described his instrument and its value in his *De l'auscultation médiate,* published in 1819. The stethoscope remains one of the indispensable aids in the diagnosis of disease of the lungs and heart. With it the physician determines whether the breath sounds are normal or whether there are signs of inflammation, bronchitis, consolidation or cavitation in the lungs. He also can tell whether the heart sounds are normal or whether there is disease of the myocardium or lesions of the four sets of heart valves. (*See* AUSCULTATION.)

Instruments of Precision.—After the physical examination has been finished, the physician turns to instruments of precision for additional aid.

Sanctorius (1561–1636), professor at Padua, was the first physician to employ instruments of precision in the practice of medicine. The legend goes that Galileo, while watching a lamp swing in the cathedral at Pisa, counted its oscillations by feeling his pulse and established the law of the isochronism of the pendulum. Sanctorius, his colleague and friend, reversed the process and timed the pulse by the swinging of a pendulum that consisted of a weight attached to a cord. The length of the cord, which was adjusted until the rate of the oscillation agreed with that of the pulse, was measured on a scale and this measurement was taken as the pulse rate. Sanctorius also employed a type of thermometer, probably the one invented by Galileo, to determine the patient's temperature and weighed his patients on a steelyard to measure accurately the effect of food, exercise and various activities upon what he called the insensible perspiration.

Although Sanctorius published his method of estimating the pulse and determining the temperature in 1625 and his work on insensible perspiration in 1614, only the latter made much impression upon medical thinking. Accurate timing of the pulse first became a recognized procedure when Sir John Floyer published in 1707 his *Pulse Watch,* in which he stated he at first employed a minute glass such as was used by mariners, "but because that was not portable, I caused a Pulse-Watch to be made which runs 60 Seconds, and I placed it in a Box to be more easily carried, and by this I now feel Pulses."

Registration of the temperature lagged even further behind, the first systematic recording dating from 1852 when Ludwig Traube published the first temperature curve in fever from the Leipzig clinic.

Sir James Mackenzie (1853–1925), while a general practitioner in Burnley, Eng., devised an instrument with which he could simultaneously register the pulse waves in the radial artery at the wrist and in the jugular vein in the neck. By comparing the two sets of curves, the jugular pulse indicating the action of the auricles and the radial pulse the changes in the ventricles, he demonstrated the mechanism by which irregularities of the pulse were produced and made some of the most noteworthy contributions in the history of cardiology.

Blood Pressure.—Measuring the blood pressure is an important part of the examination of the patient. While the skilled physician in the past could tell whether the blood pressure was elevated by palpating the pulse, this method was inexact and often misleading. In 1896 Scipione Riva Rocci devised the form of the sphygmomanometer used today for measuring blood pressure; it consists of a rubber bag surrounded by a cuff, which is pumped up until the pulse (the systolic pressure) disappears at the wrist. Later it was found that by listening at the bend of the elbow, systolic pressure as well as diastolic pressure could be estimated. The systolic pressure is the pressure during the systole, or the beat of the heart; the diastolic pressure is the pressure during diastole, or the pause of the heart between beats. Although there is still much discussion regarding the normal systolic and diastolic pressures, it is safe to state that a systolic pressure of more than 140 mm. of mercury and a diastolic of more than 100 mm. is elevated. (*See* BLOOD PRESSURE.)

Electrocardiograph.—No study of the heart or circulation is complete without the records obtained with the electrocardiograph. Augustus D. Waller showed in 1887 that an electrical current produced by the beating of the heart could be demonstrated in man by attaching electrodes to the body and connecting them with a capillary electrometer. Willem Einthoven in 1903 substituted for the capillary electrometer a string galvanometer of his own design, and the electrocardiograph became a practical clinical instrument. In the original instrument the feeble current coming from the body through the arms and legs was carried into a quartz string placed in a magnetic field. Each heartbeat caused a vibration of the string, whose movements were photographed on a moving film or sensitized paper—the electrocardiogram. Later improvements consisted of employing electron tubes similar to those used in radio that step up the weak current until it moves a string more sturdy than the original delicate quartz fibre, or even marks directly upon prepared paper. The latter method avoids the inconvenience of photography and allows the physician to watch the record as it is being written.

The information that can be obtained from study of the electrocardiogram is amazing. It shows whether the heart is enlarged and where the enlargement occurs, whether the heart action is irregular and where the irregularity originates, whether a coronary vessel is occluded and where the occlusion is located, and whether a slow rate is physiological or caused by heart block. It also indicates high blood pressure, thyroid disease and certain types of malnutrition.

Cardiac Catheterization.—This procedure, carried out first by Werner Forssmann in 1929, has been of great value in diagnosing diseases of the heart, particularly congenital malformations. The procedure, which consists of introducing a small catheter into a vein and then passing it into the heart, gives the doctor accurate measurements of the (blood) pressure within the auricles and ventricles and also of the oxygen and carbon-dioxide content of the blood in each auricle and ventricle.

Electroencephalograph.—One of the latest instruments of precision, the electroencephalograph, was first described in 1929 by Hans Berger of Jena. It records the electrical activity of the human brain and has been of special value in diagnosing epilepsy and locating lesions of the brain, such as tumours, abscess or hemorrhage.

X-rays.—No examination tool has been more useful to general diagnosis than X-rays, or Röntgen rays, which were discovered by Wilhelm Conrad Röntgen in 1895. The original X-rays were photographs made on sensitive plates. With the development of fluoroscopy, X-ray diagnosis became even more helpful. When a patient is placed in front of the X-ray tube and behind the fluorescent screen, the physician sees clearly the outlines of the body, can watch the heart beat and note any irregularities, and can watch the lungs expand in respiration and observe whether this expansion is normal. When the patient swallows a gruel containing barium or any other substance opaque to the X-ray, the course of this material can be followed by the physician as it passes from the mouth, through the esophagus and stomach and into the intestines. The X-ray demonstrates the structure of the bones of the body and lesions of the bone such as defects of structure, fractures, tumours, arthritis and inflammations. It reveals the size of the heart; irregularities and defects of the heart; pulmonary diseases such as bronchitis; pulmonary tuberculosis; collapse and abscess of the lungs; tumours of the lung; thickening of the pleura; fluid in the pleural cavity; enlargement of the liver, spleen and kidneys; and stones in the kidneys, gall bladder, bladder and pancreas.

The employment of contrast mediums, which is the name given to the opaque solutions that cast shadows, greatly enlarged the scope of X-ray diagnosis. This method made possible the demonstration of bronchiectasis; diverticula and cancer of the esophagus, stomach and intestines; and lesions of the kidneys, ureters and bladder. Similarly, the employment of the opaque dye iodophthalein, which was first used by Evarts A. Graham and W. H. Cole in 1924, demonstrates enlargement of the gall bladder and lack of function or the presence of gallstones. Lesions of the heart and blood vessels and obstructions to the blood flow through the heart, arteries or veins can be revealed by injecting partially opaque solutions into the circulatory system. Ventriculography, introduced by Walter E. Dandy in 1918, consists of introducing air into the ventricles of the brain and then taking an X-ray of the skull. The resultant picture shows the size and location of the ventricles, which may be displaced or distorted by a tumour or abscess of the brain. (*See* RADIOLOGY: *Diagnostic Radiology.*)

Basal Metabolism Test.—Another method of examination, the basal metabolic test, is of great value in certain patients. The method employed consists of estimating the amount of oxygen consumed in a certain amount of time. When more oxygen than normal is consumed, the metabolic rate is increased; when the amount of oxygen consumed is less than normal, the rate is decreased. The test is of especial value in the diagnosis of the thyroid disease. In hyperthyroidism or exophthalmic goitre the metabolic rate is increased; in hypothyroidism the rate is decreased.

Other Instruments.—In addition to these instruments of precision, the physician also has at his disposal the ophthalmoscope, which permits inspection of the retina; the bronchoscope, which shows the interior of the bronchi; the gastroscope, which gives a clear view of the interior of the stomach; the laryngoscope, for studying the larynx and vocal cords; the cystoscope, with which the interior of the bladder can be seen; and the proctoscope, which can be used to reveal lesions of the rectum and sigmoid flexure.

Laboratory.—After the physician has completed the physical examination and his examination with instruments of precision, he turns next to the laboratory for study of the blood, urine, body fluids, secretions and any tissue that was removed for microscopic examination. In an examination of the blood, the red cells and white cells are counted; the amount of hemoglobin is determined; the white blood cells are then stained and the relative percentages of the different types are estimated. The number of red cells is decreased in the anemias and is increased in the polycythemia. In most infectious diseases the number of white blood cells is increased, but in some infectious diseases a decrease in the number of white blood cells is characteristic. In the leukemias, the number of white blood cells is often tremendously increased. The clotting time of the blood is increased in hemophilia; the formation of the clot is often abnormal in purpura. The number of blood platelets, a third type of blood cell, is markedly diminished in purpura haemorrhagica, or Werlhof's disease (thrombocytopenic purpura). Blood typing is of the greatest importance in certain conditions and in connection with treatment by transfusion. The sedimentation rate, a valuable aid in the diagnosis of certain diseases, is determined by placing the blood in a test tube containing an anticoagulant and noting the rate of settling or sedimentation of the red blood cells. The direct study of the bone marrow has been of great value in the diagnosis and treatment of blood diseases. A small amount of bone marrow is obtained by puncture, usually of the sternum. The physician can study the processes of blood formation by examining the immature cells that have not yet been released from the marrow into the circulation.

The blood serum yields important information in many diseases. For example, the serum contains substances in syphilis that produce a positive Wassermann reaction; in typhoid fever, the serum contains specific agglutinins that agglutinate the typhoid bacillus (Widal's reaction); other specific agglutinins are present in brucellosis (undulant or Malta fever), tularemia and other less common infections.

Blood cultures are a routine procedure in establishing diagnosis of many infectious diseases and may demonstrate the presence in the circulating blood of the typhoid bacillus, the pneumococcus, the meningococcus and the streptococcus, to mention a few well-known examples.

Studies of the blood chemistry are of great importance in many diseases. In diabetes, for example, the amount of sugar in the blood is greatly increased; in nephritis (Bright's disease), when the kidney is unable to excrete properly, the blood values for urea, uric acid, protein and creatinine may rise sharply. The blood cholesterol may be diminished in hyperthyroidism and greatly increased in hypothyroidism. In many diseases a study of the patient is incomplete without certain determinations of the blood chemistry.

By means of the stomach tube, the physician is able to study the gastric contents. The most important finding is the degree of acidity present. Gastric acidity is usually greatly increased in gastric or duodenal ulcer and decreased in cancer of the stomach; in pernicious anemia no acid is present.

Lumbar puncture, which was introduced by Heinrich Quincke in 1891, consists of introducing a small needle between the lumbar vertebrae into the subarachnoid space. The pressure of the spinal fluid is measured, and the fluid itself can be studied. This procedure is of great value in the diagnosis of meningitis, poliomyelitis, syphilis, brain tumours and many other diseases of the nervous system.

Tissue examination is a valuable aid in the diagnosis of cancer. (*See* CANCER: *Diagnosis.*)

Functional Tests.—These tests are assuming increased importance in diagnosis. The functional capacity of the heart is tested by noting the increase in the heart rate and in the blood pressure following exercise, and also by recording the time necessary for both to return to their normal values. Kidney function is tested by noting the rate at which the dye phenolsulfonphthalein when injected in the cubital vein is excreted in the urine and by the urea clearance test, in which the blood urea and the amount of urea present in 75 ml. of urine is estimated. Functional tests for the liver employ the intravenous injection of dyes, such as sulfobromophthalein sodium, which a normal liver withdraws from the circulation in 30 min. Carbohydrate function tests are performed by giving the patient 100 g. of glucose by mouth on an empty stomach. Normally the level of blood sugar rises sharply from the normal of 100 mg. per 100 ml. of blood to 130 mg. or 150 mg., then falls sharply and returns to its original level in two hours. In diabetes mellitus it may rise to two or three times its normal value and remain quite high for two, three or even four hours.

Skin tests are valuable in diagnosis. When the skin is scratched and a drop of tuberculin is placed on the spot, an area of redness with induration of the skin appears within 24 to 48 hours in persons who are or have been infected by tuberculosis (Von Pirquet test). This test is of special value in children. Similarly, when a drop of diphtheria toxin is employed, individuals who have no immunity to diphtheria show a reaction (Schick test). A similar test is employed in the allergic diseases, notably asthma and hay fever, where the offending material, such as milk, wheat, horse serum or ragweed pollen, causes a reaction.

In many patients an examination of pathological secretions for bacteria may be a deciding point in diagnosis. The exudate from an inflamed tonsil, pharynx or nostril when stained by proper methods may reveal the diphtheria bacillus or the streptococcus as the cause of the disease. Cultures of such secretions or of the urine, feces, pus or sputum demonstrate the organism even more conclusively. The demonstration of a single tubercle bacillus in the sputum makes positive, often, a suspicion of pulmonary tuberculosis.

Final Diagnosis.—The physician has now collected his data. He now thinks over the facts that he has obtained and the suggested solutions—sugar in the urine, for instance, would suggest diabetes mellitus. Then he reasons out the implications of the suggestions; thus a diabetic patient in addition to having sugar in the urine should have an abnormal amount of sugar in the blood

and should give a history of excessive thirst, excessive urination and loss of weight.

The physician next arrives at the last stage of the mental process required in making a diagnosis. He compares the actual facts with the suggestions that have occurred to him to see if there is an identity between such facts and the suggested solutions. If further study brought out the existence of all of the above symptoms, the actual facts would agree with the suggested solution. The diagnosis would be diabetes.

This is the method pursued by the physician in making a diagnosis. While the task of collecting data on the patient—history, physical examination, special examinations and laboratory tests—requires accurate observation, the process of correct reasoning is, in the last analysis, more important. False diagnoses often result not from false data but from faulty interpretation. To assemble the data, to make use of the relevant and to discard the irrelevant information, and to pass final judgment—all of which are important steps in making the diagnosis—often requires a mental ability of the highest order.

See also references under "Diagnosis" in the Index volume.

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DIALA: *see* Diyala.

DIALECT, a peculiar manner of speech in the language of a person, community, profession, social group, country or district (from Gr. *dialektos*). In its widest sense, languages which are branches of a common or parent language are its dialects, as Attic, Ionic, Greek, and the various Romance languages of Latin. Where there have existed side by side, as in England, various branches of a language, such as the languages of the Angles, the Jutes and the Saxons, and the descendant of one particular language has predominated, the traces of the others remain in the dialects of the districts where once the original language prevailed. Thus a dialect of a language represents a variation. *See* also Language: *Historical Development of Languages.*

See *Orbis*, pub. by Centre International de Dialectologie générale, Louvain (1952 *et seq.*). (J. Wh.)

DIALECT GEOGRAPHY, or linguistic geography (areal linguistics), deals with the geographic dissemination of linguistic features and their interpretation in terms of population history (demography).

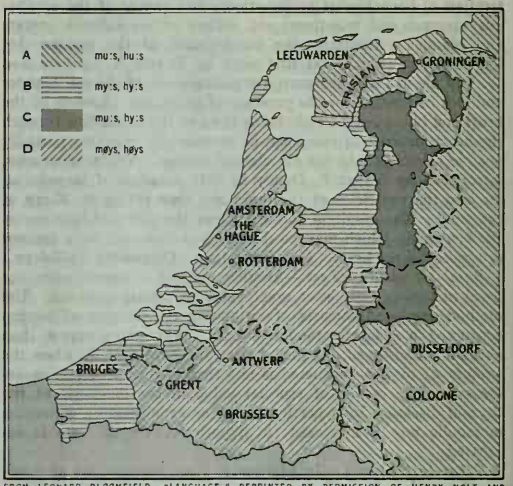
The data are secured from the speech (vocabulary, grammar, pronunciation) of representative speakers in selected communities within an area. The findings are mapped separately for each item investigated. Lines are drawn around areas of uniform or majority usage (inner isoglosses, setting off the focuses) and around areas of minority usage (outer isoglosses, setting off the margins of the focuses).

Such word lines (isolexes), form lines (isomorphs) and phonetic lines (isophones) furnish the basis for establishing major and minor dialect boundaries within the area. For, although isoglosses rarely follow precisely the same course, they are apt to run in more or less closely knit bundles. The relative importance of such bundles (dialect boundaries) depends partly upon the number of isoglosses they contain and partly upon their character, structural isoglosses (phonemic or morphological) being obviously more important than nonstructural ones (isolexes, incidental isophones and isomorphs).

The dialectal subdivisions of an area established in this way lend themselves to historical interpretation by determining correlations with areas of settlement and trade, political subdivision and culture areas. Relatively uniform focal areas and their margins are usually directed toward important cultural centres; dialect boundaries often coincide with political, social and economic barriers, where features disseminated from these centres are apt to be arrested. However, usage is always in flux, shifting with a complex of factors in the history of the population.

Though concerned chiefly with regional folk dialects, linguistic geographers also turned their attention to social dialects and their interrelations, especially in the United States, where class usage shades off from the "folk" to the cultured.

Linguistic geography has developed its techniques since 1875, and has achieved highly significant results. It has taken its place



FROM LEONARD BLOOMFIELD, "LANGUAGE," REPRINTED BY PERMISSION OF HENRY NOLT AND COMPANY, INC., COPYRIGHT 1933

MAP SHOWING THE DIFFERENCES IN THE PRONUNCIATION OF THE WORDS "MOUSE" AND "HOUSE" IN THE LOW COUNTRIES

(A) Primitive Germanic pronunciation, once prevalent over entire area; (B) later pronunciation which spread during the middle ages, perhaps from Flanders; (C) primitive Germanic pronunciation retained in the word "mouse," and the pronunciation of the middle ages adopted in the word "house"; (D) present-day standard Dutch-Flemish pronunciation which spread from Antwerp during the 16th and 17th centuries

by the side of comparative and historical linguistics, and is refining its methods by applying the methods of more recently developed structural linguistics. Linguistic atlases and numerous interpretative studies have been published, first in Europe and later in the U.S.

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DIALECTIC (Dialectics), a term in logic, generally used in common parlance in a contemptuous sense for verbal or purely abstract disputation devoid of practical value (from Greek *dialektos*, "discourse"; *dialektike* [*techne*], "art of debate"). According to Aristotle, Zeno of Elea "invented" dialectic, which was in his hands a method of refuting an opponent's opinion by accepting it hypothetically and then forcing the opponent to admit that it led to contradictory conclusions. This destructive form of dialectic was much used by the Sophists. In the hands of Socrates dialectic became the art of eliciting a satisfactory definition (or of rejecting an unsatisfactory definition) of some ethical or other term by the systematic use of question and answer. In Plato this dialectical quest for definition was transformed into an investigation of the forms or ideas, which were thought of as entities shared in by, or copied by, the things to which a general term may be applied. This dialectic was envisaged (perhaps at different stages in Plato's development) as a study which connects the forms with the culminating "Idea of the Good" (*Republic*, vii), or as a science which arranges forms hierarchically from the most narrowly specific to the most comprehensively generic and which also determines whether they will or will not "blend" (that is, whether they can or cannot be predicated of one another or of the same subject). In Aristotle's use the dialectical is opposed to the demonstrative use of reasoning (which alone yields knowledge): in the former one's premisses are the opinions of the many or the experts, whereas in the latter one may only make use of such premisses as are either true and primary, or else deducible

from true and primary premisses. The Stoics divided logic into rhetoric and dialectic, and from their time till the end of the middle ages dialectic was either synonymous with, or a part of, logic.

In modern philosophy the word has received certain special meanings. In the critical philosophy of Kant the part known as the "transcendental dialectic" endeavours to expose the illusion involved in attempting to use the categories and principles of the understanding beyond the bounds of phenomena and possible experience. In the system of Hegel dialectic becomes the tendency of a finite object or notion to "suppress itself," to "develop contradictions" and to pass over into its own negation. Such dialectic occurs in the realm of thought and science, but it also occurs in the spheres of nature and history: "Wherever there is movement, wherever there is life . . . there dialectic is at work." The Hegelian word and notion were taken over by Karl Marx (*see* MARXISM; DIALECTICAL MATERIALISM).

See also references under "Dialectic" in the Index volume.

(J. N. F.)

DIALECTICAL MATERIALISM, the philosophy of the world Communist movement, is derived from the philosophical and social teachings of Karl Marx (1818–83) and Friedrich Engels (1820–95) (*qq.v.; see* also MARXISM). Its essential feature is the combination of philosophical materialism with dialectics.

For Marx and Engels, materialism meant that the material world, perceptible to the senses, had objective reality independent of mind or spirit. They did not deny the reality of mental or spiritual processes, but affirmed their dependence on material processes of which they were the product. Feeling, sensation, thought, etc., were functions of the brain. Ideas could arise, therefore, only as products and reflections of material conditions—though having once arisen, they play an essential part in human activity. Marx and Engels understood materialism as the opposite to "idealism," by which they meant any theory which treats matter as dependent on mind or spirit, or mind or spirit as capable of existing independent of matter. For them, the materialist and idealist views were irreconcilably opposed, throughout the historical development of philosophy. They adopted a thoroughgoing materialist approach, holding that any attempt to combine or reconcile materialism with idealism must lead to confusion and inconsistency. Stressing the priority of matter and the secondary or derivative character of mind and ideas, they denied the possibility of supernatural or transcendental reality.

While acknowledging their debt to the materialism of the philosophers of the 18th-century French "Enlightenment," Marx and Engels criticized earlier materialist philosophy as "mechanistic" or "metaphysical." They saw in it two major defects. First, it unjustifiably extended the conception of mechanical causes to all processes of nature and society, thus seeking to reduce everything to the mechanical interaction of material particles. Secondly, and consequently, it could not cope with development, either in nature or society. Marx and Engels saw the scientific discoveries of their time—notably in thermodynamics, in geology and in biology (cell theory and theory of evolution)—as confirming their general criticism of mechanistic materialism. Motion, they insisted, was the mode of existence of matter. Within the material world there was continual change and development, one form of motion arising from another. For example, chemical processes gave rise to living processes and living organisms developed consciousness—life and consciousness being higher forms of the motion of matter, arising from and based on lower forms but having their own qualities and laws of development. Materialism, therefore, must cease to be "mechanistic" and become "dialectical."

Marx's and Engels' conception of dialectics owes much to Hegel. In opposition to the "metaphysical" mode of thought, which viewed things in abstraction, each by itself and as though endowed with fixed properties, dialectics considered things in their movements and changes, inter-relations and interactions. Everything is in continual process of becoming and ceasing to be, in which nothing is permanent but everything changes and is eventually superseded. All things contain contradictory sides or aspects, whose tension or conflict is the driving force of change and eventually transforms or dissolves them. Processes of gradual quantitative increase or decrease, at a certain stage when internal tensions reach breaking point, give rise to fundamental changes of quality. But while Hegel saw change and development as the expression of the world spirit, or Idea, realizing itself in nature and in human society, for Marx and Engels it was inherent in the nature of the material world. They therefore held that one could not, as Hegel tried, deduce the actual course of events from any "principles of dialectics"; the principles must be inferred from the events.

The theory of knowledge of Marx and Engels started from the materialist premise that all knowledge is derived from the senses. But against the mechanist view which derives knowledge exclusively from given sense impressions, they stressed the dialectical development of human knowledge, socially acquired in the course of practical activity. Men can gain knowledge of things only through their practical interaction with those things, framing their ideas corresponding to their practice; and social practice alone provides the test of the correspondence of idea with reality; *i.e.,* of truth. This theory of knowledge is opposed equally to the "subjective idealism" according to which we can know only sensible appearances while things-in-themselves elude us, and to the "objective idealism" according to which we can know supersensible reality by pure intuition or thought, independent of sense. For it rules out supersensible reality as illusory and holds that, by applying our ideas of things in social practice and by experimental techniques, we come to know not merely "phenomena" but things-in-themselves, though this knowledge always remains incomplete.

Marx's and Engels' materialist conception of history was consistent with their general philosophical views. They held that man's mental and spiritual life, his ideas and aims, reflect his material conditions of existence, the growth of which conditions human development. Above all men must co-operate to produce the means of life. Independent of any conscious decision, men enter into the social relations required by the level of their productive forces. These relations of production, which include property relations, define the economic structure and determine the class relations in society. Social institutions and the prevailing patterns of ideas arise as a superstructure on this economic basis. As the forces of production develop, existing relations of production tend to hinder further advance. Then a period of social revolution begins, when an old social system, with its typical institutions and social ideas, is more or less violently replaced by a new one.

In his detailed analysis of contemporary society (especially in the three volumes of *Capital*), Marx sought to show that capitalist production was merely a temporary phase of social evolution: itself a result of the breakup of feudalism, it must in turn be replaced by socialism. The contradictions of capitalism, under which private appropriation frustrates the full development of production to satisfy social needs, must lead to socialism, where all means of production become social property, while exploitation of man by man and class antagonisms would cease. Production would now be planned to meet human needs, leading to a communist society organized on the principle "from each according to his abilities, to each according to his needs." This would also mark the dawn of human freedom: men would become the masters of their own conditions of existence, no longer constrained and limited in their ideas and actions by circumstances beyond their control.

The political philosophy of Marx and Engels followed from their materialist conception of history. From the beginnings of private property in means of production, society had split into antagonistic classes—exploiters and exploited; and all politics was the expression of the consequent class struggle. The state arose as an instrument of the domination of a ruling class over the rest of society. Religious, philosophical, political and moral systems of ideas ("ideologies") had always expressed the outlook of particular classes, serving to support either the dominance of one class or the struggle of another to resist or overthrow it. The socialist revolution could be achieved only by the contemporary working class, which must wrest state power from the ruling capitalist class, break up its "bureaucratic-military machine" and create a workers' socialist state. With the eventual transition to

classless communist society, the state would in the end wither away and the government of men be replaced by the administration of things.

After Marx and Engels, the main contribution to dialectical materialism was made by V. I. Lenin (1870–1924; [*q.v.*]). To him was chiefly due the conception of a political party "of a new type," highly organized and disciplined and in each country leading the class struggle of the working class to the victory of socialism. The party, Lenin insisted, must adopt as its own the philosophy of dialectical materialism and use it as a guide in all its activities. This was above all necessary to resist the intrusion of alien ideas which would weaken the party's theoretical clarity and unity in action. He wrote against those in the world socialist movement who considered Marx's and Engels' philosophical teachings as superseded by later developments, especially by new advances in the natural sciences, and sought to show that recent scientific discoveries confirmed the dialectical materialist philosophy. In these polemics he contributed especially to dialectics and to the theory of knowledge.

There exists no systematic exposition of dialectical materialism by its founders, who stated their philosophical views mainly in the course of polemics arising from their political activities and sociological and economic researches.

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DIALLAGE: *see* Pyroxenite.

DIALOGUE, in its widest sense, is the recorded conversation of two or more persons. As a literary form it is a carefully organized exposition, by means of invented conversation, of contrasting philosophical positions or intellectual attitudes; or it is an element in drama and fiction. The oldest known dialogues are the Sicilian mimes, written in rhythmic prose by Sophron of Syracuse in the early 5th century B.C. Although none of these have survived, their nature may be inferred from the verse mimes of Herodas (Herondas), an Alexandrian of the 3rd century B.C. They depict brief realistic scenes of everyday life involving common character types. Although Plato knew and admired the Sicilian mimes, the form of philosophic dialogue that he had perfected by 400 B.C. was sufficiently original to be an independent literary creation. With due attention to characterization and the dramatic situation from which the discussion arises, it develops dialectically the main tenets of Platonic philosophy. To Lucian in the 2nd century A.D. the dialogue owes a new tone and function. His influential *Dialogues of the Dead* with their coolly satirical tone inspired innumerable imitations in England and France during the 17th and 18th centuries; of these, the best known are works of the same name by Bernard de Fontenelle (1683) and François Fénelon (1712).

The revival of interest in Plato during the Renaissance encouraged numerous imitations and adaptations of the Platonic dialogue. In Spain Juan de Valdes used it to discuss problems of philology (1533) and Vincenzo Carducci, theories of painting (1633). In Italy dialogues on the Platonic model were written by Torquato Tasso (1580), Giordano Bruno (1584) and Galileo (1632). The Renaissance also adapted the dialogue form to uses unsuspected by either Plato or Lucian. It was widely used in the teaching of languages by the direct method.

In the 16th and 17th centuries dialogue lent itself easily and frequently to the presentation of controversial religious, political and economic ideas. Berkeley's *Dialogues Between Hylas and Philonous* (1713) are perhaps the best of the English imitations of Plato. The best-known 19th-century examples of the form are Walter Savage Landor's *Imaginary Conversations* (1824–29), sensitive re-creations of historical personages. G. Lowes Dickinson's *A Modern Symposium* (1905) and André Gide's *Imaginary Interviews* (1944) illustrate the continued appeal of this ancient form in the 20th century.

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DIALYSIS, a mechanical-physical separation process first employed by Thomas Graham (1861) to separate colloidal particles from those of ionic or small molecular dimensions (crystalloids). If such a mixture is placed in a sack made of parchment, collodion or cellophane, or in a drum provided with a bottom of such material, and suspended in water, the ions and small molecules pass through the membrane, leaving the colloidal particles in the drum or sack.

The process is a slow one and may, in some cases, be accelerated by heating or by an electric field (electrodialysis). The separation depends upon the difference in size between the colloidal and crystalloidal constituents, and the difference in the speeds at which they diffuse through the pores of the semipermeable membrane. *See* Colloid; Diffusion. (A. E. A.)

DIAMAGNETISM. Some substances, like iron, are attracted strongly by the pole of a magnet and are said to be ferromagnetic; others are attracted weakly and are called paramagnetic; still others are repelled and these are called diamagnetic. In 1778 S. J. Brugmans observed for the first time the repulsive action of bismuth and antimony in the strong nonuniform field of an electromagnet.

In 1845 and the following years Michael Faraday examined a great many substances and found many of the elements and most of the compounds to be diamagnetic; it was he who first used the words diamagnetic and paramagnetic. The most highly diamagnetic substance known is bismuth; in a nonuniform field its repulsive force is measured by its susceptibility, -0.00001_3, a value very small compared to the (paramagnetic) susceptibility often found in iron, $+500$. Diamagnetic materials are composed of atoms that have completed electron shells (*see* Atom: *Atomic Structure and Periodic System*) and no permanent magnetic moments. The electrons circulating in such atoms are either speeded up or slowed down by the application of a field, and the resulting change in magnetization, the "induced" moment, opposes the field. This opposition of the magnetic field and the induced magnetism is characteristic of diamagnetism. *See* Magnetism: *Diamagnetism.* (R. M. B.)

DIAMETER, in geometry, a straight line passing through the centre of a conic section and terminated by the curve (from the Greek *dia,* "through," *metroh,* "measure"). The most familiar type of diameter is that bisecting a circle. The principal diameters of the ellipse and hyperbola coincide with the axes and are at right angles; conjugate diameters are such that each bisects chords parallel to the other.

The diameter of a quadric surface is a line at the extremities of which the tangent planes are parallel. Newton defined the diameter of a curve of any order as the locus of the centres of the mean distances of the points of intersection of a system of parallel chords with the curve.

See Circle; Conic Section; Ellipse; Hyperbola; Parabola.

In architecture, the term is used with reference to the lower part of the shaft of a column (*see* Order).

DIAMOND, a mineral composed of pure carbon, is the hardest naturally occurring substance known to man. Its great hardness, brilliance and fire make it chief among precious stones. Because of its unsurpassed hardness, diamond also has many important industrial uses.

Origin of Name.—The name *adamas,* "the invincible," was probably applied by the Greeks to hard metals and thence to corundum and other hard stones. The first known undoubted application of the name to diamond is found in Manilius (A.D. 16). Pliny (A.D. 100) speaks of the rarity of the stone, "the most valuable of gems, known only to kings." Later Roman authors men-

tion various rivers in India as yielding the *adamas* among their sands. The name *adamas* became corrupted into the forms *adamant, diamaunt, diamant* and diamond.

Varieties.—There are four varieties of diamond: (1) diamond proper; (2) bort; (3) ballas; and (4) carbonado. The term "diamond proper" includes the well-crystallized, transparent stones valued as gems. Bort (*q.v.*), also called boart or bortz, is poorly crystallized gray to brown, translucent to opaque diamond widely used in industry. The term is also applied to diamond crystals and fragments useless as gem stones. Ballas is a name given to spherical masses of minute diamond crystals arranged more or less concentrically. It is extremely hard and very tough and has important industrial applications. Carbonado (*q.v.*) is an opaque, black or gray, tough compact variety of diamond, also used in industry.

Unit of Weight (Carat).—Diamonds are invariably weighed in carats: 1 metric carat (now nearly universally used) = 0.200 g. or 200 mg. Some confusion exists in the recorded weights of famous diamonds because the value of the carat has been changed from time to time. (*See* CARAT.)

This article deals with diamond as a gem and the cutting of gem stones, the expanding industrial uses of diamonds and the development of industrial-grade synthetic diamonds, the physical properties of diamonds, their origin, their occurrence and the history of famous diamonds.

USES OF DIAMONDS

GEM

As noted previously, diamond uses may be divided into two main categories, gem and industrial. The use of diamonds as gems is well known, for their great hardness, brilliance and fire make them unsurpassed for this purpose.

The most popular style of cut for diamonds is the 58-facet brilliant, a round stone having 33 facets above the girdle and 25 below (fig. 1). When cut to the proportions shown in fig. 1, a diamond will possess its maximum brilliance and fire. Other cuts frequently used are the emerald and marquise. Important fancy cuts include kite, triangle and baguette.

The term melee is applied to stones cut from small fragments of diamonds resulting from sawing or cleaving. Usually from 8 to 16 melees are required to make a carat, and many are cut with the usual 58 facets. Smaller melees commonly have only 18 facets and may be so small as to require several hundred to make a carat. (G. S. Sr.)

Diamond Cutting.—On account of its extreme hardness, the treatment of the diamond in preparation for use in jewelry constitutes a separate and special branch of lapidary art. Any valuable gem must first be trimmed, cleaved or sawed into suitable shape and size, then cut into the desired form and finally polished.

The stages in diamond working are, therefore: (1) cleavage or division; (2) cutting; (3) polishing; but in point of fact there are four processes, as the setting of the stone for cutting is a somewhat distinct branch.

Cleaving or Dividing.—Gem diamonds are always found as crystals, usually octahedral in form, though often irregular or distorted. The problem involved in each case is twofold: (1) to obtain the largest perfect stone possible; and (2) to remove any portions containing flaws or defects. These ends are generally met by sawing or by cleaving the crystal; *i.e.*, causing it to split along certain natural planes of structural weakness, which are parallel with the faces of the octahedron.

The stone is first examined closely, to determine the directions of the cleavage planes, which are recognizable only by an expert. The cleaver then cuts a narrow notch, at the place selected, with another diamond having a sharp point; a rather dull iron or steel edge is then laid on this line, and a smart blow struck upon it. If all has been skillfully done, the diamond divides at once in the direction desired.

When the stone is large and valuable, the cleaving is a most critical process. In the case of the immense Excelsior diamond of 995.2 carats, which was divided at Amsterdam in 1904 and made into ten splendid stones, the most elaborate study extending over two months was given to the work beforehand, and many models were made of the irregular stone and divided in different ways to determine those most advantageous. This process was applied in 1908 to the most remarkable piece of work of the kind ever undertaken—the cutting of the gigantic Cullinan diamond of 3,106 carats. This stone also was taken to Amsterdam to be treated by the old-fashioned hand method, with innumerable precautions of every kind at every step, and the cutting was successfully accomplished after nine months' work (see *History of Famous Diamonds*, below).

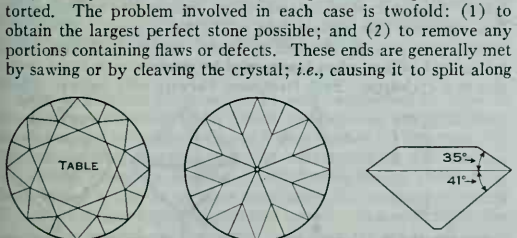
This process of cleavage is still used but sawing by means of a high-speed saw employing a thin disk charged with diamond particles is generally employed.

After the cleaving or sawing, however, the diamond is rarely in a form for cutting the facets, and requires considerable shaping. This rough "blocking out" of the final form it is to assume, by removing irregularities and making it symmetrical, is called brutage. Well-shaped and flawless crystals, indeed, may not need to be cleaved, and then the brutage is the first process. Here again, the old hand methods have given place to mechanization. In either case two diamonds are taken, each fixed in cement on the end of a handle or support, and are rubbed one against the other until the irregularities are ground away and the general shape desired is attained. The old method was to do this by hand—an extremely tedious and laborious process. The machine method, invented about 1885, employs the principle of the lathe with a diamond as the cutting tool.

Cutting and Setting.—The next process is that of cutting the facets; but an intervening step is the fixing or setting of the stone for that purpose. One method used is to embed it in a fusible alloy, melting at 440° F., in a little cup-shaped depression on the end of a handle, the whole being called a dop. Only the portion to be ground off is left exposed; and two such mounted diamonds are then rubbed against each other until a face is produced. This is the work of the cutter; it is laborious, and requires great care and skill whether done by hand or by machine using a diamond lathe. The powder produced is carefully saved, as in the former processes, for use in the final polishing. When one face has been produced, the alloy is softened by heating, and the stone reset for grinding another surface. As this process is necessary for every face cut, it must be repeated many times for each stone. A metal clutch or adjustable dop has been devised in which the diamond is held by a system of teeth claws so that the heating and resetting can be obviated, and the cutting completed with only two changes.

Polishing.—The faces having been cut, the last stage is the polishing. This is done on horizontal iron wheels called skaifs, made to rotate up to 2,500 r.p.m. The diamond powder saved in the preceding operations, and also made by crushing inferior diamonds. here comes into use as the only material for polishing. It is applied with oil, and the stones are fixed in a dop in much the same way as in the cutting process. Again, the utmost skill and watchfulness are necessary, as the angles of the faces must be mathematically exact in order to yield the best effects by refraction and reflection of light, and their sizes must be accurately regulated to preserve symmetry.

The rapid development of mechanical and electric devices for the several stages of diamond cutting has greatly influenced the art. (G. F. K.; X.)



BY COURTESY OF GEORGE SWITZER

FIG. 1.—THREE VIEWS OF THE BRILLIANT-CUT DIAMOND. OF THE 58 FACETS, 33 ARE ABOVE THE GIRDLE AND 25 BELOW

Industrial Uses

Industrial uses of diamonds are so important that a deficiency of industrial diamonds would cause a breakdown in the modern metalworking industry and devastate mass production. Bort, which is the cheapest grade of industrial diamond and is used in the largest amounts, is crushed and graded into powders of various sizes for use in a great variety of grinding and polishing operations. The chief use of diamond powder is in the manufacture of grinding wheels for sharpening sintered carbide metal cutting tools. Diamond powder is also used as loose grains suspended in oil or water for many types of lapping and polishing operations. Another important application of industrial diamonds is as diamond drills, used for many purposes, and ranging in size from dental to oil-well drills. Rock-coring drills are made by mounting diamonds around the rim of a hollow metal drill crown. As the drill is turned and bites downward, it cuts a continuous rock core, which can be withdrawn for examination. Such drills are widely used in exploring for new mineral deposits (*see* Drilling Machinery). Other important applications include saws for cutting rock and other hard materials, tools for truing or dressing grinding wheels, glass cutters, phonograph needles, hardness testers, lathe and other types of cutting tools and wire-drawing dies.

Synthetic Diamonds

Principal efforts in the past to make diamond in the laboratory were by J. B. Hannay and Henri Moissan. In 1880 Hannay reported that he had made diamonds by heating a mixture of hydrocarbons, bone oil and lithium at red heat in sealed wrought-iron tubes. Moissan, in about 1890, dissolved sugar charcoal in molten iron and quenched the solution in cold water in order to crystallize the carbon under the great internal pressure supposedly generated by contraction as the mass cooled. Both workers claimed to have succeeded in making diamonds, but attempts to repeat their work proved unsuccessful. The question of success or failure of Hannay and Moissan was discussed and evaluated by various leading authorities; the conclusions, however, were confusing, and the modern consensus is that up to 1955 the successful synthesis of diamond had not been reported in the literature.

On Feb. 16, 1955, the General Electric company, Schenectady, N.Y., announced the successful accomplishment of the task of making diamonds in the laboratory. The diamonds were made by subjecting carbonaceous material simultaneously to pressures in excess of 1,500,000 lb. per square inch and to temperatures above 5,000° F. Single runs produced up to one-tenth of a carat of diamond. The diamonds were of industrial quality. The General Electric company by 1960 was producing industrial diamonds on a large scale. Production figures were not made public but were estimated to have reached at least 1,000,000 carats annually. Prices were comparable to natural diamonds of the same category. Details of the company's process for making diamonds were made public in 1959. In that same year synthetic diamonds were also made in several other laboratories including the De Beers Adamant laboratory in Johannesburg, S.Af.

PHYSICAL PROPERTIES

Hardness.—The scratch hardness of diamond is ordinarily given as 10 on the Mohs' scale of hardness, and corundum, the mineral next to diamond in hardness, is rated as 9. Actually diamond is very much harder than corundum; its true value on the Mohs' scale is about 42. Synthetic cubic boron nitride (*see* Boron: *Boron Nitrides*) is said to be as hard as diamond but the artificial abrasives silicon carbide and boron carbide have values of 14 and 19.7, respectively, on this same scale. The abrasion hardness of diamond is still greater in comparison with these abrasives. Diamond has been found to be as much as 200 times more effective in its abrasion action than boron carbide and silicon carbide.

The hardness of a diamond varies significantly in different directions. The optimum directions for polishing are those parallel to a crystallographic axis. Facets parallel to faces of the cube (fig. 3[A]) are easiest to polish, for these faces are parallel to two crystallographic axes. Octahedron faces (fig. 3[B]) are equally inclined to three crystallographic axes and are the most difficult to polish. (*See* also Mohs' Scale.)

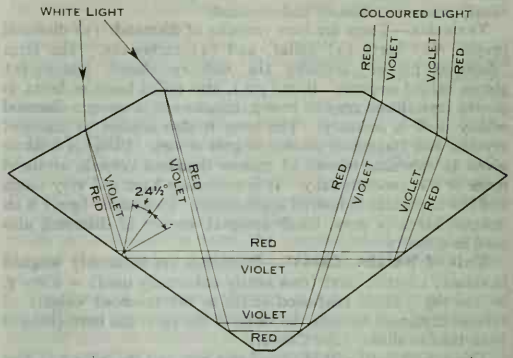


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FIG. 2.—REFRACTIVE QUALITIES OF PROPERLY CUT DIAMOND

Refraction and Colour.—The very high refractive power of diamond (index of refraction = 2.42 for ordinary light) gives the stone its extraordinary brilliance when properly cut and polished. Light incident within a diamond at an angle greater than 24½° to any facet is reflected back into the stone instead of passing through it. The corresponding angle for rock crystal (quartz) is 42½°. Hence, a diamond cut to proper proportions (fig. 2) will return a greater amount of light to the eye of the observer than will gems of lesser refractive index and will appear more brilliant. The very high dispersion (index of refraction for red light = 2.407, for violet light = 2.465) gives diamond its fire, caused by the separation of white light into the spectral colours as it passes through the stone (fig. 2). Because of its very high index of refraction, diamond has a brilliant lustre, best observed on polished stones. The stones as they come from the mine are usually somewhat rounded and have a rather greasy appearance. Anomalous double refraction, caused by internal strains, is often noted. Some diamonds fluoresce or phosphoresce on exposure to ultraviolet, cathode and X-rays. Gem diamonds often fluoresce blue under ultraviolet light.

The colour of diamond varies from colourless to black, and it may be transparent, translucent or opaque. Most diamonds used as gems are transparent and colourless or nearly so. Colourless or pale-blue stones are considered best, but these are rare; most gem diamonds are tinged with yellow. Stones having a high degree of transparency and a distinct body colour (such as green, blue, pink or yellow) are known as fancy stones. Gray, brown, black, milky and opalescent stones are sometimes found. Most industrial diamonds are gray or brown, translucent to opaque, but better quality industrial diamonds grade imperceptibly into poor quality gem stones.

Artificial Coloration.—The colour of a diamond may be changed by bombarding it with atomic projectiles of various types. Exposure of white and yellow diamonds to radium radiation colours a thin surface film of the stone green. White diamonds may also be changed to other colours, including green, amber and yellow, when bombarded by deuterons or alpha particles in a cyclotron. Such treatment likewise only induces colour

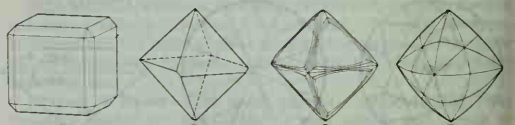

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FIG. 3.—(A) CUBE MODIFIED BY OCTAHEDRON AND DODECAHEDRON, (B) OCTAHEDRON, (C) OCTAHEDRON MODIFIED BY TRISOCTAHEDRA, (D) HEXOCTAHEDRON

into a thin surface film. The colour may be induced all the way through the stone by neutron irradiation either in a cyclotron or in an atomic pile. Bombardment of a white diamond with high-energy electrons produces a pale-blue colour. In all cases diamonds which have been bombarded appear to retain their change in colour permanently, even when exposed for long intervals to sun or artificial light at room temperature.

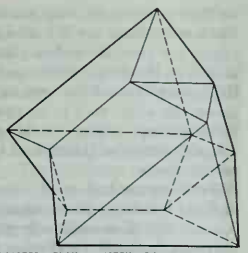

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FIG. 4.—TWIN CRYSTAL OF TWO OCTAHEDRA

Crystallography.—Diamond crystallizes in the isometric crystal system (fig. 3). Some features of the crystallography of diamond indicate hextetrahedral symmetry, and others indicate that diamond has hexoctahedral symmetry. The most common crystal form is the octahedron (8 faces), but other forms are also found, such as the cube (6 faces), dodecahedron (12 faces), trisoctahedron (24 faces) and hexoctahedron (48 faces). The crystal faces are commonly curved by growth and solution facets and are often striated. Twin crystals are common, in which two octahedra (fig. 4) are united by contact along a surface parallel to an octahedron face. These twins are often flattened and are called macles. Other types of twins include penetration twins, cyclic groups and grooved octahedra resulting from the interpenetration of twinned tetrahedra.

The atomic structure of diamond has been determined by X-ray studies (fig. 5). Each carbon atom is linked to four equidistant neighbours so that a tetrahedral linkage occurs throughout the entire crystal. The distance between adjacent carbon atoms is 1.54 Å ($1 \text{ Å} = \frac{1}{10.000.000}$ mm.).

Two types of diamond are known, type I and type II. Type II diamond gives a normal X-ray diffraction pattern, but patterns of type I show extra spots and streaks. The photoconductivity of type I diamond is poor, of type II good; type I diamonds are birefringent (show double refraction), and type II diamonds are not. The two types also differ in their infrared and ultraviolet absorption characteristics. Diamonds intermediate between type I and type II have also been noted, as well as two varieties of type II. Large diamonds of gem quality are always type I.

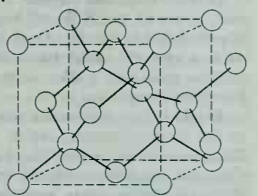

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FIG. 5.—ATOMIC STRUCTURE OF A DIAMOND

Other Properties.—Diamond has a perfect cleavage (referred to as grain by diamond cutters) in four directions, parallel to its octahedral crystal faces (fig. 3[B]). This property is made use of by diamond cutters to split a large stone. The specific gravity of diamond is 3.52, and its melting point is 3,700° C. Since diamond is composed of pure carbon, it will burn in an atmosphere of oxygen, or in air if heated to a very high temperature. The stone is unattacked by acids. *See* also CARBON.

ORIGIN OF DIAMOND

Only in diamond pipes, especially well exemplified by those in the Kimberley district, South Africa, are diamonds known to occur in the original rock matrix in which they formed. These pipes are funnels, more or less oval in section and narrowing with increasing depth. They go downward to unknown depths (some have been mined to depths of more than 4,000 ft.), and are evidently the result of some type of eruptive action. The rock filling the pipes is an altered and brecciated basic rock related to peridotite and known as kimberlite or blue ground. The kimberlite must have been forced up from great depths because it is entirely unrelated to the country rock surrounding the pipes. There is no evidence to indicate that the blue ground was extremely hot when forced into its present position. Therefore, it is concluded that the diamonds were formed in the depths of the earth under conditions of great heat and pressure, and reached the surface by extrusion up pipes of the kind found in South Africa and elsewhere. Diamonds in alluvial deposits originally must have been formed in kimberlite, later released by erosion from their mother rock and redeposited in rivers and streams. The theory that diamonds were formed deep within the earth under great pressure and temperature is substantiated by the known occurrence of diamond in iron meteorites. Synthesis of diamond was accomplished in a machine which simulated pressure-temperature conditions 240 mi. deep within the earth. *See* also ECLOGITE.

WORLD OCCURRENCE

The most important localities for diamonds have been: (1) India, where diamonds have been mined from earliest times; (2) South America, where they have been mined since the middle of the 18th century; and (3) Africa, to which almost the whole of the diamond-mining industry has been transferred since 1870. Annual world production in the second half of the 20th century amounted to more than 26,000,000 carats, or nearly 4½ tons. Of this total 20,000,000 carats, or about 77% were of industrial grade.

India.—Diamonds are found in the states of Madras, Madhya Pradesh, Orissa and Gujarat. Annual production averages about 2,000 to 4,000 carats. In the second half of the 20th century, 95% of the production came from the Panna district, Madhya Pradesh. Richest deposits are in the area around Mujgawan, Panna district, where diamonds are found in the kimberlite pipe, in Pre-Cambrian conglomerates older than the pipe and in recent stream gravels. Many of the large diamonds of antiquity came from the mines in the Kollur group, near the Kistna river.

South America.—Diamonds are mined in South America in Brazil, British Guiana and Venezuela. Annual production in the second half of the 20th century was: Brazil, about 300,000 carats; British Guiana, 100,000 carats; Venezuela, 90,000 carats.

Brazil.—Diamonds were discovered in Brazil about 1725 at Tejuco (now Diamantina) in Minas Gerais. Mining became important about 1740, and from that time until the discovery of the South African deposits in 1867 Brazil was the world's largest diamond producer. The most important producing areas are in the states of Minas Gerais, Bahia and Mato Grosso, but they are found also in six other states: Goiás, São Paulo, Paraná, Piauí, Maranhão and Amazonas. Principal production is from gravel in river valleys. Most mining is done by natives in a primitive fashion. Carbonado, a valuable type of industrial diamond, occurs in the stream beds in northern Minas Gerais. One mass of carbonado weighing 3,148 carats (more than the weight of the Cullinan diamond; see *History of Famous Diamonds*, below) was found in the Chapada Diamantina district in the state of Bahia. A number of large gem diamonds have been found, including the Star of the South (261.9 carats), English Dresden (119.5 carats) and President Vargas (726.6 carats). Annual production averages about 50% gem quality.

British Guiana.—A diamondiferous belt from 10 to 30 mi. wide is known to run across nearly the whole of British Guiana. The diamonds occur in the gravels of rivers and streams; the most important areas are along the following five rivers and their tributaries: Mazaruni, Puruni, Potaro, Cuyuni and Berbice.

The diamonds are generally small, averaging six to the carat, but occasionally as large as ten carats. The largest, found in 1926 at the Potaro river, weighed 56 carats. Production is about 40% gem quality.

Venezuela.—The diamondiferous area of Venezuela is in the state of Bolívar, particularly in the area known as the Gran Sabana. Diamond-bearing gravels have been reported also in Amazonas. Both of these areas are along the Brazilian border and are little known and sparsely populated. The richest deposits are around Peraitepu in the upper Caroní on the Gran Sabana. Other diamondiferous gravels are found along the Paragua and Uriman rivers and at Icabaru. The diamonds produced are generally small, and production averages about 73% industrial quality.

Africa.—More than 97% of the world's annual diamond production comes from Africa. The chief producing countries and territories have been: Republic of the Congo, Ghana, Republic of South Africa, Sierra Leone, Guinea, Angola, South-West Africa, Liberia, Tanganyika, Ivory Coast and Central African Republic. The Republic of South Africa has a much higher ratio of gem to industrial quality than the Republic of the Congo.

Republic of South Africa.—The first African diamond was discovered in 1867 on the bank of the Orange river. A second stone weighing 83.5 carats was discovered in 1869; this was purchased by the earl of Dudley for £25,000 and became famous as the Star of South Africa. Prospectors rushed to the banks of the Orange and Vaal rivers, and by 1870 about 10,000 persons were engaged in recovering diamonds from river gravels, using primitive hand methods.

Toward the close of 1870 stones were found at Jagersfontein, Dutoitspan and Bultfontein, far from the Vaal river, and in 1871 at what is now known as the Kimberley mine. These diggings were at first thought to be alluvial in origin, but it was soon found that the diamonds were restricted to vertical pipes having a roughly oval cross section and nearly vertical sides. In the Kimberley district five of these pipes were found within an area a little more than three miles in diameter. The pipe at Kimberley (*q.v.*) occupies about 10 ac., that at Dutoitspan 23 ac. The pipes are filled with the heavy dark-blue rock, known as blue ground or kimberlite, in which the diamonds occur.

Many more kimberlite pipes were discovered in South Africa, most of them unworkable because of low diamond content. Principal mines are the Premier, near Pretoria in the Transvaal; the Jagersfontein and Koffiefontein mines in the Orange Free State, near Kimberley; and the Wesselton, Bultfontein, Dutoitspan, De Beers and Kimberley mines in northern Cape Province, also near Kimberley. In the second half of the 20th century the Wesselton, Bultfontein, Jagersfontein and Premier mines were major producers. Largest of the mines is the Premier, discovered in 1902. It is a pipe with a surface area of about 75 ac. and has an annual production of about 1,250,000 carats. The Cullinan diamond, weighing 3,106 metric carats, was found there in 1905.

Mining in the early days was done by individual miners, each allowed to work a 31 by 31 ft. claim. At first each miner worked an individual pit, and roadways were left across the pipe to allow access to the claims. Soon the roadways crumbled, and the diamondiferous blue ground was hauled to the edge of the mine by means of windlasses.

In a few years open-pit mining became impossible because of the fall of barren rock left standing in the mine and landslides from the sides. Some consolidation of claims began to take place, and mining using modern underground methods was begun. Finally, under the leadership of Cecil Rhodes, all of the major pipe mines were consolidated into the De Beers Consolidated Mines, Ltd., and were worked by this company or its subsidiaries.

The pipe mines are worked underground by a method known as chambering. A main hoisting shaft is located 800 ft. or more from the rim of the pipe, and sunk to a depth well below that of the lowest level being worked. The working levels are 40 ft. apart vertically. Cuts of blue ground are mined out between adjacent levels, supported by pillars of rock. The mining method depends upon natural caving and recovery of the pillars when undermined by the level below.

Block caving (*see* MINING, METAL) was introduced in the second half of the 20th century. The broken ore is loaded into cars, hauled by an endless cable to the main shaft for hoisting to the surface. As the blue ground comes from the mine, it contains only about 1 part of diamond to 14,000,000 parts of worthless rock.

Blue ground hoisted from the mines is passed through three main stages of treatment before the diamonds are recovered: (1) crushing plant; (2) washing plant; and (3) recovery plant. The ore is crushed into fragments $1\frac{1}{4}$ in. or less in size and hauled to the washing plant, where by various washing and concentrating processes the material is reduced to a small fraction of its original volume. Concentrates from the washing plant go to the recovery plant. There the recovery of diamonds depends almost entirely on their property of being nonwettable when in contact with water. The concentrates are fed onto sloping flat or stepped tables. The tables are covered with a thin layer of grease. Wash water is played on the grease tables and the concentrates are dropped onto the grease through the stream of water. An oscillating motion causes the waste rock to move across the table and drop off, while the diamonds adhere to the grease. Periodically the grease is scraped from the tables, and the diamonds recovered by boiling off the grease.

Recovery methods used in the alluvial mines, as in Namaqualand in Cape Province, differ considerably from those used in the pipe mines. The diamondiferous gravel is taken from open pits using draglines, bulldozers and other types of modern earth-moving machinery. Alluvial diamonds do not adhere to grease as do diamonds from the pipe mines. Therefore, concentrates from the washing plant are either hand-picked or passed through an electrostatic separator.

Republic of the Congo.—The Republic of the Congo has been the world's largest producer of diamonds in quantity. Production is about 95% industrial grade, and it supplies about three-fourths of the world's supply of crushing bort. The diamondiferous area occupies a wide area covering the tributaries of the Kasai-Sankuru river system. The two principal deposits are (1) the Kasai field, an extension of the Angola deposits; and (2) the Bakwanga deposits, located between the Kanshi and Bushimaie rivers. About 95% of the production comes from the Bakwanga deposits. The deposits are all alluvial, and worked on a large scale as open pits using modern earth-moving machinery. Pipes of low diamond content are known in the Katanga district. Production dropped from a peak of 225,000 carats in 1920 to 164,000 carats in 1921 and thereafter increased steadily, reaching more than 14,000,000 carats a year in the second half of the 20th century, although there was some decrease due to political unrest after independence was proclaimed in 1960.

Ghana.—Diamond deposits of Ghana are in the Birim river district, about 65 mi. N.W. of Accra. The diamonds occur in beds of gravel two to five feet thick lying near or in stream beds. Production averages about 3,000,000 carats annually, of which about 70% is industrial grade. The deposits are worked in part by European companies.

Angola.—The diamondiferous area of Angola is a continuation of the diamond-bearing region of Kasai, Republic of the Congo. The deposits lie within the basins of the Chicapa, Luachimo, Chiumbe and Luembe rivers, tributaries of the Kasai. Exclusive diamond mining rights were acquired by a European company. Annual production is about 1,000,000 carats, of which 58% is gem quality.

South-West Africa.—The alluvial deposits of South-West Africa are a northward extension of those in Namaqualand. They extend from the mouth of the Orange river north 300 mi. to Conception bay. Mining is on a large scale. Production approaches 1,000,000 carats a year, of which about 80% is gem quality. Average size of the stones recovered is about 0.9 carats.

Sierra Leone diamondiferous gravels lie within the Bafi-Sewa river drainage system. Most production is from the Kono district. Production is in excess of 1,500,000 carats annually, of which about 55% is industrial quality. In deposits along the Woyie river some very large diamonds have been found, including stones of 294, 532 and 770 carats. To the southwest, Liberia and the Ivory Coast have become diamond producers.

Guinea.—The alluvial diamond deposits in Guinea are midway between Beyla and Kissidougou. Total production reaches over 800,000 carats, of which about 66% is industrial grade.

Central African Republic.—The principal diamond production comes from alluvial deposits in the Carnot-Berbérati-Nola region in the Haute-Sangha. Production amounts to about 80,000 carats, of which about 66% is industrial quality.

Tanganyika.—Most of the diamond production in Tanganyika is from the surface portion of a pipe deposit at Mwadui in the Shinyanga district. Production amounts to more than 500,000 carats, of which about 50% is industrial grade.

Other Countries.—Diamonds are also found in small quanti-

ties in other countries, including Borneo, Australia, Southern Rhodesia, Surinam and the United States. Total production from these probably does not exceed 3,000 carats yearly.

New discoveries of diamonds were made in the U.S.S.R. in 1954, in northwestern Yakut (Yakutia). Production in 1960 reached approximately 950,000 carats.

Production and Distribution.—Practically the entire world output of diamonds is controlled by De Beers Consolidated Mines, Ltd., and its subsidiary companies. The company operates some mines, and has contracts to purchase the entire output from all other major mining areas except those in South America. Marketing of the diamonds is also handled by De Beers subsidiaries.

After being mined, diamonds are sorted into the two main types —gem and industrial. Each type is then further sorted into many categories of size and quality. The gem diamonds are divided into parcels containing varying proportions of high and lower quality diamonds to give the cutters a wide choice. The distributing company then invites certain cutters to apply for sights, that is, the cutters are asked to apply for parcels, specifying the total amount they wish to pay and the proportions of different kinds of diamonds they wish in the parcels. The cutters are offered the parcels which most closely conform to their wishes. A buyer attending a sight must buy the entire contents of a parcel, for the parcels are never broken up. The sights are held only in London. Industrial diamonds are also graded into many categories depending upon the use to which they are to be put, and are sold in parcels in much the same way as are gem diamonds.

HISTORY OF FAMOUS DIAMONDS

All of the famous diamonds of antiquity must have been Indian stones. Large and extremely valuable diamonds discovered since about 1850 have come from South Africa and Brazil.

The Great Mogul was found in the Golconda mines in India in about 1650, and was said to have weighed 787 carats in the rough. It was seen in the treasury of the Mogul Aurangzeb in 1665 by the French traveler and jewel trader Jean Baptiste Tavernier, who estimated its weight after cutting as 280 carats and described it as a rounded rose-cut stone, high on one side. It has been unreported for many years and some believe that what Tavernier saw was the Koh-i-nor; others hold it may have been the Orloff, which although of smaller size is much like the description of the Great Mogul.

The Orloff, stolen by a French soldier from the eye of an idol in a Brahman temple, was finally bought by Prince Orloff for £90.000 and given to Catherine the Great, empress of Russia. The exact weight of the gem is 199.6 carats. It is $\frac{7}{8}$ in. in height, $1\frac{1}{4}$ in. wide and $1\frac{3}{8}$ in. long. It is mounted in the sceptre of the Romanoffs and was placed in the diamond treasury of the U.S.S.R. in Moscow.

The Koh-i-nor has the longest known history of all famous diamonds. Sultan Ala-ed-din is credited with having taken the jewel in the year 1304 from the raja of Malwa, in whose family it had been for unknown generations. The Koh-i-nor (*q.v.*) changed hands many times and finally was acquired by the British in 1849. The Koh-i-nor weighed, when brought to England, 191 carats. It was recut in London and now weighs 108 carats. It is the central stone of the queen's state crown, made for the coronation of Queen Elizabeth, consort of George VI, in 1937. There has been much discussion concerning the possibility that this stone may have once been part of the Great Mogul.

The Shah weighs 88.7 carats, is of yellowish colour and is bounded by eight slightly rounded facets. Three ancient Persian inscriptions partly cover the gem; the oldest indicating that the stone was discovered before 1591, probably in Golconda. The stone is in the U.S.S.R. diamond treasury in Moscow.

The Akbar Shah originally weighed 116 carats and had two Arabic inscriptions. One of these read "Shah Akbar, the Shah of the World, 1028 A.H.," and the other "To the lord of two worlds, 1039 A.H. Shah Jehan." The first date corresponds to A.D. 1650 and the second to 1661. The location of the stone was unknown from about 1700 to 1866, when it was brought to London, recut and sold to the gaekwar of Baroda for about $175,000. The stone now weighs 71.7 carats.

The Sancy is about the size and shape of a peach pit and weighs 55 carats. It is a stone of Indian origin and has been owned successively by Nicolas Harlay de Sancy, King James I of England, Henrietta Maria, King James II and Louis XIV. It was stolen during the French Revolution, along with the Regent. It reappeared about 1828 and was sold to Prince Demidoff and later became the property of the maharaja of Patiala.

Coloured Indian—and especially sapphire-blue—diamonds are very rare. Tavernier bought one weighing $112\frac{1}{2}$ carats and brought it to Paris, where it was sold to Louis XIV and cut into a triangular stone weighing about 68 carats. This stone was stolen in 1792, along with the Sancy and the Regent. It was never recovered, but in 1830 there appeared on the market a $44\frac{1}{2}$-carat blue diamond, now known as the Hope, that is probably part of the missing stone. The stone was owned successively by Henry Thomas Hope, Habib Bey, Mrs. Evalyn Walsh McLean and Harry Winston, who in 1958 gave it to the Smithsonian institution, Washington, D.C., to start a jewel collection.

Other large and famous Indian diamonds include the Florentine and Regent. The Florentine, a pale-yellow stone weighing 137 carats, at one time one of the Austrian crown jewels, was seized by the Germans after the *Anschluss* (1938); it was restored to Austria after World War II and is in the Schatzkammer, Vienna. The Regent was one of the last of the large diamonds to be found in India. It is said to have been found in the Partial mines on the Kistna river about 1701 and as a rough stone weighed 410 carats. It was purchased by Thomas Pitt, the governor of Madras, for about $100,000. It was cut into a cushion-shaped brilliant $1\frac{1}{16}$ in. long, 1 in. wide and $\frac{3}{4}$ in. deep, weighing 140.5 carats. The gem was subsequently sold to the duke of Orléans, then regent of France. It was stolen in 1792, along with the Sancy and Hope diamonds, but was recovered. It was used as security for a loan which is said to have been a great aid to Napoleon after he assumed the dictatorship as first consul in 1799. The gem is now in the Louvre museum in Paris.

Most famous Brazilian diamonds are the Star of the South and the President Vargas. The Star of the South was found in the mines at Bagagem in 1853. It weighed in the rough 261.9 carats. It was sold to the gaekwar of Baroda for about $400,000 and cut into a gem weighing 128.8 metric carats. The President Vargas was discovered in 1938 by a poor prospector who found the stone in the San Antonio river in Minas Gerais. Its weight was 726.6 carats. The prospector sold the stone for $10.000 to a broker who resold it to an exporter for about $425,000. It was later purchased by a U.S. importer, who cut it into 29 stones having a total weight of approximately 411 carats, the largest of which is 48.26 metric carats.

The first large South African diamond, discovered in 1869, was the Star of South Africa or Dudley, 83.5 metric carats rough, 47.75 carats cut. Since that time many fine large stones have been found in the South African diamond mines, the most famous of which are the following (weights in metric carats): the Jubilee, 650.8 carats rough, 245.35 carats cut; the Victoria, 469 carats rough, 184.5 carats cut; the Excelsior, 995.2 carats rough, cut into 21 stones ranging in weight from less than a carat to 70 carats; the Stewart, 296 carats rough, 128 carats cut; the Tiffany, a yellow stone weighing 128.7 carats cut; and the Jonker, found in 1934, 726 carats rough, cut into 12 stones of from 5.30 to 125.35 carats.

The world's largest gem diamond, the Cullinan, was found in 1905 at the Premier mine in the Transvaal, South Africa. It weighed in the rough 3,106 metric carats, or about $1\frac{1}{4}$ lb. It was purchased by the Transvaal government in 1907 and presented to King Edward VII. It was sent to Amsterdam to be cut and was fashioned into nine principal gems, the four largest of which weigh 530.20, 317, 95 and 63.7 metric carats, respectively. They are part of the crown jewels of England. *See* GEM.

See also references under "Diamond" in the Index volume.

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For a popular account of diamonds, especially of the De Beers and the industry in South Africa *see* Emily Hahn, *Diamond* (1956).

DIAMOND NECKLACE, AFFAIR OF THE, was a scandal at the court of Louis XVI in 1785 which gravely discredited and weakened the French monarchy on the eve of the Revolution. It began as an intrigue on the part of an adventuress, the comtesse de La Motte (Jeanne de Luz de Saint-Rémy de Valois, 1756–91; descended from a bastard of Henry II) to procure, supposedly for the queen, Marie Antoinette, but in reality for herself and her associates, a diamond necklace worth 1,600,000 livres. This was the property of the Parisian firm of jewelers Boehmer and Bassenge, who had tried unsuccessfully to sell it, first to Louis XV as a present for his mistress Madame du Barry, and later to Louis XVI for the queen. The other leading person involved was cardinal de Rohan, bishop of Strasbourg, provisor of the Sorbonne, grand almoner of France and a member of one of the greatest noble families. Rohan, who as French ambassador to Vienna from 1772 to 1774 had aroused the dislike of the queen's mother, the empress Maria Theresa, and who had subsequently incurred the hostility of Marie Antoinette herself, was anxious to be restored to favour at the French court.

The comtesse de La Motte saw her opportunity of posing as a mediator between him and the queen. She suggested to Rohan that the queen wished to acquire the necklace surreptitiously and would be prepared for a formal reconciliation at court if he would facilitate its purchase by negotiating with the jewelers. Rohan consented to these arrangements after consulting his friend the fashionable imposter Alessandro di Cagliostro (*q.v.*). He did so, however, mainly on the strength of spurious letters from the queen to himself forged by La Motte and, after a brief nocturnal interview in the gardens of Versailles with a prostitute disguised as the queen, Rohan entered into a contract with the jewelers to pledge his credit to pay for the necklace in installments. The imposture came to light, however, when the cardinal failed to raise the first installment in full and the jewelers applied directly to the queen. Meanwhile the necklace, which Rohan had supposed to be in the queen's possession, had been broken up and sold in London.

Instead of concealing the intrigue, Louis XVI allowed the secretary of state for the royal household, the baron de Breteuil (Louis Auguste le Tonnelier), a personal enemy of Rohan, to arrest the cardinal at Versailles while he was preparing to officiate in the royal chapel on Assumption day, Aug. 15, 1785. When Rohan was imprisoned in the Bastille his friends and sympathizers depicted this act of authority as an exercise in royal despotism and as the result of Breteuil's vendetta against the man who had replaced him as ambassador at Vienna. The cardinal was tried, along with his alleged accomplices, before the *parlement* of Paris. Though he was eventually acquitted of the charge of having fraudulently acquired the necklace (May 31, 1786), he was deprived of all his offices and exiled to the abbey of Chaise-Dieu in Auvergne. Cagliostro was acquitted but banished from the kingdom, while the real criminal, the comtesse de La Motte, was sentenced to be flogged, branded and imprisoned for life in the Salpêtrière prison in Paris. She later escaped to England and there published scandalous *Mémoires* vilifying the queen.

Though Marie Antoinette was guiltless, the scandal confirmed the belief of contemporaries in her moral laxness and frivolity. The arbitrary arrest of the cardinal, the pressure put on his judges by Breteuil and his final disgrace deepened the impression of the king's weakness and the despotic character of his government. The incident also encouraged the aristocratic resistance to the crown and provoked an alliance of the higher magistracy with the upper clergy which facilitated the aristocratic opposition of 1787. In that sense Napoleon was correct in regarding the affair as one of the causes of the French Revolution.

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DIANA, an Italian goddess later identified with the Greek Artemis (*q.v.*). Her name has the root *di* ("to shine") and probably means "bright one." Although indistinguishable from Artemis in Roman literature, she was originally an independent Italian deity. A woodland goddess, perhaps a tree spirit, by extension she became the mistress of forest creatures and the hunt, and like her Greek counterpart also a goddess of domestic animals. With strong associations as a fertility deity she was invoked by women to aid conception and delivery (*cf.* Juno, with whom she sometimes shares the epithet Lucina [*q.v.*]).

There was probably no original connection between the Italian deity and the moon, but Diana later absorbed Artemis' identification with both Selene (*i.e.*, Luna) and Hecate (or Trivia), a chthonic deity; hence the poetic characterization *triformis* sometimes used in Latin literature.

The most famous place of worship for the Italian spirit was the grove of Diana Nemorensis (*i.e.*, Diana of the Wood) on the shore of the lake of Nemi near Aricia. Nineteenth-century excavations there disclosed a temple, an extensively terraced sacred precinct and votive objects revealing all the aspects of her divinity outlined above. There were held female processions in her honour, reflecting her role as a goddess of women. The Aricia cult was traditionally founded by the Latin dictator Egerius Baebius, although other evidences indicate a shrine of even greater antiquity. It is certain, however, that it became a shrine common to the cities of the Latin league and hence of some political importance. Associated with Diana there were two lesser divinities: Egeria (*q.v.*), spirit of a nearby stream who shared with Diana the functions of causing and easing childbirth, and the hero Virbius, an Italian counterpart of Hippolytus (*q.v.*). Traditionally, after he had been trampled to death by his horses, Hippolytus was restored to life by Asclepius and was removed by Artemis to the grove at Aricia from which horses were excluded; there as Virbius he became the first priest of Diana, *rex nemorensis*.

A unique and peculiar custom, perhaps derived from a primitive human sacrifice, dictated that the *rex nemorensis* be a runaway slave and that he slay his predecessor in combat after a formal challenge consisting of the plucking of a certain branch from the sacred grove. Associations arose with the Tauric Artemis, who required the sacrifice of all strangers, and it was said that Orestes (*q.v.*) had brought the image of the goddess from Taurus to Aricia. The unusual ceremony at the Arician grove is the point of departure for Sir James Frazer's *Golden Bough*. Regarding the myths of Hippolytus and Orestes at this shrine Frazer concludes that they are later rationalizations of a primitive and barbarous ritual.

At Rome the most important temple of Diana was on the Aventine. Traditionally it was founded as a sanctuary of the Latin league by Servius Tullius, the founding being interpreted as an attempt to transfer not only the cult but also the political leadership to Rome. The worship of Diana at Rome was early associated with the plebeians, who were probably responsible for her introduction. In the cult on the Aventine, itself a plebeian settlement, Diana was the protector of the lower classes, especially slaves (*cf.* the ritual at Aricia); the ides (13th) of August, her festival at Rome and Aricia, was a holiday for slaves. The Aventine Diana was the sister of Apollo, and they were worshiped together in the secular games (*q.v.*), in which their importance was greatly increased by Augustus. Another famous shrine of Diana was on Mt. Tifata near Capua, where she was worshiped as Tifatina. In Roman art she usually appears as a huntress with bow and quiver, accompanied by a hound or deer (*cf.* the Artemis of Versailles).

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DIANE DE FRANCE (1538–1619), the natural daughter of Henry II of France and of a young Piedmontese, Filippa Duc, was born in Paris in 1538. A true Renaissance princess, Diane was not only beautiful but also cultured and intelligent. Legitimized in 1547, she was married in 1553 to Orazio Farnese, duke of Castro, the third son of Pierluigi Farnese, first duke of Parma, but Orazio was killed at Hesdin in the same year. In 1559 she married François, eldest son of Anne, constable duc de Montmorency, after the dissolution of a clandestine marriage of his. During Charles IX's reign she helped to make her husband chief of the *Politiques* (*see* FRANCE: *History*). Widowed a second time in 1579, she enjoyed even greater influence with Henry III and in 1582 received the duchy of Angoulême in appanage. She did much to prepare the king's reconciliation with Henry of Navarre (1589). When the latter became king of France as Henry IV he always showed her great consideration. She moreover acted as mother to her niece Charlotte de Montmorency, later princesse de Condé, with whom the king fell madly in love before he died. After Henry IV's death the duchesse d'Angoulême conducted the bodies of Catherine de Médicis and Henry III to St. Denis. She died in Paris at the Hôtel d'Angoulême on Jan. 11, 1619.

(P. ER.)

DIANE DE POITIERS, DUCHESSE DE VALENTINOIS (1499–1566), mistress of Henry II of France, was born on Sept. 3, 1499. Daughter of Jean de Poitiers, seigneur de Saint-Vallier, she was married in 1515 to Louis de Brézé, comte de Maulevrier, grand seneschal of Normandy. She came to court as a lady in waiting, first to Francis I's mother, Louise of Savoy, then to Queen Claude. Shortly after her husband's death in 1531, the prince Henry, then duc d'Orléans, 20 years her junior, fell violently in love with her and she became his mistress.

Before Henry became king, Diane de Poitiers was the great rival at court of Francis I's mistress, Anne de Pisseleu, duchesse d'Étampes. Throughout Henry's reign she held court as queen of France in all but name, while the real queen, Catherine de Médicis, lived in comparative obscurity. Writers anxious to justify the kings of France at the expense of their favourites' reputations have ascribed a major role in politics to Diane (accusing her, for instance, of having inspired the persecution of the Protestants), but in fact she seems to have concerned herself rather with augmenting her income and with making provision for her family and protégés than with public affairs, which Henry kept in his own hands. Henry, however, gave her the duchy of Valentinois in appanage in 1548. On Henry's death (1559), Catherine forced her to restore those of the crown jewels that Henry had given her and to accept the château of Chaumont in exchange for Chenonceaux. Diane then retired to Anet, where she died on April 22, 1566.

Even in their own time legends grew up around the love of Henry and Diane de Poitiers. It has been maintained, without much foundation, that Diane had previously been Francis I's mistress, so as to secure a pardon for her father, who was compromised in the constable duc de Bourbon's treason in 1523. Some serious writers alleged that Diane, who was nearly 60 years old when Henry died, had used magic to retain his love. Diane was certainly beautiful: she also had a lively, cultivated mind and was a friend and patron of poets and artists; *e.g.*, Pierre de Ronsard, Philibert de l'Orme, Jean Goujon and Jean Cousin. Philibert de l'Orme built her château at Anet, which was decorated with Goujon's statues and with Cousin's stained glass. It was for Diane that Goujon executed his masterpiece, the statue of Diana, now in the Louvre. The *Lettres inédites de Diane de Poitiers* were published by G. Guiffrey (1866).

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(RO. M.)

DIANTHUS is a genus of herbs, some of which, for their showy flowers, are cultivated in the garden. Most of the almost 300 species are native to Eurasia. The name *Dianthus* is derived from the Greek for "flower of god." *See* PINK; CARYOPHYLLACEAE; CARNATION; SWEET WILLIAM.

DIAPASON, a term in music originally denoting the interval of an octave. It is derived from the Greek *dia pason,* an abbreviation of *dia pason chordon* ("through all the strings"), signifying in medieval theory the interval encompassing all the degrees of the scale. The French term *diapason* indicates the range of a voice and is also the word for a tuning fork. The latter meaning is connected with the use of the same word in French to mean pitch (*see* PITCH, MUSICAL). The name is also given to the two foundation stops of the organ, the open and stopped diapason (*see* ORGAN).

DIAPHONY: *see* ORGANUM; DESCANT; GREEK MUSIC (ANCIENT).

DIAPHORETICS (SUDORIFICS), those remedies that promote perspiration. Among the best known are vapour or hot-water baths, or that part of the process of the Turkish bath that consists in exposing the body to a dry and hot atmosphere. Such measures, particularly if followed by the drinking of hot liquids and the wrapping of the body in warm clothing, seldom fail to excite copious perspiration. Numerous medicinal substances have the same effect, such as pilocarpine, which stimulates the sweat glands, or camphor and ammonium acetate, which stimulate the sweating centre.

(F. O. K.)

DIAPHRAGM, in human anatomy, a large fibromuscular partition between the chest and abdominal cavities; it is convex toward the chest, concave toward the abdomen, and consists of a central tendon and a muscular margin. The central tendon is trefoil in shape. The fleshy fibres rise in front from the back of the xiphoid cartilage; at the side by six serrations from the inner surfaces of the lower six ribs; at the back from the five arcuate ligaments, two external, two internal and one median.

There are three large openings in the diaphragm. The aortic opening is behind the middle arcuate ligament and transmits the aorta, the azygos vein and the thoracic duct of the lymphatic system. In the right leaflet is an opening for the inferior vena cava and a branch of the right phrenic nerve. In front and a little to the left of the aortic opening is an opening from the esophagus and the two pneumogastric nerves. Through the processes by which the diaphragm is attached to the spinal column pass the splanchnic nerves. The sympathetic nerves usually enter the abdomen behind the internal arcuate ligaments. The phrenic nerves, which are the main supply of the diaphragm, divide before reaching the muscle and pierce it in a number of places to enter its abdominal surface, but some of the lower intercostal nerves assist in the supply.

The diaphragm is at first developed in the neck region of the embryo. With growth of the body and development of the lungs the diaphragm shifts its position downward.

A complete diaphragm is characteristic of all mammals; it usually has the human structure and relations, except that below the Anthropoidea (monkeys, apes and man) it is separated from the pericardium by the azygous lobe of the lung. In some mammals (*e.g.*, echidna and porpoise) it is entirely muscular. In the whales it is remarkable for its obliquity; this allows a larger lung space in the dorsal than in the ventral part of the chest, and may be concerned with the equipoise of the animal. Below the mammals incomplete partitions are found in turtles, crocodiles and birds, and in amphibians (*Xenopus* and *Pipa*).

For the action of the diaphragm *see* RESPIRATION.

DIARRHEA, a looseness of the bowels. This is understood to mean frequent soft or watery stools, which may contain mucus and blood, usually accompanied by griping pain or colic. It may be due to many causes, differing somewhat in adults and children.

In adults diarrhea may result from a large variety of causes, including food poisoning, sprue, infective conditions such as typhoid fever, toxic causes, avitaminosis, antibiotics, colitis, polyposis, foreign bodies in the rectum and nervous conditions. Diarrhea in children may be caused by all these. In addition, children may suffer from errors in diet, such as excess fruits and vegetables; the bacillary dysenteries; amoebic dysentery (rare); celiac disease (fatty diarrhea); intussusception; and polyps. *See* also DYSENTERY; GASTROINTESTINAL TRACT, DISEASES OF.

DIARY, a book in which are preserved the daily memorandums regarding events and actions which come under the writer's personal observation or are related to him by others.

Diary-keeping of a sort was common among the Romans (*see*

COMMENTARII), but it was not until the close of the Renaissance that diaries (as distinguished from memoirs) began to have literary value. In the 17th century they began to be largely written in England, although in most cases without any idea of even eventual publication. Sir William Dugdale (1605–86) had certainly no expectation that his slight diary would ever see the light. Bulstrode Whitelocke (1605–75), whose *Memorials of the English Affairs* covers the ground from 1625 to 1660, was a genuine diarist. So was the elder George Fox (1624–91), who kept not merely "a great journal," but "the little journal books," and whose work was published in 1694.

The famous diary of John Evelyn (1620–1706) professes to be the record of 70 years and, although large tracts of it are covered in a perfunctory manner, while in others many of the entries have the air of having been written in long after the event, this is a most interesting and diverting work; it was not published until 1818. It would hold a still higher position in the history of literature than it does if it were not overshadowed by what is unquestionably the most deservedly celebrated of the diaries of the world, that of Samuel Pepys (*q.v.*). This was begun on Jan. 1, 1660, and was carried on until May 29, 1669. The exceptional value of Pepys's diary consists in its fidelity to the portrayal of its author's character. In the age which succeeded that of Pepys, a diary of extraordinary emotional interest was kept by Jonathan Swift from 1710 to 1713, and was sent to Ireland in the form of a *Journal to Stella;* it is a surprising amalgam of ambition, affection, wit and freakishness.

The diary of the celebrated dissenting divine Philip Doddridge (1702–51) was printed in 1829. Of far greater interest are the admirably composed and vigorously written journals of John Wesley (1703–91). But the most celebrated work of this kind produced in the latter half of the 18th century was the diary of Fanny Burney (Madame d'Arblay), published in 1842–46. These works were all posthumously published. James Boswell's *Journal of a Tour to the Hebrides* (1785), a genuine diary though somewhat expanded, was published during the author's lifetime.

Many of the diaries described above were first published in the opening years of the 19th century, and the interest which they awakened led to their imitation. Diaries ceased to be rare, but as a rule those which appeared did not present much literary interest. Sir Walter Scott's *Journal* (published 1890) and the diaristic portions of B. R. Haydon's *Autobiography and Journal* are eminent exceptions. Exception must also be made in favour of the journals of two minor politicians, Charles Greville (1794–1865) and Thomas Creevey (1768–1838), whose indiscretions added much to the gaiety of nations; the papers of the former appeared in 1874–87, those of the latter in 1903. The diary of Henry Crabb Robinson (1775–1867), printed in 1869, contains excellent biographical material. Tom Moore's journal, published in 1856 by Lord John Russell, disappointed its readers, and Lewis Carroll's diaries, first published in 1954, proved a somewhat dry matter-of-fact record. Charles Darwin's historic *Voyage Round the World* is written in diary form. R. W. Emerson's *Journals* are the notebook of an author rather than a book of intimate confessions. Of the many women who kept interesting diaries in the 19th century, three may be mentioned as of special and contrasting value—Queen Victoria, excerpts from whose diaries appeared in *Leaves From the Journal of Our Life in the Highlands* (1862) and *More Leaves* (1883); Dorothy Wordsworth, whose vivid and sensitive *Journals* (1897) emphasized her influence on her brother William's poetry; and the Quaker Caroline Fox, whose literary diary was first published in 1882. The child-diarist Marjorie Fleming (1803–11) also deserves her place; her diaries may be read in L. Macbean's *The Story of Pet Marjorie* (1914).

In the 20th century many men and women published their diaries during their lifetimes. Col. Charles Repington's diary of World War I was a monument of indiscretion. "W. N. P. Barbellion" was still alive when his tragic *Diary of a Disappointed Man* (1919) was published. Of later diaries none has possessed more literary grace than the *Journal of Katherine Mansfield* (1927).

The diary has lent itself to parody, and has inspired at least one humorous masterpiece, *The Diary of a Nobody* (1892) by George and Weedon Grossmith, most of which originally appeared in *Punch*. The fictional *Mrs. Dale's Diary* engrossed British Broadcasting corporation audiences in the 1950s.

It was natural that the form of the diary should appeal to a people so sensitive to social peculiarities as the French. A medieval document of immense value is the diary kept by an anonymous curé during the reigns of Charles VI and Charles VII. This *Journal d'un bourgeois de Paris* was kept from 1409 to 1431, and was continued by another hand until 1449. The marquis de Dangeau (1638–1720) kept a diary from 1684 till the year of his death; this is an inexhaustible storehouse of facts about the reign of Louis XIV. Saint-Simon's own brilliant memoirs, written from 1691 to 1723, may be considered as a sort of diary.

The song writer Charles Collé (1709–83) kept a *journal historique* from 1748 to 1777; it is full of vivacity, but very scandalous. Petit de Bachaumont (1690–1771) had access to remarkable sources of information, and his *Mémoires secrets* contains a valuable mass of documents. The posthumous publication of the diaries of the Russian artist, Marie Bashkirtseff (1860–84), produced a great sensation in 1887. The brothers Jules and Edmond de Goncourt kept a very minute diary of artistic and literary Paris; after the death of Jules, in 1870, this was continued by Edmond, who published three volumes in 1887–88, the work being extended to nine volumes covering the years up to Edmond's death in 1896; the complete *Journal* was first published in 1956–59. Among later French diaries, the *Journal* (its parts covering the period 1889–1949) of André Gide is perhaps the most notable. The chief historians of the diary have been Arthur Ponsonby, 1st Baron Ponsonby of Shulbrede (1871–1946), and the American William Matthews.

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DIAS DE NOVAES, BARTOLOMEU (fl. 1478–1500), Portuguese navigator and the discoverer of the Cape of Good Hope, was a knight of the royal household. The date and place of his birth are unknown. In 1478 a certain Bartolomeu Dias, probably identical with the navigator, was exempted from certain customary dues on ivory taken to Portugal from the Guinea coast. In 1481 the navigator commanded one of the vessels under Diogo d'Azambuja dispatched to the Gold Coast by John II. Five years later he was granted an annuity of 6,000 reis for "services to come" by John II.

In Aug. 1487 he sailed from Lisbon with two ships, probably caravels, and a storeship with the triple object of continuing the charting of the African coast (so greatly advanced by Diogo Cam, *q.v.*), of finding Prester John and of discovering a sea route to India. With him were two Negroes whom Cam had taken to Portugal. Passing Cape Cross (21° 50′ S.), the farthest point reached by Cam, Bartolomeu landed the two Negroes at Angra do Salto (Port Alexander). He probably then left his storeship in Walvis bay before continuing to Cabo da Volta, near Angra Pequena, where he erected a stone pillar to mark the overlordship of Portugal. From this point (according to João de Barros) he ran 13 days southward; then failing to find land he turned north and struck the coast at Mossel bay (Bahia dos Vaqueiros) on Feb. 3, 1488. Thence he coasted eastward and set up a second pillar at Cape Padrone. There his officers and men insisted that the expedition return to Portugal, and Dias could persuade them to continue only as far as the mouth of the Great Fish river. There the northeasterly trend of the coast became unmistakable; thus Dias confirmed a sea route round the south coast of Africa, but was prevented from sailing further and from opening the Cape route to India.

On the return voyage to Portugal, he erected a pillar at the Cape of Good Hope (which one tradition says he named the "cape of storms"). Then he returned to Lisbon, calling at Prince's Island (southwest of the Cameroons) where he took aboard Duarte Pacheco Pereira (who had been sent by John II to reconnoitre the rivers on the adjoining mainland) and at Mina where he obtained gold dust. He finally arrived at Lisbon in Dec. 1488. He

had discovered 1,260 mi. of coast, and his voyage, taken with letters received not long afterward from Pedro de Covilhão (*q.v.*) who, by way of Aden and Cairo, had reached (1487–88) the Malabar coast on one side of the Indian ocean and Sofala (20° 8′ E.) on the other side, was considered to have solved the question of an ocean route round Africa to India.

Dias was greeted with enthusiasm on his return, but there is no record of his having been rewarded for his great achievement. John II and his successor, Manuel I, alike preferred Vasco da Gama to command the great expedition to India in 1497. Dias was employed to supervise the building of the "St. Gabriel" and the "St. Raphael," but he was allowed to sail with the expedition only as far as the Cape Verde Islands. Three years later he sailed with Alvares Cabral and landed on the coast of Brazil on April 22, 1500, en route to India. He perished in a storm off the Cape of Good Hope on May 29, 1500.

BIBLIOGRAPHY.—João de Barros, *Asia*, book iii, ch. 4, ed. by A. A. and G. A. Grillo (1866); Duarte Pacheco Pereira, *Esmeraldo de situ orbis*, ed. by R. Basto (1892), ed. by A. da Silva Dias (1905). *See* also A. Galvão, *The Discoveries of the World*, Hakluyt Society (1862); *Journal of the First Voyage of Vasco da Gama*, ed. by E. G. Ravenstein (1898); E. G. Ravenstein, "The Voyages of Diogo Cão and Bartolomeu Dias," *Geogr. J.*, vol. xvi (1900). (E. M. J. C.)

DIASIA, a festival of Zeus (*q.v.*), particularly that held outside Athens in honour of Zeus Meilichios ("easily entreated"). It was a ritual of atonement celebrated annually on the 23rd day of Anthesterion (early March). Whole burnt offerings of animals or sacred cakes in animal shapes were offered to the god, represented as a snake. This cult appears to have been a survival of primitive ritual connected later with the name of Zeus.

See L. Deubner, *Attische Feste*, p. 155 ff. (1956). (H. W. Pa.)

DIASPORA is the term generally applied to Jewish communities living outside Palestine. The word, which has its origin in the Septuagint translation of Deut. xxviii, 35 and is used as the equivalent of the Hebrew terms *Gola*, *Galut* and *Tefuzot*, describes a historical manifestation but also has religious-eschatological and philosophical-political connotations. Historically, Diaspora Jewry goes back to the period of the Babylonian exile in the 8th century B.C. With the re-establishment of the second commonwealth the coexistence of an independent Jewish centre in Palestine with Jewish community life in various parts of the world became an established and continuing fact in Jewish history.

The largest, most significant and most creative Diaspora centre in the early period of Jewish history was the Jewish community in Alexandria in the 1st century B.C. Over 40% of the population of the city was Jewish, and the flowering of Hellenistic Jewish culture took place there. It is estimated that there were over 4,000,000 Jews within the Roman empire and about 1,000,000 in areas not under Rome who lived outside Palestine but looked to Palestine as the centre of Jewish religious and cultural life. Diaspora Jewry thus by far outnumbered the Jews in Palestine even before the destruction of the second Temple.

The extinction of Jewish statehood in A.D. 70 led to elimination of the central role of Palestinian Jewry. Jewish history from then on is a history of Diaspora Jewry, with shifting centres of hegemony from epoch to epoch—Babylonia and Persia, Arab and Christian Spain, France and Germany, Poland and Russia and most recently the United States. Variations in language, ritual and culture developed within the general framework of common tradition, and autonomous institutions governing internal Jewish community life were fashioned within the various centres. The Diaspora saw the emergence of the "Jewish problem" and anti-Semitism as well as the continuing struggle between the forces leading to assimilation to the non-Jewish environment and those tending to maintain Jewish national identity.

The very use of the term Diaspora implies a special relationship between the land of Israel and the Jewish settlements outside Palestine and hence involves basic religious and eschatological conceptions in Judaism. These range from the messianic hope of traditional Judaism for the eventual ingathering of the exiles to Zion to the "mission idea" of Reform Judaism which holds that the dispersion of the Jews was providentially designed to further the cause of pure monotheism throughout the world. In medieval Christian teaching the Diaspora gave rise to the image of the "wandering Jew" who had been relegated to the position of a pariah nation as punishment for having rejected Jesus and who was to continue to live on as the eternal symbol of divine visitation. The growth of secularism and nationalism in the 19th and 20th centuries produced diverse attitudes to the Diaspora. Political Zionism (*q.v.*) regards the land of Israel as the sole "home" for the Jews, negating the future of Jewish life in the Diaspora. Cultural Zionism as expounded by Ahad Ha-am regards the world-wide Jewish community as one cultural unit, with its vital centre in Palestine. The Diaspora nationalism of Simon Dubnow (*q.v.*) and of the Jewish Workers' Bund regarded all Jewish settlements as equal partners in one cultural enterprise, with no particular pre-eminence for Palestine. For those Jews who reject every form of Jewish nationalism the concept of Diaspora no longer has meaning or validity. In this view, all Jewish communities are simply disparate cultural-religious associations. The creation of the state of Israel in 1948 has made the problem of the relation of Zion to Diaspora Jewry once more acute.

In 1939 the estimated number of Jews in the world was about 16,000,000, of whom about 475,000 were in Palestine. The destruction of European Jewries by the Nazis and the establishment of the state of Israel radically changed the population picture. According to the best estimates there were in the 1960s a total of about 12,900,000 Jews in the world. Of these, 1,940,000 were in the state of Israel, approximately 2,345,000 in the U.S.S.R. and about 5,500,000 in the United States. Zion and the Diaspora were once again the twin poles of Jewish existence.

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DIASPORE, an aluminum oxide mineral, is associated with corundum and at times is a major constituent of bauxite (*q.v.*), an important source of aluminum, and aluminous clays. It occurs as platyorthorhombic crystals and as lamellar or scaly masses, the flattened surfaces being the direction of a perfect cleavage and having a markedly pearly lustre. It may be colourless, grayish, greenish, brownish, yellowish or pink, and sometimes violet with marked pleochroism. It is readily distinguished from other common platyminerals, such as mica, talc, gypsum and brucite, by its greater hardness, 6.5 to 7. The specific gravity is 3.4. When heated in the blowpipe it decrepitates violently, forming white scales, hence the name from the Greek *diaspora*, a scattering. In composition it is a monohydrate of aluminum, $Al_2O_3(H_2O)$. *See* ALUMINUM: *Chemical Compounds*. (L. S. Rl.; X.)

DIATESSARON ("out of the four [Gospels]") is an edition of the Gospels by Tatian, written as a single narrative, perhaps about A.D. 170 (according to Eusebius). Tatian occasionally included elements from another tradition, and sometimes the mark of his ascetic convictions also can be seen in the text. Whether it was composed originally in Syriac or in Greek is a matter of dispute; however, a 3rd-century Greek papyrus fragment discovered in the 1920s at Dura Europos (on the Euphrates, between Aleppo and Baghdad) exhibits the flavour of a Syriac original. Apparently the Diatessaron found acceptance immediately in the Syrian orient, and for generations it was the standard Gospel text. When it finally was replaced by the four separate Gospels, beginning in the 4th century, it continued to be used privately. It must early have been translated into Latin and would have been welcomed among the Latin-speaking Christians at a time when only Greek was used in the liturgy. Centuries later, it had a new and enormous success, for during the middle ages it enjoyed wide attention in the occident and recensions circulated in European languages. A considerable part of this material has survived.

The Diatessaron would have been an invaluable source for the history of the 2nd-century Gospel text, but no original manuscript survived. Not a fragment of the Syriac escaped, except for quotations in ancient Syriac literature. It was translated into several languages, however, and late manuscripts of these texts have been salvaged, in Arabic and particularly Persian. *See* also GOSPELS.

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DIATOMACEOUS EARTH (DIATOMITE) is a hydrous form of silica or opal composed of the siliceous shells of diatoms, which are unicelled aquatic plants of microscopic size. It is light coloured and occurs in sedimentary beds that somewhat resemble chalk, but it is much lighter and will not effervesce in acid. Under a high-powered microscope the form of the diatoms can be distinguished. These are so small and abundant that several million are contained in one cubic inch of diatomite. Many thousands of different varieties of diatoms are known (*see* DIATOMS).

Diatomite, formerly used principally as a filter in clarifying sugar and sirups, has been adapted to almost all industrial filtration applications, including processing oils, alcoholic and nonalcoholic beverages, antibiotics, solvents and chemicals. A second major use is as a filler or extender in paper, paints, brick, tile, ceramics, linoleum, plastics, soap, detergents and a large number of other products.

Still another major use of diatomite is in the insulation of boilers, blast furnaces and other places where high temperatures are maintained. At temperatures higher than 1,000° F. diatomaceous earth is a more efficient insulator than asbestos or magnesia because it is more resistant to shrinkage and does not fail at red heat. It is also used for sound insulation and as a vehicle for herbicides and fungicides. In Europe, under the name kieselguhr, it has been used as the inert ingredient of dynamite. The oldest and best-known commercial use of diatomite is that of a very mild abrasive in metal polishes and tooth paste. The amount used in polishes increased greatly with the utilization of diatomaceous dust as the base of polishes for automobiles finished in artificial lacquers.

The largest deposit worked in the United States is in northern Santa Barbara county, Calif. Miocene beds more than 1,000 ft. thick extend over several square miles and vary from soft earth to hard compact rock that can be sawed into blocks. The principal production in the United States has come from these deposits and those of Nevada and Oregon. Denmark, France and the Federal Republic of Germany have well-developed diatomite industries and numerous deposits exist in Algeria. (V. T. A.; X.)

DIATOMS (BACILLARIOPHYCEAE) are microscopic unicellular or colonial algae, distinguished by the complex structure of their cell walls, which are usually strongly impregnated with silica. The majority are minute, and one with a length of $\frac{1}{200}$ in. is well beyond the medium size. The first forms were discovered by O. F. Müller toward the close of the 18th century. With the perfection of modern microscopes and microscopic methods, the study of these minute plants progressed, until over 5,500 species of diatoms have been described.

INTRODUCTION

Occurrence and Distribution.—Moisture and light are needed for the growth of diatoms, and wherever these factors coexist, diatoms will almost invariably be found. They occur abundantly in cultivated soils, and mixed with other forms on the surface of moist rocks; in pools and other small pieces of water they form a brownish stratum on the surface of the mud, or cover the stems and leaves of water plants or floating twigs with a furry investment. Marine forms are usually attached to seaweeds, and many are found in the stomachs of mollusks, holothurians, ascidians and other ocean creatures. Both in fresh waters and in the sea, moreover, there are myriads of free-floating diatoms, which at times indeed make up the main bulk of the plankton (*q.v.*). Diatoms are most abundant in cold latitudes, having a general preference for cold water, and exist in prodigious numbers in the Arctic and Antarctic oceans. The fresh-water species are almost always distinct from those found in salt or brackish water.

Diatomaceous Earth.—Large numbers of fossil diatoms are known. Since the siliceous wall is practically imperishable, it persists after the death of the individual, so that where diatoms occur abundantly there is an unceasing rain of their minute valves onto the bottom of sea or lake. In this way extensive deposits of diatomaceous earth may arise, and such are not only being formed at the present but have been produced abundantly in the past. Deposits of diatomaceous earth have been discovered in various parts of the earth, some of fresh-water, others of marine origin. Most deposits are a few feet in thickness but some are much thicker, the thickest deposits thus far discovered being in California, where there is a subterranean deposit about 3,000 ft. thick. Most of the fossil deposits are in Tertiary rocks, although there are records of diatoms in the Triassic period (extending from about 160,000,000 to 200,000,000 years ago). Industrial uses of diatomaceous earth are covered in the article DIATOMACEOUS EARTH.

STRUCTURE AND FUNCTION

Structure.—In spite of the immense number of diverse forms included in it, the class of diatoms as a whole exhibits a remarkable uniformity of structure. The individual cells of diatoms are called frustules, and the cell wall consists of two similar halves, each composed of a slightly convex valve to whose incurved edges is attached at right angles a broad, hooplike, connecting band. The two connecting bands together form the girdle (fig. 2). One half is slightly smaller than the other, the smaller fitting into the larger much as a box fits into its cover (fig. 2). By visualizing a circular, oval or otherwise shaped box, a mental picture of the varied forms assumed by the frustules of diatoms may be obtained; the sides of the box correspond to the connecting bands. As the protoplasmic contents increase in volume, the siliceous valves are pushed apart and the connecting bands become broader.

Diatoms are usually described from two aspects, one in which the surface of the valve is exposed, the valve (top) view; and one in which the girdle is exposed, the girdle (side) view. The valve view exhibits great variety of form; the girdle view is much more uniform and commonly rectangular. The valves may be circular, triangular or oval in outline. Some are linear, others more or less crescentic; others again are wedge shaped. The prevailing forms, however, are boat shaped (naviculoid), as in the genus *Navicula*, which embraces more than 1,000 species.

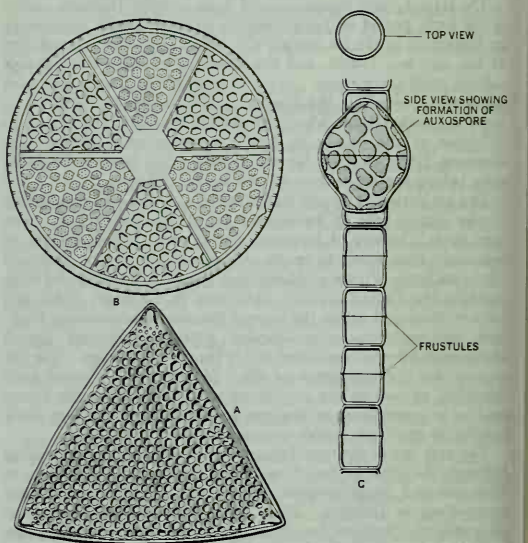
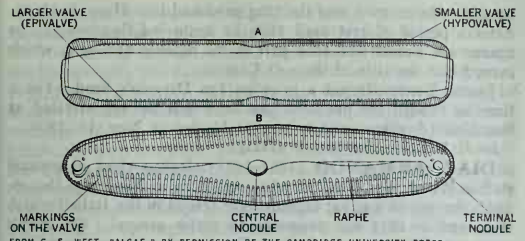


FIG. 1.—CENTRIC DIATOMS: TOP VIEWS OF UNICELLULAR (A) TRICERATIUM FAVUS (B) ACTINOCYCLUS UNDULATUS; (C) PART OF COLONY OF MELOSIRA VARIANS



FROM G. S. WEST, "ALGAE," BY PERMISSION OF THE CAMBRIDGE UNIVERSITY PRESS

FIG. 2.—DETAIL OF FRUSTULE OF PENNATE DIATOM: (A) SIDE VIEW; (B) TOP VIEW

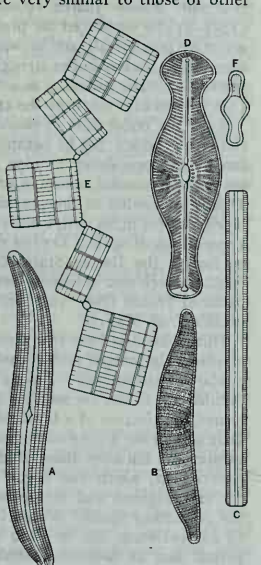
Many diatoms are free-floating, but some (*Gomphonema*) are attached to foreign bodies by simple or branched gelatinous stalks. The frustules of some are connected to form ribbon-shaped colonies (*Fragilaria*) or zigzag chains (fig. 3[E]). In a few genera numerous individuals are enclosed in a tubelike gelatinous envelope.

The valves are thin and transparent and generally ornamented with a variety of markings. The latter often appear as fine lines on the face of the valve, and the best lenses show them in many cases to consist of a series of separate dots which correspond to small cavities within the siliceous wall. The valves of certain marine genera exhibit a beautiful areolated structure due to the presence of larger chambers within the wall. A good many diatoms, especially those of the naviculoid type, have thickenings at the centre and at each extremity of the valve, known as nodules (fig. 2). These possess a complex structure and are generally connected by a long narrow cleft, the raphe (fig. 2), which appears as a straight or slightly undulating line in the valve view.

The contents of diatom cells are very similar to those of other algae. Beneath the wall there is a lining cytoplasmic layer enclosing the cell sap and connected either by two broad bands or by a number of anastomosing strands with the central cytoplasm in which the nucleus is embedded. The chromatophores are either one or two of large size, or numerous small lobed disks. The former often include a variable number of glistening bodies called pyrenoids. The characteristic brown colour is due to diatomin, a pigment resembling that of the brown algae and masking the chlorophyll. The cells often contain abundant oil.

Many diatoms, but only those that possess a true raphe in their valves (*Navicula*, etc.), are able to move through the water, sometimes with considerable rapidity. The movements are, in all cases, doubtless related to the presence of the raphe, which in all probability contains streaming cytoplasm connected with that in the interior of the cell by a complex system of canals within the nodules.

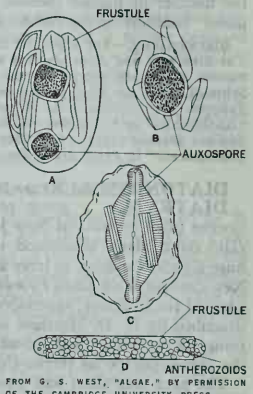
Some believe that the movements depend upon an extrusion of mucilage from the region of the raphe. In *Cocconeis*, whose disc-shaped frustules are found attached in enormous numbers to *Cladophora* and other fresh-water plants, only the valve in contact with the substratum possesses a raphe.



D AND E FROM SMITH, "BRITISH DIATOMACEAE"

FIG. 3.—PENNATE DIATOMS. UNICELLULAR: (A) PLEUROSIGMA BALTICUM (TOP VIEW); (B) EPITHEMIA TURGIDA (TOP VIEW); (C) SYNEDRA ULNA (SIDE VIEW); (D) GOMPHONEMA GEMINATUM (TOP VIEW); (E) COLONY OF TABELLARIA FLOCCULOSA (SIDE VIEW); (F) SINGLE FRUSTULE OF TABELLARIA FLOCCULOSA (TOP VIEW)

Reproduction.—The ordinary mode of multiplication is by cell division, which usually occurs at night. The cell contents divide into two masses and the halves of the cell wall commence to separate; thereupon, fresh valves, which are at first very delicate, are secreted on the surfaces of the new protoplasmic masses opposite to the valves of the parent. The new valves are situated within the girdle of the original frustule, but as their own connecting bands develop, those of the parent separate. Each of the new individuals thus has one valve derived from the parent, and one that is newly formed and more or less parallel to it. This process of division is repeated at frequent intervals, and it has been calculated that from a single frustule 1,000,000,000 new individuals may arise in the course of a month.



FROM G. S. WEST, "ALGAE," BY PERMISSION OF THE CAMBRIDGE UNIVERSITY PRESS

FIG. 4.—REPRODUCTIVE STRUCTURES IN: (A) NAVICULA LIMOSA; (B) ACHNANTHES FLEXELLA; (C) NAVICULA AMPHISBAENA; (D) CORETHRON VALOIVIAE (BEFORE LIBERATION FROM FRUSTULE)

The individual diatom, owing to the rigidity of the siliceous wall, is ordinarily incapable of any increase in length and, since the new valves are always formed within the girdle of the old ones, it would follow that one of the two cells in every succeeding cell generation is reduced in length by the thickness of the girdle. This is not, however, strictly true, as daughter cells are sometimes formed that are larger than the parent cell, so that the reduction in size is not always proportional to the number of divisions. The progressive diminution in size does not continue indefinitely because cells of small size may produce special rejuvenescent cells (auxospores) of considerably larger dimensions.

In pennate diatoms the auxospore is a zygote produced by union of two nonflagellate gametes. Two small cells become surrounded by a common gelatinous envelope and the valves of the cell walls spread apart. In most species the protoplast of each cell functions as a gamete and there is a formation of a single auxospore (fig. 4[B]). In some other species each cell produces two gametes and there is a formation of two auxospores. Cells functioning as gametes always have a reduction (meiotic) division of their nuclei.

Cells of centric diatoms always produce a single auxospore. For a long time these were thought to be asexual in nature. However, auxospores of certain centric diatoms are now known to be produced sexually, and there is a strong presumption that this holds for the entire group. In auxospore formation of centric diatoms the valves of certain cells of a species pull apart and the protoplast rounds up to form a single egg. Other cells of the species have the protoplast dividing into 8, 16, 32, 64 or 128 flagellated antherozoids (called microspores before their sexual nature was discovered). Antherozoids liberated from a cell producing them swim to and fuse with the eggs. The zygotes thus formed become auxospores. Cells producing either antherozoids or eggs have a meiotic division of their nuclei.

CLASSIFICATION

The diatoms, or Bacillariophyceae, are one of the three classes of the phylum (or division) Chrysophyta. The class is divided into two orders, Centrales and Pennales.

Valves of Centrales have an ornamentation that is radial or concentric about a central point. The cells usually contain many chromatophores, are immobile, form microspores and produce auxospores asexually. The order includes about 100 genera and 2,400 species, the great majority of which are marine.

Valves of Pennales have an ornamentation that is bilaterally symmetrical or asymmetrical. The cells usually have but one or two chromatophores, never form microspores, and form auxospores by a fusion of two gametes. Species with a raphe move spontaneously. The order includes about 70 genera and 2,900 species.

The number of fresh-water species is somewhat smaller than the number of marine species. *See* ALGAE; *see* also references under "Diatoms" in the Index volume.

BIBLIOGRAPHY.—For a general account of diatoms *see* F. E. Fritsch, *The Structure and Reproduction of the Algae* (1935). There are numerous systematic works for the determination of diatoms; *e.g.*, A. Schmidt, *Atlas der Diatomaceenkunde* (1874 *et seq.*); H. van Heurck, *Synopsis des Diatomées de Belgique* (1880–85); H. von Schönfeldt, "Bacillariales" in A. Pascher, *Süsswasserflora Deutschlands, Österreichs, und der Schweiz* (1913); C. S. Boyer, "Synopsis of the North American Diatomaceae" in *Proc. Acad. Nat. Sci. Philad.*, vol. 78 (1927).
(G. M. S.)

DIATONIC SCALE: *see* SCALE.

DIATRYMA, a group of extinct birds known from the Eocene fossil deposits of New Jersey, Wyoming and New Mexico (laid down about 60,000,000 to 40,000,000 years ago). These huge flightless species, as large as the larger of the extinct moas of New Zealand or the fossil *Phororhacos* of South America, were well adapted for an active, aggressive terrestrial life. *Diatryma steini,* described by W. D. Matthew and Walter Granger from a nearly complete skeleton, stood almost seven feet high and towered over the contemporaneous terrier-sized horse.

The neck was short and strong, and the head huge, the skull being 17 in. long with a compressed beak, which, as preserved without the horny sheath (rhamphotheca), measured 9 in. long and 6½ in. high. The postorbital and squamosal bones were joined distally to form a temporal fenestra. The jawbone (mandible) was massive, though having a slender tip, with strong muscular attachments.

The coracoid and scapula bones were fused, and the humerus much reduced; the wing was completely nonfunctional for flight. The pelvis and leg were large and strong; the femur was 15 in. long and the tibia nearly 2 ft. The metatarsus (part of the foot skeleton) was incompletely preserved, but was a heavy bone with two perforations of the shaft at the upper end. The three anterior toes were strong, whereas the hind toe (hallux) was small and elevated.

Three other species, *Diatryma ajax, D. giganteum* and *Omorhamphus storchii,* have been described and another, *Baronis regens* from the Eocene of New Jersey, is placed with these somewhat uncertainly. *Diatryma sarasini* was named from Monthelon near Épernay, France. These form the family Diatrymidae, which, is placed in the order Diatrymiformes, near the cranes, with which, however, it does not show close affinity. The fossil family of the Gastornithidae, represented by six species from the Eocene of western Europe, is placed tentatively in this order.

See W. D. Matthew and Walter Granger, "The Skeleton of *Diatryma,* a Gigantic Bird From the Lower Eocene of Wyoming," *Bull. Amer. Mus. Nat. Hist.*, vol. xxxvii, pp. 307–326 (1917); Kálmán Lambrecht, *Handbuch der Palaeornithologie,* pp. 566–579 (1933). (A. WT.)

DIAVOLO, FRA (1771–1806), the popular name of a famous Italian guerrilla leader whose real name was MICHELE PEZZA. Of low parentage, he was born at Itri, near Foggia, on April 7, 1771. After a serious childhood illness, his mother made him wear a monk's habit, a customary form of thanksgiving; because of his violent nature his schoolmates called him *diavolo* ("devil"). Hence the nickname "Brother Devil," which later lent itself to popular superstition.

Fra Diavolo was apprenticed to a saddler, whom he mortally wounded with an awl after an altercation. To escape justice, he took to the hills in the Terra di Lavoro, where he committed several robberies and murders. He surrendered and was pardoned (Jan. 20, 1798) on condition that he join one of the bands raised by Ferdinand IV of Naples against the French occupation. His band promptly interrupted French communications between Rome and Naples and he received the rank of colonel.

Fra Diavolo took terrible reprisals on the French invaders for their atrocities, and the behaviour of his men at the sack of Albano eventually led to his arrest and imprisonment in the Castel Sant' Angelo. He escaped, and the king pardoned him (Dec. 2, 1800). After a period of rest until 1806 he again led Bourbon troops against the French and took part in the defense of Gaeta, which earned him the title of duca di Cassano.

Joseph Bonaparte put a price on Fra Diavolo's head. For a time he evaded his pursuers, but at length he was arrested at Baronissi (Avellino) and hanged at Naples on Nov. 11, 1806.

See E. Jallonghi, *Fra Diavolo* (1911).

DIAZ, ARMANDO (1861–1928), Italian chief of general staff in World War I and marshal, was born in Naples on Dec. 6, 1861, the son of a naval captain. He served in the Italo-Turkish War, and in 1914 was promoted to major general. On Italy's entry into World War I he was director of military operations, and in 1916 became lieutenant general in command of the 49th division. In 1917 he was put in command of the 23rd corps and saw much hard fighting on the Carso.

In Nov. 1917, after Caporetto, Diaz succeeded Luigi Cadorna as chief of the general staff. Under him the battle front was successfully reconstituted and the Austrian armies were destroyed at Vittorio Veneto (Oct.–Nov. 1918). After the signature of the armistice he became inspector general of the army. He received many honours, Italian and foreign, and in Dec. 1921 was created duca della Vittoria.

On the advent of the Fascist government he was appointed minister of war, in Oct. 1922. Ill-health obliged him to resign in April 1924. On Nov. 4, 1924, the newly created rank of marshal was conferred on him. He died on Feb. 29, 1928, in Rome.

DÍAZ, PORFIRIO (1830–1915), Mexican soldier and president, was born in the city of Oaxaca, state of Oaxaca, Sept. 15, 1830, of a poor family; his mother was part Indian. At the age of 15 he entered training for the priesthood, but during the war with the United States (1846–48) he served in the army, and in 1849 began to study law at the suggestion of the liberal state governor, Benito Juárez (*q.v.*). During the War of Reform (1858–61) he supported the presidency of Juárez against the conservative proclericals, and he was one of the most prominent Juarist military leaders in the struggle against the French intervention (1861–67). His gallantry as a line officer at the battle of Puebla (1862) won him much of the credit for that unexpected victory.

After the restoration of peace Díaz resigned his command and retired to Oaxaca, but he became dissatisfied with Juárez' policies, ran for the presidency in 1871 and, when Juárez was re-elected, led an unsuccessful revolt in protest. After Sebastián Lerdo de Tejada succeeded to the presidency in the following year, Díaz bided his time in his native hills, and in the spring of 1876 launched a second revolt against Lerdo's re-election. Temporarily defeated, he fled to the United States but returned after six months to counterattack and decisively defeat the government forces in the battle of Tecoac (Nov. 16). In May 1877 he was formally elected president of Mexico.

During his first four-year term of office Díaz built up a political machine, suppressed revolts and bandits and made a few modest public improvements. Having opposed Lerdo's re-election, he decided not to run for another term himself, and in 1880 he engineered the election of a loyal subordinate, Gen. Manuel González. Díaz served for a time in the cabinet as minister of *fomento* (development) but soon dissociated himself openly from the González government, which had begun to attract unfavourable criticism for extravagance and corruption. In 1884 Díaz was elected to the presidency again. Within two years he had reduced congress to subservience, and in 1890 the constitution was amended to permit him an indefinite number of re-elections.

For over 26 years after 1884 Díaz brought the mixed blessings of peace and stability to Mexico. His government imprisoned opponents, occasionally assassinated political prisoners "trying to escape" and regularly subsidized and censored the press. Díaz cleverly played off his subordinates against each other, and his well-lubricated machine kept up the forms of democracy in periodic elections, mainly for the benefit of Mexico's reputation abroad. Meanwhile, banditry diminished until life and property were safer in Mexico than in many parts of the United States at the beginning of the 20th century.

The economic policies of the Díaz regime, though sometimes haphazard and imperfectly planned, greatly stimulated Mexican industry, mining and agriculture. Díaz himself was no economist, but his two principal financial advisers, Matías Romero and, after 1893, José Y. Limantour, invited foreign capital and technology to Mexico to build railroads and bridges, dig mines, irrigate fields and establish colonies of immigrants. Investments from the United States, the most important source of capital, rose from a few million dollars to between $800,000,000 and $1,000,000,000 under the Díaz regime. (No exact figures of investments exist, and estimates vary.) Railroad mileage increased from 416 mi. in 1876 to about 15,360 mi. in 1910, and Mexican exports are said to have risen from 27,318,788 pesos in 1874–75 to 293,752,150 pesos in 1910–11, although the simultaneous inflation of the Mexican silver peso robs these statistics of some of their force.

While Díaz ushered his country through the first stages of its industrial revolution, he made little effort to divide the benefits of economic expansion among the common people, and at the end of his regime the gap between rich and poor was as wide as ever. Wealthy Mexican landowners and foreigners received most of the irrigation and survey grants, railroad and mining concessions and government subsidies, but the starvation wages of most of rural Mexico and wretched conditions in the Mexico City slums belied the official propaganda of peace and prosperity and made social revolution inevitable.

In 1910 Díaz allowed Francisco I. Madero to run against him for the presidency. As everyone expected, Madero lost the election by a wide margin, but when he resorted to military revolution, the government forces proved surprisingly weak, and a few victories released the pent-up hatred against the dictator. In May 1911 Díaz, then senile, resigned his office and went into exile in Paris, where he died on July 2, 1915.

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DIAZ DE LA PEÑA, NARCISSE VIRGILE (1808–1876), French painter and lithographer of the Barbizon school, was born in Bordeaux of Spanish parents. He became famous for his paintings of the forest of Fontainebleau, and for his landscape fantasies with mythological figures. He had no well-known pupils, but Léon Richet followed markedly his methods of tree painting, and J. F. Millet at one period painted small figures in avowed imitation of Díaz' then popular subjects.

When he was 15 Diaz began working as a porcelain painter at Sèvres. He then studied with Cabanel and Souchon, and became acquainted with Dupré, Raffet and Cabat. As a young artist he was strongly influenced by the romantics, and enthusiastically admired the art of Delacroix, the middle ages and the near east. He entered several exotic subjects in the *salons* of 1831, 1834 and 1835, but his strongly coloured figure subjects met with little public success.

About 1840 Diaz turned more toward subtly toned landscape painting and, together with Corot and others, began to frequent the forest of Fontainebleau near the village of Barbizon. Although Diaz showed regularly in the *salons* of the late 1830s and the 1840s, he seldom exhibited publicly during the last 15 years of his life. After 1871 his work became especially favoured among collectors, and he worked constantly and successfully. He died at Mentone on Nov. 18, 1876. *See* also BARBIZON SCHOOL.

DÍAZ DEL CASTILLO, BERNAL (*c.* 1492–*c.* 1581), Spanish soldier and author, who took part in the conquest of Mexico, was born in Medina del Campo, and died in Guatemala. In protest against the academic chronicles of sedentary historians he wrote his *Verdadera historia de la conquista de la Nueva España* (1632), insisting that, as actor and eyewitness, he was better situated to record the truth of the expeditions in their topographical and military details. This "true history," written in an unassuming, colloquial style enlivened by popular expressions, has important historical and artistic values and is a source book of idiomatic 16th-century Spanish. (I. L. Mc C.)

DÍAZ DE SOLÍS, JUAN: *see* SOLÍS, JUAN DIAZ DE.

DIAZO COMPOUNDS. A diazo compound is an organic substance containing two nitrogen atoms that are bonded together; one of the nitrogens is attached to a single carbon atom. Both aromatic and aliphatic diazo compounds are known.

AROMATIC DIAZO COMPOUNDS

The first known compound of this group was prepared by P. Griess at Marburg, Ger., in 1858. As Griess continued his work, first in London at the Royal College of Chemistry and later in the laboratories of Allsopp's brewery at Burton-on-Trent, the technical importance of the compounds became rapidly apparent, and by 1863 azo dyes derived from them were being manufactured and sold. Their multifarious reactions, which lead to aromatic compounds of a large number of types, soon made aniline and the simple aromatic amines in general the most important intermediates known and gave great impetus to technical organic chemistry and especially to the utilization of coal tar as raw material for manufacture.

Aromatic diazo compounds can exist in three distinct isomeric forms; the reasons for the structures given are summarized below. As usually prepared they are diazonium salts which contain the cation of a strong base, $(ArN{\equiv}N)^+ \ {}^-OH$, where Ar is an aromatic radical. The free bases are hardly known since in alkaline solution they change into the normal diazoates which contain the anion of a weak acid, Ar.N:N.OH; this is usually quite unstable. The normal diazoate ion can be converted by simple means into a more stable isomeric form, the isodiazoate ion. Lastly, the weak acid liberated from an isodiazoate by acetic acid is known to change in certain cases into a neutral form to which the structure of a primary nitrosamine, Ar.NH.NO, must be allotted. All these three last forms are reconverted into a diazonium salt by a mineral acid. In general, all forms of a diazo compound are unstable, the diazoate usually the most, though certain isodiazoates are sufficiently stable to be manufactured and sold as intermediates in dye manufacture. This instability has been a constant handicap in elucidating the structures of the isomeric forms.

The most important method of preparation is by the action of nitrous acid on a primary aromatic amine in presence of a mineral acid: $Ar.NH_2 + ONOH + HCl \rightarrow [Ar.N_2]Cl + 2H_2O$. If the solid diazonium salt is required, the reaction can be carried out by passing nitrous fumes into a paste of the amine hydrochloride and water; addition of alcohol and ether to the resulting solution precipitates the diazonium chloride.

For many years most chemists regarded diazonium formation as the result of interaction of nitrous acid and the arylammonium salt ($ArNH_3{}^+Cl^-$). It is true that hydrochloric acid does react with aniline to form a salt but an aqueous solution of this salt undergoes considerable hydrolysis into aniline. The purpose of the mineral acid is to convert nitrous acid into the nitrosyl positive ion ($HONO + H^+ \rightarrow H_2O + {}^+NO$) which then reacts with the free amine. One may interpret the mechanism in this way:

$$ArNH_2 + {}^+NO \xrightarrow{-H^+} ArNH{-}N{=}O \rightleftarrows ArN{=}N{-}OH \xrightarrow{H^+}$$

$$+ \qquad\qquad +$$

$$[ArN{=}NOH_2] \rightarrow H_2O + ArN{\equiv}N$$

The solid diazonium salts are explosive and are seldom prepared. Usually an aqueous solution suffices and is obtained by adding sodium nitrite to a solution of the amine in excess (two to three equivalents) of the mineral acid. The temperature must usually be kept below 10° C. during and after the reaction because of the

decomposition of the diazonium salt if warmed. Other methods of preparation are known; *e.g.*, the oxidation of salts of phenylhydrazine by mercuric acetate and the action of bromine on phenylhydrazine in alcohol; they have no practical importance, though they are interesting from the point of view of structure.

The chemical reactivity of the aromatic diazo compounds is the reason for their importance in the laboratory and in industry. Aromatic compounds in general can be nitrated with ease and the product reduced to the primary amine. Diazotization of this amine followed by a diazo reaction chosen to give the desired product is a method used in innumerable cases. The reactions can be divided into two classes, those in which the two nitrogen atoms are lost and are evolved as gaseous nitrogen and those in which they are retained in the molecule of the product. In the first class the diazo group is replaced by some other group. Examples are:

Replacement by hydroxyl, leading to a phenol, usually takes place easily by warming the aqueous solution of the diazonium salt:

$$[Ar.N_2]Cl + H_2O \rightarrow ArOH + N_2 + HCl$$

Side reactions may interfere, especially the coupling of the phenol with an undecomposed diazo compound, and this can be avoided by working in strongly acid solution or by passing steam into the solution to remove the phenol as formed.

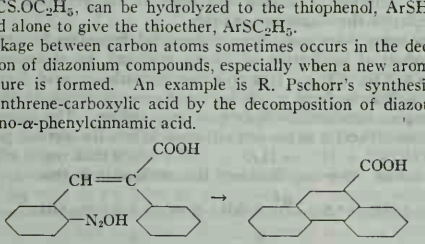
Replacement by hydrogen is brought about by reducing agents such as formic acid, hypophosphorous acid and sodium stannite. Addition of alcohol often gives the same result but sometimes the ethoxy compound, $ArOC_2H_5$, is formed together with, or instead of, ArH. This reaction is of value where an amino group has been introduced to act as a powerful directing group for some desired substitution. The amino group can later be eliminated by diazotization and replacement by hydrogen.

Replacement by a halogen takes place readily with iodide ion since diazonium iodides decompose spontaneously into nitrogen and the iodo compound. With chlorine the usual methods are to treat the diazonium chloride with cuprous chloride (Sandmeyer's reaction) or with finely divided copper (Gattermann's reaction). Similar methods are used for bromine. Fluorine is best introduced by precipitating the sparingly soluble fluoborate, $[Ar.N_2]BF_4$, by adding fluoboric acid to the solution. The dry fluoborate decomposes smoothly on heating into boron fluoride, nitrogen and the fluoro compound.

Replacement by cyanogen can be achieved by Sandmeyer's method, by use of a solution of cuprous cyanide in potassium cyanide. Since the product is a nitrile, it can be hydrolyzed to a carboxylic acid and the reaction is valuable for effecting the change $Ar.NH_2 \rightarrow Ar.COOH$. There is evidence to show that the reactions mentioned so far are those of the positively charged aromatic radical formed by loss of nitrogen from the diazonium cation.

Groups containing sulfur can be linked to the aromatic ring in a variety of ways and the processes are of technical importance since they give intermediates for the preparation of dyes containing sulfur. An example is to treat the diazo compound with potassium ethyl dithiocarbonate (xanthogenate). The product, $Ar.S.CS.OC_2H_5$, can be hydrolyzed to the thiophenol, ArSH, or heated alone to give the thioether, $ArSC_2H_5$.

Linkage between carbon atoms sometimes occurs in the decomposition of diazonium compounds, especially when a new aromatic structure is formed. An example is R. Pschorr's synthesis of phenanthrene-carboxylic acid by the decomposition of diazotized *o*-amino-α-phenylcinnamic acid.

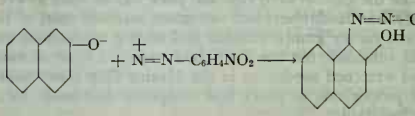


Of the second class of reactions, in which nitrogen is not lost, an example is reduction to a hydrazine, $ArNH.NH_2$; this is carried out with stannous chloride or sulfites and is the general method for preparing phenylhydrazine and related compounds. The most important example of this class is diazo coupling with anilines and phenols to produce azo compounds (*q.v.*). The industrially important azo dyes are prepared in this way. Coupling occurs by adding alkali to a mixture of the diazonium salt and phenol or aniline. Alkali converts the phenol into phenoxide ion and liberates the free aniline from its salt, following which these bodies react with the diazonium ion. The diazonium ion is a resonance hybrid of structures I and II:

$$Ar{-}\overset{+}{N}{\equiv}N: \longleftrightarrow Ar{-}\overset{+}{N}{=}\ddot{N}:$$

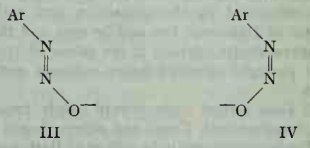
I II

In a strongly acidic medium, the ion usually reacts in accordance with structure I, but in a less acidic or in a basic medium it more frequently reacts in accordance with structure II. The terminal, electron-deficient nitrogen of the cation is attracted to the electron-rich ortho or para positions of the phenoxide ion or of the aniline as the azo bond is created. As an illustration, diazotized para nitroaniline couples in alkaline solution with 2-naphthol to give a red dye (para red) much used for cotton.



Coupling also takes place with aliphatic amines, phenolic ethers, aliphatic β-ketonic esters and β-diketones and with reactive unsaturated hydrocarbons such as isoprene. With most amides (as acetanilide) there is no coupling, but the 2-acetamido derivative of thiophene couples readily, even in acid solution. In some cases the product first formed is not the azo compound; thus primary amines, both aliphatic and aromatic, often give diazoamino compounds, Ar.N:N.NHR; such a product can, however, usually be transformed into the azo compound. Because of the technical importance of the reaction there is an enormous mass of empirical knowledge on the rates of coupling and conditions and factors which affect the reaction.

Constitution of the Aromatic Diazo Compounds.—The reasons for the structures of the various forms of a diazo compound which have been given above can be summarized as follows: a diazonium salt behaves as the salt of a strong base and resembles a salt of an alkali metal. The carbonate is soluble in water with an alkaline reaction. The salt must contain a cation similar to that of a quaternary ammonium salt and hence one nitrogen atom must be tetracovalent. Christian Blomstrand's view that this cation is $[Ar.\overset{+}{N}{\equiv}N]$ is clearly correct. As stated above, this structure is considered to be one of those which contribute to the state of the resonance hybrid. A second contributing structure is $ArN{=}N^+$, which is related to that of the normal diazoate, ArN=NONa, formed when the diazonium salt is treated with alkali in excess. Acidification of sodium benzenediazoate with a weak acid yields benzenediazoic acid, $C_6H_5N{=}NOH$. This is a weak acid like nitrous acid (O=NOH) to which it is structurally related. Heated with excess alkali, the diazoate is converted into the isodiazoate which, though more stable, resembles the normal diazoate in all its properties. The two anions must be geometrical isomers which can be represented by the formulas,



III IV

The main reason for this view is that a similar isomerism occurs in the diazo sulfonates, $Ar.N:N.SO_3K$, and the diazo cyanides, Ar.N:N.CN, and all these cases must almost certainly arise from a common cause which can only be geometrical isomerism. In the diazo cyanides careful study of the physical properties shows that any other type of isomerism is excluded. It also shows that the

more stable isomer has the *anti* configuration so that on the presumption that all the more stable forms have the same configuration the isodiazoate is the *anti*-diazoate (III) and the normal diazoate is the *syn*-diazoate (IV).

Acidification of III with strong acids changes it back to the diazonium form, whereas acidification with weak acids yields the *anti*-diazoic acid. The latter, $C_6H_5N{=}NOH$, is colourless. In chloroform solution it tautomerizes into a yellow, neutral isomer for which the nitrosamide structure is offered, $C_6H_5NH{-}N{=}O$.

Diazo compounds of the aromatic type occur not only in the benzene and naphthalene series, but also in many heterocyclic aromatic systems, as pyrazoles, thiazoles and triazoles. With pyridine and quinoline only the β-amino compounds can be diazotized.

ALIPHATIC DIAZO COMPOUNDS

If aliphatic amines such as carbethoxymethylamine (glycine ester), $C_2H_5OOC{-}CH_2{-}NH_2$, or cyanomethylamine (aminoacetonitrile), $NC{-}CH_2{-}NH_2$, underwent diazotization in the manner of aniline, the products would be diazonium salts $R{-}CH_2{-}N_2Cl$ ($R = {-}COOC_2H_5, {-}CN$); however, compounds with this structure are not formed. Instead, the structure is that of a substituted diazomethane, $R{-}CHN_2$, as if the elements of HCl had been detached from the RCH_2N_2Cl. This method fails in the synthesis of diazomethane itself or its homologs, since nitrogen gas is evolved instead on reaction of nitrous acid with simple aliphatic amines.

Thus, these aliphatic diazo compounds are sharply differentiated from the aromatic diazo compounds in that they show neither basic nor acidic properties. With the exception of diazomethane, which is used in the laboratory as a methylating agent, they have little practical interest, but the problem of the structure of the group was a subject of dispute for many years and was solved only when quantum mechanics gave a clearer picture of chemical valence.

There are three chief methods for obtaining these compounds:

1. Reaction of substituted nitrosamides with alkali:

$$X{-}N(CH_3){-}NO + KOH \rightarrow X{-}OK + CH_2N_2 + H_2O$$

Nitrosamides used in this approach are *p*-tosylmethylnitrosamide (X = tosyl), carbethoxymethylnitrosamide or N-methyl-N-nitrosourethan (X = carbethoxy), carbamylmethylnitrosamide (X = carbamyl) and others. By substituting other groups for methyl, *i.e.*, by starting with $X{-}N(CH_2R){-}NO$, one may obtain other aliphatic diazo compounds. For example, if CH_2R is ethyl there is formed diazoethane CH_3CHN_2, and if it is allyl there is formed vinyldiazomethane $CH_2{=}CHCHN_2$.

2. Reaction of α-amino ester, α-amino nitriles and α-amino ketones with nitrous acid. This was the method used by T. Curtius in 1883 to prepare the first aliphatic diazo compound, namely, diazoacetic ester, $N_2CH{-}COOC_2H_5$, from ethyl aminoacetate. Diazomethane itself was not discovered until 1894.

3. Oxidation of the hydrazones of aldehydes and ketones. Thus, diphenyldiazomethane, $(C_6H_5)_2CN_2$, is obtained by shaking benzophenone hydrazone with yellow mercuric oxide in cold hexane for six hours.

The aliphatic diazo compounds vary in stability over a wide range. Those with hydrocarbon residues attached to the diazo group are coloured and unstable; those with a carbonyl or carbethoxy group on the next carbon atom, such as diazoacetic ester, are paler yellow and more stable while those with two such groups, as $C_6H_5CO.CN_2COCH_3$, are colourless and comparatively unreactive, so much so that at one time they were allotted a different constitution. Diazomethane is a deep yellow gas boiling at $-23°$ C.; higher members are liquids or low-melting solids. Nearly all explode on rapid heating but are reasonably stable in solution. A solution of vinyldiazomethane is wine red in colour, but on standing for several hours it becomes colourless because of isomerization to pyrazole.

Aliphatic diazo compounds react readily with carboxylic acids causing esterification, an example being the quantitative conversion of benzoic acid into methyl benzoate by means of diazomethane. Phenols and imides react similarly, with evolution of nitrogen, but as a rule alcohols fail to react with diazomethane unless catalyzed by aluminum ethoxide.

Diazomethane reacts at the carbonyl group of aldehydes and ketones to give either ethylene oxide derivatives or homologous ketones. Acid chlorides, R—CO—Cl, react similarly with diazomethane at the carbonyl group to yield any one of three types of products, depending on experimental conditions: a chloromethyl ketone $R{-}CO{-}CH_2Cl$, an acyldiazomethane $R{-}CO{-}CHN_2$ or the homologous acid $RCH_2{-}CO{-}OH$.

Unsaturated compounds, as acetylenes or dienes, frequently add to diazomethane with no loss of nitrogen, yielding pyrazoles or pyrazolines. The structure of the characteristic group $>CN_2$ was a matter of controversy for many years. Curtius in 1883 proposed the formula

which was accepted until A. Angeli in 1907 pointed out that the relationship to hydrazones, both in oxidation and reduction, was evidence for a straight chain formula, written as $>C{=}N{\equiv}N$.

Electron diffraction by diazomethane vapour (H. Boersch, 1935) shows beyond doubt that the straight chain is correct. In modern representation the linear structure of diazomethane is represented as $CH_2{=}\overset{+}{N}{=}\overline{\underset{\cdot\cdot}{N}}$; other structures contributing to the state of the resonance hybrid are $\overline{\underset{\cdot\cdot}{C}}H_2{-}\overset{+}{N}{\equiv}N{:}$ and $CH_2{=}\underset{\cdot\cdot}{\overset{+}{N}}{-}\underset{\cdot\cdot}{N}{:}$.

Isodiazomethane, of structure $H{-}C{\equiv}\overset{+}{N}{-}\overline{N}H$, is produced from diazomethane by reaction with methyl-lithium, followed by treatment of the lithium derivative ($LiCHN_2$) in ether with potassium dihydrogen phosphate. The colourless isodiazomethane in ether solution reacts with acids (RCOOH) to yield N-acyl-N′-formyl-hydrazine, $RCO{-}NH{-}NH{-}CHO$.

(T. W. J. T.; C. D. Hd.)

DIBDIN, CHARLES (1745–1814), British composer, author, actor, theatrical manager and entertainer, was born in Southampton and baptized on March 4, 1745. From 1756 to 1759 he was a chorister at Winchester cathedral and in 1760 he went to London and worked for a music publisher, but decided to try his luck on the stage and began his career at Richmond in 1762. He secured an engagement at Covent Garden, where his first operetta, *The Shepherd's Artifice*, was performed in 1764. He made a hit the following year as Ralph in Samuel Arnold's *The Maid of the Mill* and in 1768 produced his first great success, *The Padlock*, at the Drury Lane theatre. Later came *The Waterman* (1774) and *The Quaker* (1775). Dibdin then spent two years in France (1776–78). He was always restless and often irascible, and as a result many of his theatrical ventures ended in quarrels. In the 1783 season he had a short success as manager of the Royal Circus (later the Surrey theatre). His ballad opera *Liberty Hall*, which included the popular song "The Bells of Aberdovey," was produced at Drury Lane in 1785. He went on a tour of England (1787–88) to raise money for a projected visit to India, which never came about. Next he devoted his talents to his celebrated one-man "table entertainments," at which many of his famous sea songs were first heard; the best-known of all is the elegaic "Tom Bowling," said to have been written in memory of his brother. In these Dibdin appeared as author, composer, singer and accompanist. In 1803 the government granted him a pension in recognition of his services as a writer of patriotic songs during the Napoleonic Wars. He died in London on July 25, 1814.

Dibdin wrote about 100 dramatic pieces and about 1,400 songs, often to his own words, and a number of instrumental works. He also published *The Musical Tour of Mr. Dibdin* (1788), *The Professional Life of Mr. Dibdin*, four volumes (1803), *A Complete History of the English Stage*, five volumes (1800), and various music textbooks and several novels. As a composer he was largely self-taught, and his technique was always rather clumsy. It is as a composer of songs that his reputation must stand or fall. He was a born melodist and knew how to write a song that suited the

voice. Some of his best tunes occur in his operas, and led to 20th-century revivals of some of his stage works, including *The Waterman, The Recruiting Sergeant, The Padlock* and *Lionel and Clarissa.*

See E. R. Dibdin, *A Charles Dibdin Bibliography* (1937).
(Cs. Ch.)

DIBDIN, THOMAS FROGNALL (1776–1847), English bibliographer who helped to stimulate interest in bibliography by his own enthusiastic though often inaccurate books, by his share in founding the first English private publishing society and by his beautifully produced catalogue of Lord Spencer's private library. Born in Calcutta and educated at St. John's college, Oxford, Dibdin began a legal career, but took orders in 1805. His *An Introduction to the knowledge of rare and valuable editions of the Greek and Latin Classics* (1802) attracted the notice of Lord Spencer, through whose patronage he became in 1824 rector of St. Mary's, Bryanston square, London, where he remained until his death, Nov. 18, 1847. Lord Spencer also employed him to catalogue and augment his library at Althorp (which later formed the basis of the Rylands library, Manchester). His *Bibliotheca Spenceriana* (1814–15) became famous as an example of fine printing. Dibdin traveled widely in search of books and manuscripts and his *Bibliographical, Antiquarian and Picturesque Tour in France and Germany* (1821) is typical of his work in containing much lively anecdote, many errors of fact and excellent engravings.

His *Bibliomania* (1809) contributed to the passion for old and rare books which reached a peak in the famous Roxburghe sale (1812), to commemorate which Dibdin proposed a dinner for bibliophiles from which developed the Roxburghe club.

DIBDIN, THOMAS JOHN (1771–1841), English actor, dramatist and song writer, best known for the songs "The Oak Table" and "The Snug Little Island," was born in London, March 21, 1771, the illegitimate son of Charles Dibdin (*q.v.*), by the actress Harriet Pitt. He was apprenticed to a London upholsterer, then to William Rawlins, later sheriff of London, but ran away to join a company of actors. Returning to London in 1795, he became prompter and joint stage manager at Sadler's Wells theatre and was later prompter and pantomime writer at Drury Lane theatre. In 1816 he took the Surrey theatre, but this proved disastrous. After this he managed the Haymarket theatre but without success. He died in London, Sept. 16, 1841.

Dibdin was a prolific writer of operas, comedies, farces and pantomimes, and composed many songs. These works brought him great popularity and the theatres great profits. His pantomime *Mother Goose* (1807), in which Grimaldi appeared as clown, is said to have brought over £20,000 to Covent Garden, and another pantomime, *The High-mettled Racer* (1812), adapted from his father's play, £10,000 to the Royal amphitheatre. He wrote nearly 200 plays and operas, and published several collections of songs.

See *Reminiscences of Thomas Dibdin* (1827).

DIBELIUS, MARTIN (1883–1947), German biblical scholar, one of the originators of "form criticism" in New Testament studies (*see* Exegesis and Hermeneutics, Biblical), was born in Dresden on Sept. 14, 1883. He became New Testament *Privatdozent* at Berlin (1910) and then professor of New Testament at Heidelberg (1915), where he remained till his death on Nov. 11, 1947.

Dibelius' first publications on the demons and spirits in Paul's theology (1909) and on John the Baptist (1911) showed the connection of two questions that remained characteristic for his work: the search for the oldest tradition by literary analysis and observation of the form of the individual tradition and the religio-historical derivation. Both interests were united in the exegesis of the Epistle of James (1921), whose connection with Jewish hortatory literature he proved, and in the analysis of the forms of the tradition in the Synoptic Gospels, *Die Formgeschichte des Evangeliums* (1919; 2nd ed. 1933; Eng. trans., *From Tradition to Gospel*, 1934). In this work, which gave the name to a new method of investigation, Dibelius tried not only to sort out the individual items of the oral tradition from the written gospels but also to draw inferences about the genesis and the original sense of those traditions by studying the motives that governed the forming of the traditions. He applied this method to other parts of the New Testament, especially Acts, and investigated the ethical teaching of the New Testament, working at these questions in connection with the theological research of the ecumenical movement. His books on Jesus (1939; Eng. trans. 1951) and Paul (1951; Eng. trans. 1953) are valuable representations for the general reader.

See list of Dibelius' works in "Bibliographia Dibeliana atque Bultmanniana," *Conjectanea Nestestamentica*, vol. viii, pp. 1–22 (1944). *See* also memorial notice by W. G. Kümmel in *Theologische Literaturzeitung*, vol. lxxiv, pp. 129–140 (1949). (W. G. Kü.)

DICAEARCHUS (fl. *c.* 320 B.C.), of Messene in Sicily, Peripatetic philosopher, was a pupil of Aristotle. Neglecting systematic philosophy as did most Peripatetics of his generation, he cultivated special branches of knowledge, including the history of literature and of music, biography, political science and geography. Under the title *Bios Hellados* ("Life of Greece") he wrote a history of Greek civilization from the beginning; in another monograph he seems to have characterized Sparta as a happy mixture of monarchy, aristocracy and democracy, thus foreshadowing Polybius' interpretation of Rome and its stupendous rise. In psychology he shared the anti-Platonic view of Aristoxenus that the human soul is mortal.

See the fragments ed. by F. Wehrli, *Dikaiarchos* (1944), part i of *Die Schule des Aristoteles: Texte und Kommentar;* also "Dikaiarchos" in Pauly-Wissowa, *Realencyklopädie der klassischen Altertumswissenschaft*, v (1903). (F. Wi.)

DICE, small cubes used in gaming, each individual cube being called a die. Usually the six faces of the die are marked with a number of small dots, from one to six. The dots are arranged in conventional patterns and placed in conventional relative locations, thus: the dots on the opposite faces must always total seven, one opposite six, two opposite five, three opposite four. When the visible vertical face is two and the top face is four, then six must be to the left and one to the right. These conventional locations have no significance in games, and mathematical probabilities applying to dice are constant so long as no two faces of a die are similarly marked.

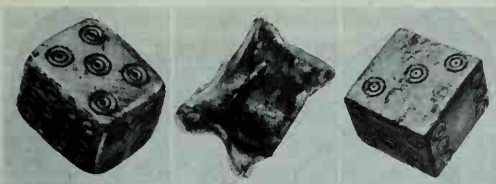
In all games played with dice, the dice are cast (or thrown, or rolled, or shot, or tossed) in such a way that they will turn at random in the air and then come to rest on some flat surface. The combination of the topmost surfaces of the dice decides, according to some predetermined pattern, whether the caster wins or loses.

Dice in various forms are the oldest gaming implements known to man, and innumerable games are and have been played with them. Craps, the most popular gambling game of the U.S., is played with two dice; chuck-a-luck, another popular gambling game, with three dice; in more social play there are poker dice, played with five dice, and various games, notably yacht and Cameroons, played with ten. In backgammon, parcheesi (pachisi) and hundreds of "track games" two or more dice are cast to determine the moves.

The forms of dice are almost as varied as the games played with them. Like many other gaming implements (*see* Gambling) dice apparently evolved independently in many primitive societies and ethnic groups. Sophocles' attribution of the invention of dice to Palamedes, a Greek, during the siege of Troy and Herodotus' attribution to the Lydians have been discredited by numerous archaeological finds. Cubical dice with markings practically equivalent to those of modern dice have been found in Egyptian tombs dated earlier than 2000 B.C. and in Chinese excavations dated as early as 600 B.C.; dice are mentioned also in the Rigveda.

American Indians, both north and south, used waferlike dice having only two effective faces. Perhaps the earliest gaming implements equivalent to dice were knucklebones (the anklebones of sheep), marked on four faces and used in games of chance or skill long before the times of written history. Similarly pyramidal dice, and also pentahedral and octahedral dice, have been used.

The first use of dice may have been for religious purposes (divination) and for lottery; the markings on early Korean and



BY COURTESY OF THE SMITHSONIAN INSTITUTION

FIG. 1.—(LEFT) EGYPTIAN DIE REPUTED TO BE FROM THE TOMB OF OSIRIS, ABYDOS, EGY.; (CENTRE) CHINESE DIE OR KNUCKLEBONE; (RIGHT) ETRUSCAN DIE FROM CHIUSI, ITALY

Chinese dice have led some scholars to that conclusion, but there is no evidence as to whether the gaming or the divinatory use was earlier. In ancient times and in primitive societies dice were most often cast from receptacles (now called dicecups) and this practice has persisted in many games but has been generally abandoned in craps. The ancient Greeks cast dice from conical beakers and the ancient Romans from cylindrical vessels similar to modern dicecups. American Indians wove special baskets, usually about 10 in. in diameter, in which they tossed their dicesticks.

Modern dice are almost all made of a cellulose or other plastic material. They are sawed from extruded rods of the material and the best dice must be within .003 in. of perfect cubes. The dots are stamped into the faces of the dice and often are then coated or filled with a paint. The most popular dice are transparent, which is considered to give protection against "loading" (introduction of a heavy metal into the dots so that one face will be most likely to come to rest downward). The corners of the dice may be rounded; but square corners are usually preferred. The earliest Asiatic and Mediterranean dice were made of bone, but ivory, wood, stone, metals, glass, amber and jade and gem stones, and even plum pits, nutshells, teeth and an almost unlimited variety of other materials have been used.

Specially made dice for cheating have been found in some of the most ancient excavations. They were not much different from "crooked" dice whose manufacture and sale is a flourishing modern business. "Loaded" dice have been mentioned. Dice that are not "square" (not perfect cubes) will tend to land more often on certain faces than on others. Dice with certain faces duplicated and certain numbers omitted will tend to produce some numbers in disproportionate frequency and never to produce certain other numbers; for example, two dice marked respectively with duplicates of 3–4–5 and 1–5–6 can never produce combinations totaling 2, 3, 7 or 12, which are the only combinations with which one can lose in the game of craps. Such dice, called "tops," must be introduced into the game by sleight of hand and so are used only by accomplished practitioners of cheating. Since it is impossible to see more than three faces of a die at any one time, mismarked dice are unlikely to be detected except by a suspicious person.

Cheating at dice is possible also by the exercise of manual skill on "square" dice. The cheater may cause one die to slide, so that its top face when it comes to rest will be the same as when it left his hand; or he may cause one or both dice to roll straight ahead, so that the two faces at the sides of each die cannot appear at the top. Such manipulations affect the mathematical probabilities and permit the cheater to make favourable bets. In many games a person may win by no other expedient than superior knowledge of the probabilities; his method is to make only bets that give him a mathematical advantage. Though this may objectively be considered an exercise of skill, which is deemed legitimate in other games, in most dice games it is considered unethical to exploit such an advantage.

Probabilities.—Assuming the use of square dice, skill in dice games consists solely in knowing the mathematical likelihood that any total number will appear when two or more dice are cast at random. The ultimate probabilities are subject to the theory of combinations and permutations, but in most dice games they can be ascertained by application of the most simple arithmetic. The basic assumption is that any one face on each die is as likely to appear face up as any other face. Given a standard six-faced die, when one tosses it there is one chance in six that any specified face will appear, which is to say that the odds are 5 to 1 against the appearance of any specified face. When two dice are used, the number of ways in which the faces can appear is $6 \times 6 = 36$. In these 36 combinations there is only one combination (1–1) that will produce the result 2, and 35 that will not, so the chances are 35 to 1 against casting a 2. There are 6 combinations that will produce 7 (4–3, 3–4, 5–2, 2–5, 6–1, 1–6) and 30 that will not, so the odds against casting a 7 on any particular cast are 30 to 6, which is 5 to 1. When three dice are cast, as in chuck-a-luck, the combinations are $6 \times 6 \times 6 = 216$; when four dice are cast the combinations are $6 \times 6 \times 6 \times 6 = 1{,}296$; and so on. The chances of success are calculated by comparing the number of favourable casts with the number of unfavourable casts. For example, the only casts that will produce the total 5 with four dice are 1–1–1–2, 1–1–2–1, 1–2–1–1 and 2–1–1–1, making the odds 1,292 to 4, or 323 to 1, against such a cast.

GAMES PLAYED WITH DICE

Craps.—Early in the 20th century craps replaced faro (*q.v.*) as the principal gambling game of the United States. The game of craps is played in all U.S. gambling houses and has been introduced into several European casinos including that at Monte Carlo. Its popularity with U.S. military personnel caused it to spread to many other parts of the world during World Wars I and II.

The name craps derives from a nickname of the cast 1–1, which was called "crabs" at least as early as the 16th century. The modern rules of craps grew out of an old English dice game called hazard (*q.v.*). There are considered to be three ways to play craps (in U.S. idiom invariably called crapshooting or shooting crap); they are respectively called a crap game (all participants amateurs, with no common gambler present), bank craps (the gambling house game, in which all bets must be made against the house) and open craps, a game in which the players are permitted to bet among themselves but a common gambler is present to serve as arbiter and to accept (on his own terms) any bet that a player is unable to place with another player. In bank craps and open craps, the proprietor fixes the rules so that he has a mathematical advantage on every bet, but usually this advantage is quite small (for example 1.4%) and is not objectionable to the players.

The bank craps game requires a special table, in size and form not unlike a billiard table, which includes a layout or marked area in which players may place their bets and an open area in which the dice are thrown. In open craps a layout is used, but no other special equipment. In an amateur crap game the players stand or sit in a circle, in the centre of which the bets are placed and the dice are thrown.

The following rules apply to all forms of craps:

Two matched dice are used. One player, the shooter, "has the dice." He bets whatever amount he wishes. Any other player may "fade" (accept, or cover) all or any part of this bet. When the entire bet has been faded (or when the shooter has "dragged down" any part of the bet that was not faded or that he wishes to withdraw), the shooter rolls the dice.

On the first roll, if the uppermost faces of the dice total 7 or 11 (a "natural"), the shooter wins; if they total 2, 3 or 12 ("craps"), the shooter loses but remains the shooter ("keeps the dice") and may place another bet. If on the first roll the total is 4, 5, 6, 8, 9 or 10, the respective number becomes the shooter's "point." He continues to throw the dice until his point appears again, in which case he wins, or until a seven appears, in which case he is said to "miss," "missout," "seven out" or "crap out"—he loses the bet and the dice, and the man at his left becomes the next shooter.

Every time the shooter wins a bet either by throwing a natural on the first roll or by "making a point," he is said to "pass" or "make a pass." After each pass, the shooter may drag down, taking part of his winnings and leaving the rest for his next bet; "let it ride," betting his original stake plus all his winnings; or withdraw all his money and "pass the dice" (let the next player in turn become the shooter). A player is said to be "right" when he wins and "wrong" when he loses.

There are no official rules for any dice game, but the following are generally accepted in amateur games:

1. When the dice have come to rest, they must not be touched until the shooter and all who faded him have had an opportunity to see them.

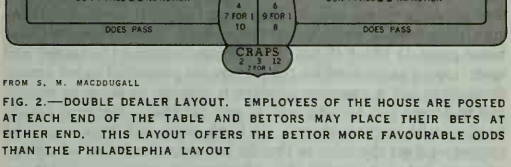
2. If either die rolls outside the playing area (formed by the circle of players) or is "cocked" (leaning against a foreign object) the cast is void.

3. Any player who has faded part of the bet may intercept either die before it comes to rest, in which case the cast is void. It is usual to say "No dice" when stopping a die.

4. The player who last lost the dice has the first privilege of fading as much as he wishes of the next shooter's bet.

In bank craps the equipment makes the first two of these rules unnecessary, but it is invariably required that the dice be thrown over a string or wire stretched across the table a few inches above its surface, or that the dice strike a wall of the table and bounce back. The third rule is not used and the fourth is inapplicable because all bets must be placed against the house. Bets are usually made with chips but sometimes with cash, and a player signifies his bet by placing (before any roll) the chips or cash on the appropriate part of the layout.

The shooter, or anyone wishing to bet that the shooter will win, places his bet "on the line" (in the area marked DOES PASS in fig. 2, LINE in fig. 3 or WIN on some layouts). Anyone betting against



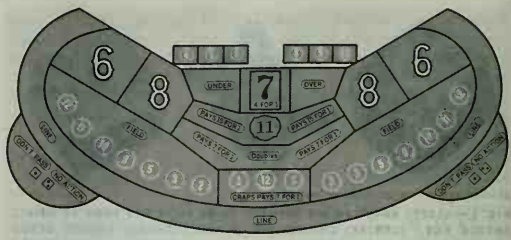
FROM S. M. MACDOUGALL

FIG. 2.—DOUBLE DEALER LAYOUT. EMPLOYEES OF THE HOUSE ARE POSTED AT EACH END OF THE TABLE AND BETTORS MAY PLACE THEIR BETS AT EITHER END. THIS LAYOUT OFFERS THE BETTOR MORE FAVOURABLE ODDS THAN THE PHILADELPHIA LAYOUT

the shooter places his bet in the area marked DON'T PASS. Anyone wishing to bet on a special contingency, such as that craps (2, 3 or 12) will or will not be thrown on the next roll, places his bet in the appropriate space in the layout; such bets are called proposition bets. A bet on the "field" is a bet that one of the numbers shown in that area will come up on the next roll. A "come bet" is a bet that the shooter will win, treating his next roll as the first, whether or not it actually is his first roll. "Point bets" are bets that the shooter will make his point, after his first roll has proved not to be a natural or craps.

In every bet, the house retains a mathematical advantage. The odds against the shooter's winning are 251 to 244, so that the shooter is always at a disadvantage of 1.41%, which means that of every $100 he bets he will lose an average of $1.41. The player who fades has a reciprocal advantage, but to offset this the gambling house provides that there shall be a standoff, or "no action," on either the 1–1 or the 6–6 first roll (one or the other, but not both). When such a number appears, instead of winning the player may merely withdraw his bet. With this special rule the house has about 1.4% advantage even when a player "bets wrong" (bets against the shooter).

The exact odds are 6 to 5 that the shooter will not make his point if it is 6 or 8, but the house offers even money; 3 to 2 that he will not make his point if it is 5 or 9, but the house offers 7 to 5; 2 to 1 that he will not make his point if it is 4 or 10, but the house offers 5 to 3. On all the other bets the house reserves an even greater advantage. The "hard way" or "gag" bets are bets by the gambling house that the shooter will not make a point of 6 with 3–3, a point of 8 with 4–4 (in each case the mathematical odds are 10 to 1 but the house bets 9 to 1), a point of 4 with 2–2 or a point of 10 with 5–5 (in each case the mathematical odds are 8 to 1 but the house bets 7 to 1).



FROM S. M. MACDOUGALL

FIG. 3.—THE PHILADELPHIA LAYOUT IS USED IN GAMBLING HOUSES WHERE THE PATRONS ARE NOT WELL-INFORMED ON THE PROPER ODDS IN CRAPS. THE TERM "FOR" IN QUOTED ODDS MEANS THAT THE PAYOFF INCLUDES THE BETTOR'S STAKE AND IS NOT IN ADDITION TO IT

Some gambling houses use the so-called Philadelphia layout (*see* fig. 3), which reserves a far greater advantage to the house. The cast 1–2 instead of 1–1 or 6–6 is barred (a standoff), increasing the house advantage to 4.13%; and bets are quoted as, for example, 7 *for* 1, which is equivalent to odds of 6 *to* 1 because the payoff of seven includes the original bet of one.

There are many special bets offered by gambling houses and by individuals at amateur and open games. The disadvantage in accepting such bets is considerably greater than the disadvantage when betting only on the shooter to win or to lose. (A. H. MD.)

Chuck-a-Luck.—This gambling game is played chiefly in the western hemisphere. A layout numbered from 1 to 6 inclusive, a table, three dice and a dicecup are the essentials. The dice may be kept in a wire cage shaped like an hourglass. When the cage is reversed the dice fall through the centre opening to the bottom half. In this form the game is often referred to as the bird cage. The dice may also be dropped through a cone-shaped chute, made of leather or metal and called a "horn," to come to rest on the table within the base of the chute. The chute is then lifted to reveal the faces of the dice. The term "tin horn gambler" derives from gamblers who set up games of chuck-a-luck with scant capital and a metal chute, which was cheaper than a leather one.

Players may bet any amount within the minimum and maximum limits on one or more of the six numbers. When all bets are down the dice are thrown or dropped through the chute, or the wire cage is upended. The uppermost faces of the three dice determine the outcome. If the player's selected number shows on one die, he wins the amount he wagered; if on two dice, he wins double; if on three dice, he wins triple. The house breaks even when three different numbers are thrown; averages a profit of one unit when a pair and a single are thrown; averages a profit of two units when three of a kind are thrown. This amounts to 7.87% of the total.

Crown and Anchor.—A game much played in Canada, uses the same equipment as chuck-a-luck except for the markings on the dice. Instead of dots, the six sides bear various symbols: anchor, crown, club, diamond, heart and spade. The layout used displays these same symbols. Method of play, amount of payoff and house percentage are identical with chuck-a-luck.

Hazard.—This is the game from which chuck-a-luck evolved. In the United States almost all houses with hazard layouts refer to the game as chuck-a-luck. This game of hazard should not be confused with the old English and French game of hazard from which the dice game craps evolved (*see* HAZARD).

The only material difference between hazard and chuck-a-luck is in the layout. (*See* fig. 4.) Besides the six chuck-a-luck numbers the hazard layout provides spaces for wagering on odd or even; on high or low; on triples (called raffles); and on any number the dice may total, from 4 to 17. Three, the lowest number possible, and 18, the highest number possible, can only be made with triples so they are not included in the regular line.

The payoff on single numbers is the same as in chuck-a-luck. A player betting on high, low, odd, or even, collects even money if he wins. The banker's advantage lies in the fact that he does not pay off if triples show. There are 216 possible combinations of 3 dice, 6 of which are triples. On this type of bet the house

advantage is 2.78%. If a player bets that any three of a kind will come up, he collects 30 to 1. (Correct odds—35 to 1; house advantage—13.9%.) If he bets that a particular triple will show, and he wins, he collects 180 to 1. (Correct odds—215 to 1; house advantage—16.2%.) The percentage in favour of the house when a player bets on any particular number varies considerably, as shown by this table.

Combination	*Actual Odds*	*House Pays*	*House Advantage*
4 or 17	71 to 1	60 to 1	15.3%
5 or 16	35 to 1	30 to 1	13.9%
6 or 15	23 to 1	18 to 1	20.8%
7 or 14	67 to 5	12 to 1	9.7%
8 or 13	65 to 7	8 to 1	12.5%
9 or 12	8 to 1	6 to 1	22.2%
10 or 11	7 to 1	6 to 1	12.5%

To explain how the percentages are figured: suppose the chosen number is 6. There are 10 ways to make 6 with three dice—1–1–4, 1–4–1, 1–2–3, 1–3–2, 2–2–2, 2–1–3, 2–3–1, 3–1–2, 3–2–1, 4–1–1. The house does not pay off when 6 is made with three deuces, leaving 9 winning combinations for the player. There are 216 possible combinations. Deduct the 9 winning combinations. The odds are 207 to 9, or 23 to 1. The house pays

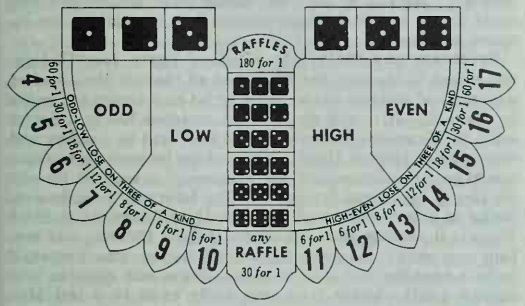


FIG. 4.—LAYOUT USED FOR HAZARD

18 to 1. The difference between these two figures—24 for the house, 19 for the player—constitutes the house "edge" (advantage)—$\frac{5}{221}$ of 100 is 20.8%. (S. M. M.; A. H. Md.)

Barbooth or Barbudi.—This is a two-dice game of Balkan and Levantine origin. It is much played in the U.S., chiefly by persons of Greek, Armenian and Syrian ancestry. Alone among popular dice games it provides no mathematical advantage for any player or for the gambling house. It is commonly played in gambling houses that charge fees (usually 2½% of the amount bet) for providing the space and equipment for the game.

Two persons play against each other. Each in turn casts two dice from a dicecup. If a player casts 3–3, 5–5, 6–6 or 6–5, he wins; if he casts 1–1, 2–2, 4–4 or 1–2, he loses. All other casts are meaningless. The shooter has the right to cover the stakes, which are named by his opponent; if he leaves any part uncovered other players may take it and the other players may also bet among themselves as to which shooter will win or lose. After each bet is decided, the losing shooter passes the dice to the player at his left, who becomes the shooter against the player who won the preceding bet.

4, 5, 6 or See-Low.—This is one of the most popular games of the U.S. and Canadian Pacific northwest and among members of the U.S. armed services. It is derived from a Chinese game several hundred years old, called Sz' 'ng Luk ("Sing luck").

Three dice are used. Each player in turn may be the banker, or one person may be a permanent banker (the latter arrangement is unusual, because the banker has an advantage). The banker stakes some amount of money and each player in turn to his left may cover any portion of his stake not already covered.

The banker casts the dice first. If he casts any three of a kind (such as 1–1–1), or any pair plus 6 (such as 2–2–6), or 4–5–6, he wins all bets. If he casts 1–2–3 or any pair plus 1 (such as 5–5–1), he loses all bets. If he casts any pair plus 2, 3, 4 or 5 (such as 5–5–2), the unpaired number is his "point." All combinations except the ones stated are meaningless and the banker casts again.

If the banker gets a point, each other player in turn to the banker's left rolls the dice to determine the outcome of his bet against the banker. The winning and losing numbers are the same for each such player as for the banker (three of a kind, 4–5–6 or a pair plus 6 wins; 1–2–3 or a pair plus 1 loses). If the player gets a point and it is higher than the banker's point, he wins; if it is lower than the banker's point, he loses; and if it is the same as the banker's point, the bet is called off.

The banker's advantage lies in the fact that there are more winning than losing combinations and he has the first chance to roll them; in 162 bets he should win 83 and lose only 79, giving him an advantage of about 2.47%.

Poker Dice.—Five standard dice may be used, but there are also special dice whose six faces are marked as playing cards, with ace, king, queen, knave (jack), ten and nine. Each player may cast three times, and after each cast he may leave any number of dice standing and cast the remaining dice. The faces of the dice at the end of his third cast are his "hand." The rank of the hands is the same as in poker (*q.v.*), except that there are no flushes and, in most games, straights do not count; in the version generally known as Horses (played in taverns for drinks) five aces lose.

Liar Dice.—A form of poker dice, popular in the U.S. army, in which a screen divides the two contestants. After casting the dice as in poker dice, a player announces the best poker hand he can make, but his announcement need not be truthful. His opponent may roll for a higher hand, or challenge the announcement, in which case the player must reveal his dice and he wins if his announcement was correct, loses if it was not.

Yacht, Other Ten-Dice Games.—In a number of games in which ten dice are used, the procedure is much the same as in poker dice. Each player has five casts. After each cast he may leave standing such dice as satisfy him and cast the rest. Various dice combinations are assigned scoring values. The ten dice faced at the end, scored by the rules of the game, determine the player's standing.

Twenty-Six, Other Counter Games.—In midwest U.S. and in some other parts of the country, taverns have dice games in which customers may play, for a small fee such as 25 cents, to win checks or tokens that can be cashed for drinks, cigarettes or other merchandise. The most popular such game is "Twenty-six." The player selects any number from one to six before he begins to cast the dice. He then throws ten dice 13 times. If his number appears 26 or more times he wins; if it appears fewer than 26 times he loses. The player's expectancy is to throw his number only $21\frac{3}{7}$ times in 13 casts, so that on each 25 cents bet against it the house should make a profit of $4\frac{1}{7}$ cents.

Other popular counter games are "Bingo," a two-dice game; "Klondike," a five-dice game similar to poker dice except that the house wins in case of a tie; and "Qualify," a game similar to poker dice except that the player tries to reach a total of 25 points, counting the spots on the dice thrown. In all such games except Qualify the house has an advantage; the game of Qualify is used chiefly to stimulate sale of merchandise.

Bibliography.—John Scarne and Clayton Rawson, *Scarne on Dice*, the definitive work (1945); A. Morehead, Richard L. Frey and G. Mott-Smith, *New Complete Hoyle* (1958); Michael MacDougall, *MacDougall on Dice and Cards* (1944). (A. H. Md.)

DICENTA, JOAQUÍN (1863–1917), Spanish dramatist and journalist, whose *Juan José* (1895), a simple yet powerful tragedy of jealousy with class-war overtones, was one of the greatest Spanish theatrical successes of the 19th century. Born in Calatayud, and baptized on Feb. 3, 1863, he spent most of his somewhat bohemian life in Madrid and died in Alicante, Feb. 20, 1917. His first play, *El suicidio de Werther* (1888), was a conventional verse drama in the romantic manner of José Echegaray, but *Los irresponsables* (1890) and *Luciano* (1894) caused scandal by their treatment of matrimony. After the success of *Juan José*, he found subsequent similar works less remunerative and turned to writing

lighter forms of entertainment, but he never entirely abandoned his mission as social dramatist, as is shown by the naturalistic mass drama, *Daniel* (1907). (H. B. Hl.)

DICENTRA, a genus of perennial herbs of the fumitory family (Fumariaceae) that includes the familiar garden plants bleeding heart (*D. spectabilis*) and dutchman's breeches (*D. cucullaria*). *See* Bleeding Heart; Dutchman's Breeches.

DICEY, ALBERT VENN (1835–1922), English jurist and author of a standard and seminal work on constitutional law. Born at Claybrook hall, near Lutterworth, Leicestershire, on Feb. 4, 1835, and educated at Balliol college, Oxford, he became a fellow of Trinity college in 1860, and was called to the bar of the Inner Temple in 1863. He became first Vinerian professor of English law at Oxford, and a fellow of All Souls, in 1882, and took silk in 1890. He retired from his academic posts in 1909, but continued to practise until 1916. He died at Oxford, April 7, 1922.

Dicey's *Introduction to the Study of the Law of the Constitution* (1885) took its rise from his professional lectures, and revealed his knowledge of both English and U.S. constitutional law. A series of lectures at Harvard (1898) formed the basis for another authoritative book, *Lectures on the Relation between Law and Public Opinion in England during the 19th Century* (1905). That detailed knowledge did not prevent him from relating specific problems to wider issues is also revealed in *A Digest of the Law of England with Reference to the Conflict of Laws* (1896). Clarity of thought and brilliance of exposition combined to make his works classics in their kind. A determined opponent of Home Rule for Ireland, he also published political works in support of Liberal Unionism.

His elder brother, Edward James Stephen Dicey (1832–1911), was a noted journalist and writer on foreign affairs. As special correspondent and leader-writer for the *Daily Telegraph* (1862–69), and editor of the *Observer* (1870–89), he exercised considerable influence on public opinion, and his descriptive skill, easy manner and shrewd judgments gave his many books, based on his journalistic travels, considerable popularity.

DICHOTOMY, literally a cutting asunder, the technical term for a form of logical division, consisting in the separation of a class into two subclasses, one of which has and the other has not a certain quality or attribute (Gr. *dicha*, "apart"; *tome*, "cutting"). Men may be thus divided into white men and men who are not white; each of these may be subdivided similarly. On the principle of contradiction this division is both exhaustive and exclusive; there can be no overlapping, and no members of the original genus or the lower groups are omitted. This method of classification, though formally accurate, has slight value in the exact sciences, partly because at every step one of the two groups is merely negatively characterized and may be unreal; but it sets forth clearly the gradual descent from the most inclusive genus (*summum genus*) through species to the lowest class (*infima species*), which is divisible only into individual persons or things. (*See* Division.)

In astronomy the term is used for the aspect of the moon or of a planet when apparently half illuminated, so that the illuminated part of its disk has the form of a semicircle.

DICK, GEORGE FREDERICK (1881–), U.S. physician, codiscoverer with his wife, Gladys Henry Dick, of the cause, prevention and cure of scarlet fever (*q.v.*), was born at Ft. Wayne, Ind., on July 21, 1881. Trained in Europe as a pathologist, Dick, a graduate of Rush Medical college, Chicago (M.D. 1905), chose scarlet fever as his research field while serving as a major in the medical corps with the American expeditionary forces in France during World War I. From 1918 to 1933 he was professor of clinical medicine at Rush. In 1933 he became chairman of the department of medicine at The University of Chicago, where he served until his retirement in 1945.

Dick's researches were presented in more than 150 papers on many subjects. In 1923 he and his wife isolated the hemolytic streptococcus that causes scarlet fever and prepared the toxin and antitoxin that act as a preventive and cure. In 1924 they developed the Dick test, a skin test for susceptibility to scarlet fever. (L. Er.)

DICKCISSEL (*Spiza americana*), a North American finch characteristic of the midwestern grasslands. A brown-backed, sparrowlike bird with yellow breast, and with black bib in the male, it is often called little meadow lark. The common name derives from the bird's metallic, grating song—*dick-dick-cissel-cissel*—often heard along the roadside in summer. The grass-cup nest is placed on the ground or in a shrub. The four or five greenish-blue eggs require 11 days to hatch, and the young receive nest care for another 11 days. In the northern part of the range, populations shift unaccountably from year to year. (W. J. Be.)

DICKENS, CHARLES JOHN HUFFAM (1812–1870), the most popular and perhaps the greatest of English novelists, was born on Feb. 7, 1812, in Landport, a division of Portsea (later in Portsmouth), in what is now 393 Commercial road. The house is a museum; and perhaps the actual address indicates little more than the drifting and often decaying fortunes of the class and family from which Dickens came. It would be an exaggeration to compare it to Lant street, in the Borough, in which Bob Sawyer (of *The Pickwick Papers*) had his lodgings and of which, it will be remembered, "the inhabitants were migratory, disappearing usually towards the verge of quarter-day." But there is the note of something nomadic about the social world to which he belonged. We talk of the solid middle class; he belonged, one might almost say, to the liquid middle class; certainly to the insecure middle class.

Parentage and Early Life.—Dickens' father, John Dickens, was a clerk in the navy pay office, and all through life a man of wavering and unstable status, partly by his misfortunes and partly by his fault. It is said that Dickens sketched him in a lighter spirit as Micawber (in *David Copperfield*) and in a sadder and more realistic spirit as Dorrit. The contrast between the two men should be a warning against the weakness of taking too literally the idea of Dickensian "originals." The habit may have done injustice to a few people, such as Leigh Hunt (Skimpole of *Bleak House*); it involves some unfairness to John Dickens; and perhaps even more to his wife, née Elizabeth Barrow, who is reported to have been the real Mrs. Nickleby. Some may question (not without grief) whether there ever really could be a real Mrs. Nickleby. But in any case we shall misunderstand the whole nature of the Dickensian imagination if we look on these things as mechanical portraits in black and white taken by "the profeel machine," as Mr. Weller (of *The Pickwick Papers*) said. It is almost the whole point of Dickens that he took hints from human beings; and then turned them, one may say, into superhuman beings. He relied on reality, but transformed it by his imagination. Yet it is true that, like Micawber, John Dickens was of the type that is often shifted from place to place; and this is the chief significance of Charles Dickens' connection with Portsea, or rather of his lack of connection with it. He was only two years old when the household moved to London. The family returned to Chatham in 1817. It was perhaps lucky that the formative period of Dickens' early childhood was also the most fortunate period of his not very fortunate family. The dockyard of Chatham, the towers of Rochester, the gardens and the great roads of Kent, remained with him through life. They were his native soil and the birthplace of his fancy. His house in later years looked down on the great Dover road from Gad's Hill and the cathedral tower of Rochester rose again in his last vision, in the opium dream called "Edwin Drood." There he had leisure to learn a little from books, who was so soon to learn mainly from life; first in the stricter sense of school books, from a Mr. Giles, a Baptist minister in Chatham; and second, and probably with greater profit, from a random heap of old novels that included much of the greatest English literature and even more of the type of literature from which he could learn most: *Roderick Random* and *Robinson Crusoe* and *Tom Jones* and *The Vicar of Wakefield*.

He was no more than ten years old when the household was once more upon the march. John Dickens had fallen into debt. His wife, the mother of eight children of whom Charles was the second, tried to open a dingy sort of school. No one ever came to it; the old novels went to the pawnshop; and Charles lingered at home. Then, "in an evil hour for me," so Dickens wrote, he

was thrown forth to earn his own living by tying and labeling pots of blacking in an old blacking warehouse, which was managed by a relative on his mother's side. The blacking was symbolical enough; Dickens never doubted that this piece of his childhood was the darkest period of his life; and he seems indeed to have been in the mood to blacken himself all over like the Othello of the Crummles company in *Nicholas Nickleby*. His father continued his tendency to change his private address; and his next address was the Debtors' prison of the Marshalsea. Of the heart-rending monotony and ignominy of this pessimistic period Dickens has given no more than a bitter abbreviation in both *David Copperfield* and in the striking fragment of autobiography preserved by his friend and biographer John Forster. But he was storing up much more than bitterness; it is obvious that he had already developed an almost uncanny vigilance and alertness of attention. By the time his servitude came to an end, by his father's falling into a legacy as he had fallen into jail, the boy was no longer a normal boy, let alone a child. He called his wandering parent "the prodigal father" and there was something of the same fantastic family inversion in the very existence of so watchful and critical a son. Some of the best passages about prison life in *Pickwick* and *Little Dorrit* derive directly from the 12-year-old boy's observation; for everything he saw then, so Dickens wrote later, was perceived "quite as well as I should perceive it now."

On his father's release he shared in the improved fortunes of the family. He went back to school, he served as a solicitor's clerk and he worked hard to educate himself. He learned shorthand and became a reporter, first in the law courts and then in parliament. He was employed on the *True Sun*, on his uncle's *Mirror of Parliament* (Hansard's rival) and, in 1834, on the *Morning Chronicle*. In all these aspects he appears as alert, sharp witted and detached. Even at this time, or soon after, he had an air of vitality and the countenance of a man of action. "Light and motion," remarked one observer, "flashed from every part of it." "It seemed as if made of steel," Mrs. Carlyle was to write four or five years later. It is worth noticing, perhaps, because certain healthy social emotions which he always championed have rather falsified his personality in the eyes of the prigs whom he loved to rap over the head. He was a genuine champion of geniality; but he was not always genial; certainly not only genial. All his life he defended the pleasures of the poor and the need for generosity; but this has sometimes clouded his character with the fumes of mere conviviality and irresponsibility which were very far from being really characteristic. In his youth, which is the period of irresponsibility, Dickens appears in many ways as highly responsible. He was in sharp reaction against the futility of his family. Even an early and intense attachment to a Miss Maria Beadnell, who was the "original" of Dora Spenlow in *David Copperfield*, did not end in tears or sentiment but in a self-confessed "habit of self-suppression" which, so Dickens explained, "makes me chary of showing my affection even to my children." He was both ambitious and industrious, and there were some who even found him hard. In many moods he had as angry a dislike of the selfishness of the irresponsible, cheerful Skimpoles as of that of the "practical" hard-hearted and hard-headed Gradgrinds (*Hard Times*).

Beginnings of Literary Career.—Dickens soon came in more ways than one to the high turning point of his fortunes. His marriage and his first real literary work can be dated at about the same time. He began by contributing to the old *Monthly Magazine* and went on to write a series of sketches which were, in the broadest sense, caricatures of the life and manners of the time. Many of them appeared in the *Morning Chronicle* and *Evening Chronicle;* they were illustrated by George Cruikshank; and they were brought out in two series, in 1836, as *Sketches by Boz*. Earlier in the same year, the publishers Chapman and Hall had wanted to approach the author with a suggestion for a larger scheme, though at first they did not know who he was. A well-known humorous artist of the time, Robert Seymour, was to produce a series of plates illustrating the adventures, or misadventures, of the Nimrod club, a group of amateur sportsmen, destined to dwindle and yet to grow infinitely greater in the single figure of Mr. Nathaniel Winkle. Dickens agreed to write the letterpress, which was to be little more than a running accompaniment like an ornamental border around the drawings; and in that strange fashion, secondary, subordinate and even trivial, first formed itself in the human fancy the epic and pantomime of *The Pickwick Papers* (1836–37). Dickens persuaded the publishers to let the Pickwick club represent more varied interests or eccentricities, retained Mr. Winkle to represent or misrepresent the original notion of sport; and by that one stroke of independence cut himself free from a stale fashion and started a new artistic adventure and revolution. He gave as one of his reasons the fact that he had no special knowledge of sports or games, and proceeded to drive his argument home triumphantly by his description of the cricket match at Dingley Dell. And yet that cricket match alone might illustrate exactly the game which Dickens so gloriously won; and why that wild and ill-instructed batsman has had so many thousand runs and is not out. What did a few mistakes in the description of cricket, or even in the description of real life, matter in a man who could invent that orator at the cricket dinner, who complimented the defeated eleven by saying, with the gesture of Alexander, "If I were not Dumkins, I would be Luffey; if I were not Podder, I would be Struggles"? Men do not read that sort of thing to learn about cricket, or even about life, but to find something more living than either. There had broken through the entanglements of that trumpery bargain a force of comic genius which swallowed up its own origin and excuses; a wild animal big enough to eat all its direction labels. People forgot about Seymour; forgot about sport; forgot about the Nimrod club; soon forgot about the Pickwick club. They forgot all that he forgot and followed whatever he followed; much bigger and wilder game than any aimed at by the mere gun of Mr. Winkle. The track of the story wandered; the tone of the story changed; a servant whom Pickwick found cleaning boots in an innyard took the centre of the stage and towered even over Pickwick; Pickwick from being a pompous buffoon became a generous and venerable old English gentleman; and the world still follows that incredible transformation scene and wishes there were more of it to this day. This was the emergence of Dickens into literature. It had, of course, many secondary effects in life. One was the first of his literary quarrels. Seymour shot himself. His family was to claim that Dickens had gained glory from another man's ideas. Nobody, we may well imagine, believes that the oration of Sergeant Buzfuz or the poem of Mrs. Leo Hunter originated with Seymour. Dickens had an inexhaustible torrent of such ideas; and no man on earth could pretend to have provided them. But it is true that in this quarrel, as in others, some found a touch of sharpness and acid self-defense in Dickens; and he was never without his enemies. His ideal was certainly the leisure and geniality of Pickwick; but he was fighting rather too hard for his own hand and had too much at stake and too pressing a knowledge of poverty to be anything but practical.

As *Pickwick* was the foundation of his public life, his marriage was naturally the foundation of his private life. His wife was Catherine Hogarth, eldest daughter of George Hogarth, editor of the *Evening Chronicle*. Their marriage has been the object of criticism and curiosity, though little good is done by making guesses about a relationship of which the spiritual balance and proportion were probably never known to more than three or four people. It is significant that those who were nearest to it agreed to be silent rather than impute blame. At the time of the marriage the bride was a bright, pleasant and rather dreamy young woman. She became the mother of a large family, of ten children in all, born over a period of 15 years. Her younger sister, Mary Hogarth, came to live with them, but died suddenly; she was extravagantly mourned by Dickens and enshrined as "Little Nell" (*The Old Curiosity Shop*). After 1842 another sister, Georgina, joined the family to help with the children; and she stayed after Catherine left. For many years the marriage was a happy one, and when the separation came it seems largely to have been due to Dickens' overpowering restlessness, to his demand to put himself and his writing first and to "that wayward and unsettled feeling which," he wrote, "is part (I suppose) of the tenure on which one holds an imaginative life." All this, however, happened long afterward.

For the moment he was a popular writer and a power in the world.

Development as a Novelist.—It is notable that Dickens' next work was *Oliver Twist* (1838); which might be meant for a contrast to *Pickwick*. If the first trick had succeeded, nobody could accuse the conjurer of trying the same trick twice. He was probably proud of proving his range; but he was certainly courageous in testing his popularity. It is true that *Oliver Twist* consists of a queer mixture of melodrama and realism; but both the realism and the melodrama are deliberately dark and grim. Nevertheless it is fortunate that with his second book he thus brought into play what may be called his second talent. It is too common to compare his humour with his pathos; for indeed there is no comparison. But there really is a comparison between his humour and his horror; and he really had a talent for a certain sort of horror, which is exactly rendered by the popular phrase of supping on horrors. For there is a sort of lurid conviviality that accompanies the panic; as if the nightmare could accompany and not follow the heavy meal. This suppressed vitality is due to his never for an instant losing the love of life. He enjoyed writing it. The sort of horror which afterward conceived the death of Krook (in *Bleak House*) is already found in *Oliver Twist;* as in that intolerable repetition throbbing in the murderer's ears: "will wash out mud-stains, blood-stains" and so on. For the rest, the plot is preposterous and the flashes of fun excellent but few; yet there is another aspect of the book which makes it important in the story of Dickens. It is not only the first of his nightmare novels but also the first of his social tracts. Something of social protest could be read between the lines of Pickwick in prison; but the prison of Pickwick was very mild compared with the charitable almshouse of Oliver. Dickens is witness, with Thomas Hood and William Cobbett and many others, that the workhouse, created by the Poor law of 1834, was felt by all generous people as something quite unnaturally new and hard and inhuman. It is sometimes said that he "killed" Bumble (the beadle); it would be truer to say that, by making Bumble live, he created something by which it will always be possible to kill bureaucracies.

Whether we call the transition from *Pickwick* to *Oliver Twist* a change from comedy to tragedy, or merely a change from farce to melodrama, it is notable that the next act of Dickens is to mix the two in about equal proportions. Having shown how much he can vary, he tries to show how well he can combine. It is worth noting because it explains much of the failure as well as the success of his art as a whole. We may even say that, to the last, this sort of exhibition of power remained his principal weakness. When the critics, like those of *The Quarterly*, called him vulgar, it meant nothing except that the critics themselves were snobbish. There is nothing vulgar about drinking beer or describing the drinking of beer, or enjoying the humours of really humorous people who happen to black boots, like Sam Weller. But there is something just a little vulgar about professing to be a Universal Provider; a man who writes not only something that he wants to write but anything that anybody wants to read. Anything in his work that can really be called failure is very largely due to this appetite for universal success. There is nothing wrong about the jester laughing at his own jokes; indeed they must be very poor jokes if even he cannot laugh at them. Dickens, in one of those endless private letters which are almost more entertaining than his published novels, describes himself as "a gentleman with rather long hair and no neckcloth, who writes and grins as if he thought he were very funny indeed"; and so he was. But when he set out to prove that he was not only very funny but very pathetic, very tragic, very powerful, he was not always enjoying the sense of power over his work, he was enjoying the sense of power over his audience. He was an admirable actor in private theatricals; and sometimes, unfortunately, they were public theatricals. At best he was that rather rare thing, a real democrat. At worst he could be something of a demagogue: not one of the crowd but one trying to dazzle and drive it. It pleased the actor in him to show his versatility and his ease in turning from one to the other. He did not realize clearly enough that in some of the parts he was a first-rate actor and in some a second-rate and in some a fifth-rate actor. He did not remind himself that though he turned to each topic with equal ease, he did not turn to each with equal effect. But, whatever the disadvantages of the universal ambition, it definitely dates from the period of his next book.

Pickwick has a prevailing tint of gaiety and *Oliver Twist* of gravity, not to say grimness; but with *Nicholas Nickleby* (1838–39) we have the new method, which is like a pattern of bright and dark stripes. The melodrama is if possible even more melodramatic than in *Oliver Twist;* and what there is of it is equally black and scowling. But the comedy or farce has already displayed the rapid ripening of his real genius in letters. There is no better company in all literature than the strolling company of Mr. Vincent Crummles. Mr. Mantalini also is one of the great gifts of Dickens to the enduring happiness of humanity. For the rest, it is very difficult to take the serious part of the story seriously. There is precious little difference between the rant and claptrap of the Crummles plays, which Dickens makes fun of, and the rant and claptrap of Ralph Nickleby and Mulberry Hawke which Dickens gravely narrates to us. All that, however, was of little consequence either immediate or permanent. Dickens was not proving that he could write smooth and probable narratives, which many people could do. He was proving that he could create Mantalini and Crummles, which nobody else could do.

Nevertheless, this pretense of providing for all tastes, which produced the seriocomic novel, is also the explanation of the next stage of his career. There runs or recurs throughout his whole life a certain ambition to preside over a more or less complex or many-sided publication; a large framework for many pictures; a system of tales within tales like the Arabian Nights. It is the ambition that he later gratified by becoming the editor of two successive magazines, *Household Words* and *All the Year Round*. He had been for a time editor of something of the sort in *Bentley's Miscellany;* and, in April 1840, this mild and genial megalomania (if we may so describe it) took the form of a weekly publication called *Master Humphrey's Clock*. It was a serial scheme, which was meant to consist chiefly of different stories told by a group of friends. With the idea of making them the more friendly he turned some of them into old friends; reintroducing Mr. Pickwick and the two Wellers, though these characters were hardly at their best, the author's mind being already on other things. One of these things was a historical novel, conceived more in the romantic manner of Scott than the prosaic manner of Smollett, which Dickens had generally followed. It was called *Barnaby Rudge* (1841) and the most interesting part of it is the business of the Gordon Riots; and the mob that has a madman for its mascot and a penny-dreadful prentice for its comic relief. *Barnaby Rudge*, however, is not so directly Dickensian as the romance that preceded or the romance that followed it. The second story, somewhat insecurely wedged into the framework of *Master Humphrey's Clock*, was *The Old Curiosity Shop* (1841). Its public reception sharply illustrates what has been said about the double character of his success. On the one side was his true success as a craftsman carving figures of a certain type, generally gargoyles and grotesques. On the other side was his inferior success as a jack-of-all-trades tending only too much to be a cheap-jack. As a matter of fact, *The Old Curiosity Shop* contains some of the most attractive and imaginative humour in all his humorous work; there is nothing better anywhere than Mr. Swiveller's imitation of the brigand or Mr. Brass's funeral oration over the dwarf. But in general gossip and association, everything else in the story is swallowed up in the lachrymose subject of Little Nell. There can be no doubt that this unfortunate female had a most unfortunate effect on Dickens' whole conception of his literary function. Little Nell was better dead, but she was an unconscionable long time dying; and we cannot altogether acquit Dickens of keeping her lingering in agony as an exhibition of his power. It tended to fix him in that unfortunate attitude, of something between a showman and a magician, which explains almost all the real mistakes of his life.

About this time a determining event interrupted his purely literary development, his first visit to America. It was destined to have, apart from any other results, a direct effect upon his next book, which was *Martin Chuzzlewit* (1843–44). There were, of course, many purely practical and personal elements in the criticism

which he directed against the western democracy. An unjust copyright law had enabled Americans to pirate his most popular works. It was stifling their own literature, but it was supported by the newspaper proprietors who profited by it most. Their differences with Dickens developed into a feud; while, for his part, his sense and sensibility were alike irritated by some real divisions in the international relation. There were things in the American culture, or lack of culture of that time, which he could not be expected to understand and which he might reasonably be expected to dislike. His English law-abiding liberalism would in any case have been startled by a certain streak of ferocity and persecution that there really is in the Americans; just as he might have recoiled from the same fierceness in the Irish or the Italians. But in the Americans it was also connected then with something crude and incomplete in the society, and was not softened by tradition or romance. He was also both annoyed and amused at the American habit of uttering solemn idealistic soliloquies and of using rhetoric very rhetorically. He was revolted by slavery. But all these impressions are important chiefly as far as they were incorporated in his next novel.

All the early books, from *Pickwick* onward, appeared, it must always be remembered, serially and in separate parts. They were awaited eagerly and were sometimes only just written up to time. One effect of this method was that it at first encouraged the novelist in a sort of opportunism and hand-to-mouth habit of work. As time went on, however, it had a very different effect: the mere fact of serial publication meant that the writer had to think ahead. Standards altered, the form of the novel was developed and public taste changed. By the time of *David Copperfield* (1849–50), a critic could write that "the serial tale . . . is probably the lowest artistic form yet invented." But by then Dickens was writing in earnest explanation to a friend: "the world would not take a *Pickwick* from me now." Though he wrote little or nothing about "the art of the novel" (a phrase which had yet to be coined) all his later books show an increasing constructive skill and a growing interest in technique. By the time he had finished his last complete work, *Our Mutual Friend* (1864–65), he could write in an almost Jamesian fashion of the difficulties for the reader of a serial in perceiving the relations of the finer threads of the story "to the whole pattern which is always before the eyes of the story weaver at his loom." All this is worth remembering, because a great deal has sometimes been made of the remarkable decision which Dickens made, in the course of writing *Martin Chuzzlewit*, when he found that the public was not taking to Pecksniff and Mrs. Gamp with the same delight that they had shown in Pickwick and Miss Squeers (*Nicholas Nickleby*). He conceived the bold idea of breaking the story in the middle and putting in a purple patch woven from his wild memories of America. However extraordinary this may seem, it was completely successful in the comedy sense. It has been remarked that there was something peculiarly Dickensian in suddenly sending Martin Chuzzlewit across the Atlantic, and that one can hardly imagine Thackeray suddenly hurling Pendennis from Mayfair into the middle of Australia, or George Eliot dislodging Felix Holt and flinging him as far as the north pole. But the difference was largely a matter of period rather than personality. From the time of *Martin Chuzzlewit* it happens that Dickens began to make written plans for the novels; and certainly from this time, each was always evolved in relation to a central idea. There may have been little to show for it at first, but it was an important new development.

At this point there is a break in the life of Dickens, in more ways than one. It is represented by his decision to live abroad for a time, chiefly on grounds of economy. He took a villa in the neighbourhood of Genoa in 1844; and he and his family, already a fairly large one, settled down there with a certain air of finality that deserved for a time the name of exile. But it is curious to note that the literary work done there has something of the character of an interlude, and indeed of a rather incongruous interlude. For it was in that Italian landscape that he concentrated on a study so very domestic, insular and even cockney as *The Chimes* (1844); and industriously continued the series of short Christmas stories which had recently begun in the very London fog of *A Christmas Carol* (1843). Whatever be the merits or demerits of the *Christmas Carol*, it really is a carol; in the sense of being short and direct and having the same chorus throughout. The same is true in another way of *The Chimes;* and of most things that occupied him in his Italian home. He had not settled down to another long and important book; and it soon became apparent that he had not settled down at all. He returned to London, the landscape which for him was really the most romantic and even historic; and did something so ominously typical of the place and time as almost to seem like tempting providence. He became the first editor of the *Daily News*, a paper started to maintain those liberal, if not radical, opinions of which he always shared the confident outlook. The first number appeared in Jan. 1846. Dickens' editorship lasted only three weeks. He at once went to Lausanne and immediately wanted to return to London.

It seems probable that this break in his social life corresponded to a break in his artistic life; which was in a sense just about to begin all over again and begin at the other end. He did indeed write one more full-size novel of the earlier type, *Dombey and Son* (1846–48); but it has very much the character of the winding up of an old business, like the winding up of the Dombey firm at the end of it. It is comic as the earlier books were comic, and no praise can be higher; it is conventional as the earlier plots were conventional, and never really pretended to be anything else; it contains a dying child (Paul Dombey) upon the pattern of Little Nell; it contains a very amusing major much improved from the pattern of Mr. Dowler (*The Pickwick Papers*). But underneath all this easy repetition of the old dexterity and the old clumsiness the mind of the conjurer is already elsewhere. *Dombey and Son* was more successful in a business sense than *Martin Chuzzlewit;* though really less successful in many others. Dickens settled again in England in a more prosperous style; he was persuaded to send his son to Eton and, what was more sensational, took a rest. It was after a long holiday at Broadstairs, in easier circumstances more favourable to imaginative growth and a general change of view, that there began to appear in 1849 an entirely new novel in an entirely new style.

There is all the difference between the life and adventures of David Copperfield and the life and adventures of Nicholas Nickleby, that there is between the life of Charles Dickens and the life of Amadis of Gaul. The latter is a good or bad romance; the former is a romantic biography, only the more realistic for being romantic. For romance is a very real part of life and perhaps the most real part of youth. Dickens had turned the telescope round or was looking through the other end of it; looking perhaps into a mirror, looking in any case out of a new window. It was life as he saw it, which was somewhat fantastically; but it was his own life as he knew it, and even as he had lived it. In other words, it is fanciful but it is not fictitious; because not merely invented in the manner of fiction. In *Pickwick* or *Nickleby* he had in a sense breathed fresh imaginative life into stock characters, but they were still stage characters; in the new style he may be extravagant, but he is not stagey. That vague glow of exaggeration and glamour which lies over all the opening chapters of *David Copperfield*, which dilates some figures and distorts others, is the genuine sentimentalism and suppressed passion of youth; it is no longer a convention or tradition of caricature. There are men like Steerforth and girls like Dora; they are not as boys see them; but boys do see them so. This passionate autobiography, though it stiffens into greater conventionality at the real period of passion, is really, in the dismally battered phrase, a human document. But something of the new spirit, more subtle and sympathetic but perhaps less purely creative, belongs to all the books written after this date.

The next novel was *Bleak House* (1852–53), in which he once again made a new departure. Dickens himself said of it, "I have purposely dwelt on the romantic side of familiar things." It is a satire directed against chancery and the law's delay, which opens out to satirize the whole of society. The description of the feverish idleness of young Richard Carstone has the new note of one for whom a well-meaning young man is no longer merely a "first walking gentleman." It is a note of disillusion, though in spite of the satire of Mrs. Jellyby the novel as a whole is still inspired by

Dickens' vigorous faith in social reform, which for many years had found a practical outlet in work he undertook in co-operation with a well-known and wealthy philanthropist, Miss Angela Burdett-Coutts (*q.v.*). *Hard Times* (1854) may be considered as historically important as the revolt of a radical against the economic individualism which was originally identified with radicalism. It is not simply an attack on capitalist society, but on the soulless and sordid industrial life it had brought about and on human nature itself. Like all the novels that follow, including its immediate successor, *Little Dorrit* (1855–57), it demands the regeneration of men as well as social reform.

Hard Times shows a new mastery of form; *Little Dorrit* a lack of it. This was largely because the latter appeared in the old way as a monthly serial stretching over 20 parts, whereas *Hard Times* was concentrated into weekly installments for Dickens' new periodical, *Household Words* (1850–59). *A Tale of Two Cities* (1859), a historical romance about the French Revolution, appeared in the periodical which took its place, *All the Year Round;* it was rather too dramatic, an overbold simplification designed to appeal to the even wider audience that Dickens hoped to reach through his new medium. Yet the height of his new method was eventually attained in his next work, *Great Expectations* (1860–61), and perhaps he never did anything better than its opening chapters. There is no fine writing in it, however; it has all the virtuoso's brilliance with none of his tricks. Even his exuberant fancy was kept in check and subordinate to the main design. It revealed more than a glimpse of the Dickens world from a new window, for it showed that the writer could turn his gaze both on himself and on the nature of the world we all live in. It was a triumph of art. "I work slowly and with great care," Dickens explained to Bulwer Lytton a few years later, "and never give way to my invention recklessly, but constantly restrain it." This was evidently written in reply to Lytton's comments on *Our Mutual Friend* (1864–65). This was Dickens' last complete novel, and it is more complete than most. Indeed, it is one of his best, though not one of the most Dickensian. Its interest lies less in the story, which is of the usual complexity, but in what one supposes was meant by it; and this depends more on scenes linked by the dark river than the symbol of the Dust-heap of which, perhaps, too much has been made. Too great a preoccupation with the themes and symbols indeed, or with any limited aspect of his work, may blind a reader to the best that Dickens has to offer. For there is something about Dickens that prevents the critic from ever being quite content with criticizing his work as literature. Something larger seems involved, which is not literature but life. And he who remembers Pickwick and Pecksniff, creatures like Puck or Pan, may sometimes wonder whether the work had not most life when it was least lifelike.

Last Years.—In his last decade, Dickens both retired into private life and took up a new career which brought him directly before the public. Both appear to have been the result of the breakup of his marriage in 1858. According to his own account he felt that he could no longer live with his wife; yet, even before the separation, there is no doubt that he was deeply attracted by a young actress, Ellen Ternan. It seems clear that sometime during the 1860s she became his mistress. He provided her with somewhere to live; he left her £1,000 when he died; and, meanwhile, he divided his time between her, his public career and what remained of his family at Gad's Hill. More than this, remarkably little is certainly known. In view of Dickens' special relation with the public, and his reputation for frankness and as a champion of the home, there appears every excuse for curiosity. Yet so far there has been little reward for considerable research, except the confirmation that he was a more complex person than has sometimes been supposed. From the time of the separation he was also launched on a career as a public reader. He had a natural wish to make money and he succeeded; he enjoyed the limelight; and, however great he found the strain, it was no more than he put upon himself when he was writing. Yet his own letters, ragged with insomnia and impatience, full of desperate fatigue and more desperate courage, are enough to show that he was playing a dangerous game for someone approaching 60. The truth is that he enjoyed the danger. He was still a man of action and, in the mild mid-1860s, in a world of Twemlows and Podsnaps (*Our Mutual Friend*), he lived with zest. When he went once again to the United States, in Nov. 1867, his campaign of public reading was truly American in its scope and scale. It helped to ruin his health, but he had long ago begun burning the candle at both ends; and there have been few men, in the matter of natural endowments, with so great and glorious a candle to burn. He retired from his readings to take up his last novel, which was a detective story rather in the manner of his friend Wilkie Collins; the sort of story that begins with asking a question; in this case the question about the secret and sequel of the hero, Edwin Drood. The question will never be answered; for it was cut short by the only thing that could be more dramatic than the death of the hero: the death of the author. He died very suddenly, at Gad's Hill, on June 9, 1870.

Character and the Nature of His Genius.—He was buried in the poet's corner of Westminster abbey; and new and vulgar as many critics had called his work, he was far more of a poet than many who were buried there as poets. He left a will commending his soul to God and to the mercy of Jesus Christ, and leaving his works to the judgment of posterity; and in both respects the action was symbolic and will remain significant in history. Intellectually limited as he was by the rather cheap and optimistic negations of an age of commercial rationalism, he had never been a bitter secularist or anticlerical; he was at heart traditional and was drawn much more toward Anglican than Puritan Christianity. Contemptuous of the past and its survival in what seemed to him outworn institutions, he centred the meaning of many of his novels on the values that some call essentially Christian and which others would like to preserve under the name of humanism. Just where he stood in matters of religion it would be rash to claim, largely because he never appears to have tried to define it for himself. But even though we may feel that rather too much has been written about Dickens and Christmas (especially since it has been so commercialized) he shared much with its general spirit as a festival. No doubt it is true that in his later novels, which have sometimes been known as "the dark novels," there are new shades of irony, an earnest questioning and even a tone of resignation which is much more disturbing still. The paternal Mr. Weller (of *Pickwick*), for example, is succeeded by the paternal Mr. Dolls (of *Our Mutual Friend*); or Christmas at Dingley Dell, by Christmas round the blacksmith's forge (in *Great Expectations*) repairing the handcuffs for the hunted convicts. Yet if there was a new note of dismay in what he saw in his contemporaries, it was largely because the values he held to were still as affirmative and ordinary as those of Arthur Clennam (*Little Dorrit*), Joe Gargery (*Great Expectations*) and Rumpty Wilfer (*Our Mutual Friend*). It is this which has given him such a universal appeal; and, of course, it is this which makes him so unappealing, in spite of all his skill, to those who find it rather too savourless for a major novelist.

Indeed, even the charge of exaggeration in his manner has itself been exaggerated; and, what is more important, it has often been repeated mechanically without thought as to its true meaning. Dickens did exaggerate; but his exaggeration was purely Dickensian. In this sense his very vulgarity had the quality of distinction. Mere overstatement, to say that a tall man is ten feet high, to say that a frosty morning froze Niagara; this is something relatively easy to do. But the distinction of Dickens can be stated even in the common charge against him. He is said to have turned men into monsters of humour or horror, whereas the men were really commonplace and conventional persons in shops and offices. If any critic depreciates the Dickensian method as mere overstatement, the answer is obvious: let him take some of these commonplace people and overstate them. He will soon discover that he has not the vaguest notion of what to overstate. He will soon realize that it is not a simple matter of mere exaggeration, in the sense of mere extension. It is not a matter of making a man a little taller or a morning a little colder; the challenge to imagination is not whether he can exaggerate but whether he can find anything worth exaggerating. Now the genius of Dickens consisted in seeing in somebody, whom others might call merely prosaic, the germ of a

sort of prose poem. There was in this or that man's attitude, or affectation, or habit of thought, something which only needed a touch of exaggeration to be a charming fantasy or a dramatic contradiction. The books of Dickens are in fact full of bores; of bores who do not bore us, merely because they did not bore him. We have all of us heard a hundred times the tiresome trick of public speakers, of asking themselves rhetorical questions which they do not want answered. Any of us might have heard a fat Dissenting minister doing it at a tea party and thankfully forgotten all about him. But Dickens seized on the fallacy and turned it into a fantasy; into Mr. Chadband's demands to know why he could not fly, or his wild and beautiful apologue about the elephant and the eel (*Bleak House*). We talk of the power of drawing people out; and that is the nearest parallel to the power of Dickens. He drew reels and reels of highly coloured caricature out of an ordinary person, as dazzlingly as a conjurer draws reels and reels of highly coloured paper out of an ordinary hat. But if anybody thinks the conjuring trick is easy to perform, let him try it with the next ordinary person he sees. The exaggeration is always the logical extension of something that really exists; but genius appears in seeing that it exists. That is something totally different from giving a man a long nose; it is the delicate surgical separation or extension of a living nerve.

There were other reasons for the injustice of the accusation of exaggeration in the particular case of Dickens. Though his characters often were caricatures, they were not such wild caricatures as was supposed by those who had never met such characters. And the critics had never met the characters; because the critics did not live in the common life of the English people; and Dickens did. England was a much more amusing and horrible place than it appeared to the sort of man who wrote reviews in *The Quarterly*. The poverty and anarchy of Dickens' early life had stuffed his memory with strange things and people never to be discovered in Tennysonian country houses or even Thackerayan drawing rooms. Poverty makes strange bedfellows, the same sort of bedfellows with whom Mr. Pickwick fought for the recovery of his nightcap. In the vivid phrase, he did indeed live in Queer street and was acquainted with very queer fish. Yet it is true that he caught many of these queer fish because he liked fishing in such troubled waters. A good example of this combination of opportunity and eccentricity is to be found in his affection for traveling showmen and vagabond entertainments of all sorts, especially those that exhibited giants and dwarfs and such monstrosities. Some might see in this truth a sort of travesty of all his travesties. It would be easy to suggest a psychological theory, by which all his art tended to the antics of the abnormal; it would also be largely false. It would be much truer to say that Dickens created so many fantastic caricatures because he was himself commonplace. He never identifies himself with anything abnormal, in the more modern manner. In his traveling show, the Giant always falls far short of being a Superman. And though he was tempted only too easily to an obvious pathos, there was never anything particularly pathetic about his dwarfs. His fun is more robust. It was precisely because he had an ordinary and sensible view of life that he could measure the full madness both of Gradgrind's greed and Micawber's improvidence. It was because he was what we call commonplace that Dombey appeared to him so stiff or Jellyby so slovenly. In a later generation a real person often assumed such an unreal pose and lost the power of merely laughing at it; as, for example, when Oscar Wilde said seriously all that Skimpole had said absurdly. The Victorian common sense was not a complete common sense; and Dickens did suffer from having a narrower culture than Swift or Rabelais. But he did not suffer from being oversensible, for he was able to give us a radiant fairyland of fools.

Above all he was a great writer. At times, superficially considered, he may seem to have abused his great gifts. No doubt occasionally he did. Some of his defects are glaring; they hardly need emphasizing because, unfortunately, he always emphasized them himself. It may be a fault, but it is certainly a fact that for the first part of his career he enjoyed writing his worst work as much as his best. Yet it is not true of his career as a whole. He had an extraordinarily sensitive ear for tone and emphasis; with all but his most serious characters, he had an incomparable command of dialogue; he could even write with great economy as well as vitality and force; and the unmistakable characteristic of his writing is its sustained and imaginative fancy. Whether this imaginative fancy is expressed in the form of the absurdities of Mrs. Bayham Badger, for example, or in such a set piece as the description of Chesney wold ("the waters are out in Lincolnshire") which carries us straight into the wasted heart of Lady Dedlock; whether it is in the extraordinary aberrations of "Lord Chancellor" Krook and Miss Flite, or in the verbal excursions of Skimpole and Chadband (all of *Bleak House*); it so sustains these things, as a variable and purposeful style, that one can say that they almost never drop into mannerism but are part of the living pattern of the whole novel.

His literary work produced of course much more than a literary effect. He was the last great poet, in the true sense of maker, who made something for the people and was in the highest sense popular. He still gives his name, not to a literary clique, but to a league or fellowship numbering thousands all over the world. In this connection it is often noted that he achieved many things even considered as a practical political and social reformer. He let light into dark corners, like the dens of dirt and brutality often called schools, especially in Yorkshire; he probably had much to do with making the professional nurse a duller but more reliable person than Mrs. Gamp; it is likely enough that his vivid descriptions, assisted by the whole trend of the time, hastened the extinction of ordinary imprisonment for debt and were responsible for improvements in public health. But precisely because this has often been said, it will be well not to say it too often. It has the effect of making his satire appear much more superficial and utilitarian than it really was; for the great satirist is concerned with things not so easily destroyed. We do more honour to Dickens in noting the evils he did not destroy than those he did. The eager worship of a man merely wealthy, however dull and trivial, which appears in the affair of Merdle (*Little Dorrit*), has by no means disappeared from our own more recent affairs; the pompous old Barnacle and the agreeable young Barnacle (in the same book) are still almost as much alive as in Dickens' day. The sweeping away of a genuine gentry, in the person of Mr. Twemlow, on the tide of a new plutocracy, represented by Mr. Veneering (*Our Mutual Friend*), has gone much farther than in Dickens' day. But this makes Dickens' satire the more rather than the less valuable to posterity. The other mood, which pictures all such abuses as things of the past, tends not to reform but only too much to repose. In that spirit we may hear to this day a Stiltstalking saying that Stiltstalkings have perished before the march of progress, or a Buzfuz quoting Buzfuz and jeering at himself as an extinct monster.

Reputation.—The future of Dickens' fame is established. For a time, soon after his death, he was written down in comparison with such masters of the novel as Tolstoi and Dostoevski and in reaction against the spirit of his age. Ironically enough, these two writers meanwhile left no doubt that they were aware of his greatness and aims as a novelist. The first remarked that "all his characters are my personal friends"; the second referred to their author as "the Great Christian—Dickens." His irresistible greatness has always been recognized. Dickens is still tremendously popular in the Soviet Union, but though it is sometimes thought that this is because the Russians find it particularly easy to believe in the picture he gives of life in Britain, it would be rash to assume that this is the only reason. Indeed, wherever he finds readers, there is now no question of the importance of Dickens either as a writer or as a human event in history; as a sort of conflagration and transfiguration in the very heart of what is called the Victorian era; a naked flame of natural genius, whose best work was creative, and who has added something to life which it is hard to believe will ever entirely be taken away.

See also references under "Dickens, Charles John Huffam" in the Index volume.

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(G. K. C.; K. J. F.)

DICKINSON, EMILY ELIZABETH (1830–1886), U.S. author considered almost universally the greatest American woman poet, was born at Amherst, Mass., Dec. 10, 1830, in the sturdy brick homestead built by her grandfather Samuel Fowler Dickinson, a lawyer, sixth in the line of descent from Connecticut valley settlers. His son Edward, Emily's father, settled in Amherst where he practised law, engaged in politics and served as treasurer of Amherst college from 1835 until 1872, two years before his death. In 1828 he married Emily Norcross, and to them were born three children, William (1829–95), Emily and Lavinia (1833–99). Like her younger sister Lavinia, Emily never married and throughout her life lived at home. Together the sisters shared the later burden of caring for their mother, an invalid from 1875 until her death seven years later. One measure of the dependence of each member of this closely knit family upon each other is the fact of their lifelong residence in the same or neighbouring houses.

Slender in form, light and quick in motion, Emily Dickinson was remembered for her plain features, abundant reddish chestnut hair and brown eyes. Her early letters, those which survive from her 12th to her 18th year, show her to be natural, eager, interested in people and books; and bear out reports that in conversation she was witty and vivacious. After intermittent attendance at Amherst academy she was admitted at 16 to the middle of the three classes at Mount Holyoke Female seminary in nearby South Hadley in the autumn of 1847. Her initial enthusiasm palled during the year, in part because she could not bring herself to become a "professing" Christian as the girls were hopefully expected to do; in part because any break in the tie with her home was distasteful. She completed the year's work but did not return. Thenceforth her home and her gardens became exclusively the world she chose to inhabit. With the exception of a trip to Washington, D.C., early in 1855 with her sister, to visit her father, then serving in congress, and an enforced sojourn in Boston and Cambridge, Mass., during the summer months of 1864 and 1865 to undergo treatment for an eye affliction which seems to have been cured, she never left Amherst again.

Emily Dickinson apparently began writing poetry soon after her return from Mount Holyoke, encouraged by Benjamin Newton, a young law student in her father's office. In 1850 he moved to Worcester, Mass., soon married and died three years later. She cherished his memory over the years as her earliest guide, but her function as poet did not commence in earnest until about 1858, when she began to collect her verses into manuscript packets, small "volumes" of a few sheets of folded stationery, threaded at the spine. In 1862 her creative talent was at flood, and by 1866 most of her poetry was written. It was in April 1862 that she sensed her destiny as a poet, for in response to an *Atlantic Monthly* article written by the critic and publicist Thomas Wentworth Higginson, she brought herself to his attention by sending him four carefully chosen poems. Their metrical originalities bewildered Higginson, but he requested to see more and by midsummer gave his opinion—a verdict, as it turned out for Miss Dickinson—that her obscurity and fracture of grammar and dictionary stood in the way of public acceptance. Unable to express herself other than as she saw things, she elected obscurity and did not willingly allow any publication during her lifetime.

The correspondence thus initiated with Higginson continued all her life, and the fact that she called Higginson her "safest friend" and often signed herself "Your Scholar" opens a vista into her needs. Intense by nature, she was possessive in her friendships. The death of Newton deprived her of a mentor or muse. Perhaps soon after she felt that she had found another in the person of the noted clergyman, the Rev. Charles Wadsworth of Philadelphia, Pa., whom she evidently met on her return trip from Washington in 1855. Their correspondence does not survive. On his part it probably was conducted as that of a solicitous pastor trying to assist a troubled spirit. On hers it may have been a deep emotion, however disembodied; for his departure with his family to accept a pulpit in San Francisco, Calif., coincides with the period in which she was writing poetry, some of the best, with demonic energy. It is also the time that she began to dress entirely in white, a practice she never abandoned, and that she first wrote to Higginson. Eight years later Higginson called upon her at her earnest insistence, because as she said in her request, "Of our greatest acts we are ignorant. You were not aware that you saved my life. To thank you in person has been since then one of my few requests."

After 1865 the greater part of her poetic energies was spent, though she continued to fashion verses until her death. But they were usually composed for an occasion and for the friends to whom they were sent. Though people continued to be of utmost importance to her, direct contacts so exhausted her emotions that she shrank from all but the most intimate friends. Her seclusion thus became nearly absolute after 1870. But the intensity of her living never abated, and she associated steadily with the friends of her selection through the medium of letters. The care that she lavished on her revised drafts may suggest that letter writing sublimated the creative urge when her poetic drive lost force. In any event, she deliberately chose obscurity, evidently because she was unwilling to be diverted from her own originalities which those capable of evaluating only dimly perceived. Such withdrawal never became necessary in the presence of children, who adored her and for whom her cookie jar was always filled.

Only seven of her poems are known to have been published in her lifetime. Most of them were surreptitiously issued, perhaps by her sister-in-law Susan Dickinson, who from the first encouraged Emily's sense of dedication, and to whom Emily sent some 300 poems, usually in brief notes dispatched next door. Over the years it was by means of letters that Emily Dickinson found private audience for her poems. Higginson received more than 100, which he once acknowledged by thanking her, not for poems, but for the "beautiful thoughts and words." Her friendship with Samuel Bowles, distinguished publisher of the *Springfield Republican*, and with Josiah Holland, Bowles's associate and later founder of *Scribner's Monthly*, endured through the years. In gratitude for kindnesses from them she responded on occasion with verses which Bowles and Holland concluded (as Higginson had done) could not really be called poetry.

Among her contemporaries only Helen Hunt Jackson unreservedly believed that Miss Dickinson was a poet of genuine stature. Mrs. Jackson by the late 1870s had become a most successful writer, and was then generally acclaimed the best woman poet in America. Both women had been born in the same year in Amherst, members of the academic community. But Mrs. Jackson had grown up elsewhere, and it was Higginson who brought the poetry of Emily Dickinson to her attention. Only Mrs. Jackson's importunity secured Miss Dickinson's "Success" for inclusion in *A Masque of Poets* (1878), a collection published anonymously. Her later plea for enough poems to fill a separate volume went unheeded, as did her request to be designated Miss Dickinson's literary executor. But the conviction thus revealed of Mrs. Jackson's opinion was an accolade bestowed by no other. Their acquaintance was slight, but the unexpected death of Mrs. Jackson in 1885 seemed to Emily Dickinson especially distressing.

Otis P. Lord of Salem, Mass., a lifelong friend of Edward Dickinson and a justice of the superior court and later the supreme court of Massachusetts, frequently visited the Dickinson home with his wife until her death in 1877. Soon thereafter a deep attachment became manifest between Judge Lord and Emily. Until his death in 1884 he frequently stopped in Amherst at the inn with his nieces, and the surviving drafts of her letters to him evidence their mutual love. He may have offered marriage, but the pattern of her life was too firmly established to allow a change. Few of her close friends now survived. Judge Lord, Bowles, Hol-

land and Wadsworth were gone. She continued writing letters and occasional poems to the end, but her finest achievement had long since been consummated. The "nervous exhaustion" which overtook her after the death of Judge Lord was gradually intensified. She was confined with increasing frequency to her room or bed late in 1885, and died on May 15, 1886, in her 56th year.

After her sister's death, Lavinia Dickinson discovered the numerous packets of the many hundreds of poems, neatly placed in a locked box. She had known, of course, that Emily wrote poetry, but she contemplated the large body of verse with genuine astonishment. She set about with determination to find a publisher, and naturally turned first to Higginson. With misgivings whether a public could be reached, and with reservations of judgment whether the poems merited publication, he was finally persuaded to undertake preparation of a slender volume with the help of Mrs. Mabel Loomis Todd, who had become acquainted with the Dickinson family during Emily's lifetime. Together they edited *Poems by Emily Dickinson* (1890), 114 brief lyrics selected with an eye to public taste, and editorially tailored to fit accepted standards of metre and rhyme. Though reviewers were uniformly bewildered and for the most part hostile, the public demand for the volume encouraged Higginson and Mrs. Todd to issue *Poems: Second Series* in the following year. So reassuring was the acceptance that Mrs. Todd brought out two volumes of *Letters* (1894), and two years later a further selection, *Poems: Third Series*. No more appeared until Emily's niece, Martha Dickinson Bianchi, published *The Single Hound* (1914), *Further Poems* (1929) and *Unpublished Poems* (1932). With the appearance of *Bolts of Melody* (1945), edited by Mrs. Todd and her daughter, virtually all of the poetry had finally been brought to light.

Appraisal.—Emily Dickinson had no theory of poetics, and her achievement is confined to the genre of brief lyrical bursts of song uttered with fleetness and intensity. She wrote as she tried to live, outside of history. She was concerned with universals, and thus the two great sources of her inspiration were the Bible and the phenomena of nature. Through newspapers she had a daily eye on events, and from magazines she culled the first publications of such favourite contemporary writers as Charles Dickens and George Eliot. But her reading always passed through the alembic she distilled, for she believed that form is inherent in the created object. She adopted as the basic pattern for all her poems the hymn metres familiar from her childhood, but her innovations of half- and quarter-rhymes, her combinations of varying poetic feet, metres and rhyme patterns helped to create a new sense of the richness with which language can be used. Her laconic diction scorns the commonplace even as it clings to the homely word. Her outlook remained dualistic in the sense that it juxtaposed the abstract with the concrete, the trivial with the sublime, reverence with satire, the comic with the cosmic. Her flood subjects are the uneasy relation of impermanence to eternity, and her nervous style employs awkwardness of expression as a metaphor of the paradoxes inherent in living and dying.

BIBLIOGRAPHY.—Almost all of Emily Dickinson's poems and a great many of her letters are extant, the bulk of them in the libraries of Amherst college and Harvard university. T. H. Johnson (ed.), *The Poems of Emily Dickinson*, 3 vol. (1955) is a variorum edition, and *The Letters of Emily Dickinson*, 3 vol. (1958), fully annotated. George Frisbie Whicher, *This Was a Poet* (1938); Richard Chase, *Emily Dickinson* (1951); T. H. Johnson, *Emily Dickinson* (1955); *see* also Millicent Todd Bingham, *Ancestors' Brocades* (1945), a full account of the early publications of poems and letters; and *Emily Dickinson's Home* (1955). (T. H. JN.)

DICKINSON, JOHN (1732–1808), American statesman often referred to as "the penman of the Revolution," was born in Talbot county (Md.) Nov. 8, 1732. His father acquired large tracts of land in Kent county (Del.) and took the family there in 1740. After receiving his early education under private tutors, and reading law in Philadelphia, John Dickinson went to London in 1753 to study law at the Middle Temple. He returned to America in 1757, beginning the practice of law at Philadelphia. Three years later he entered upon a long career in public affairs, during which he held various offices in Pennsylvania and Delaware. He represented Pennsylvania at the Stamp act congress, and drafted its declaration of rights and grievances.

Dickinson won fame in 1767–68 as the author of the *Letters From a Farmer in Pennsylvania*, which appeared in many colonial newspapers and helped mold American opinion against the Townshend acts. He inveighed against the proposed use of the proceeds of the Townshend duties to pay the salaries of royal officials in the colonies; and he denounced the establishment of the American board of customs commissioners at Boston. Although he condemned the duties themselves, he took a relatively moderate approach toward them. Refusing to appeal to natural rights, he declared that the duties, because they were intended to collect a revenue, had to be classified with the stamp tax. Accordingly, he contended, they violated the rights of Englishmen and were unconstitutional. He admitted the validity of parliamentary taxation to regulate trade. His distinction between such taxation and duties for revenue was not so clear as he believed it to be.

Dickinson was also an active delegate from Pennsylvania in the first continental congress, for which he prepared the "Petition to the King" and the "Address to the Inhabitants of Quebec." In the second continental congress, again representing Pennsylvania, he was the principal author of the "Declaration . . . Setting Forth the Causes and Necessity of Their Taking Up Arms," and he wrote the so-called "Olive Branch Petition." He was also instrumental in preparing the first draft of the Articles of Confederation. However, he vigorously opposed a declaration of independence in the early summer of 1776, calling for delay, notably in a speech made on July 1. When it became apparent that sentiment ran against his views, he absented himself from the congress and was replaced. Dickinson did not sign the Declaration of Independence and temporarily retired from politics. He was unjustly suspected of turning Loyalist and afterward served in the patriot militia.

Because of his cautious attitude toward declaring independence, Dickinson lost much of his influence outside Pennsylvania and Delaware. He was nevertheless elected president of the council (*i.e.*, governor) of Pennsylvania in 1782, and also served in 1786 as the president of the Annapolis convention. As a member of the federal convention from Delaware in 1787 he stood for the small states against the large states, but signed the constitution and laboured for its adoption in the two states where he exercised influence. As "Fabius" he defended the document in a series of vigorous letters.

Dickinson college at Carlisle, Pa., chartered in 1783, was named in his honour. He was the first president of its board of trustees, and one of its principal benefactors.

Dickinson died Feb. 14, 1808, and was interred in the Friends' burial ground at Wilmington, Del.

See C. J. Stillé, "Life and Times of John Dickinson," *Memoirs of the Historical Society of Pennsylvania*, vol. xiii (1891); P. L. Ford (ed.), "The Writings of John Dickinson," *Memoirs of the Historical Society of Pennsylvania*, vol. xiv (1895). (J. R. AL.)

DICKINSON, JONATHAN (1688–1747), American Presbyterian clergyman, one of the foremost of the colonial period, and first president of Princeton university, was born in Hatfield, Mass., April 22, 1688, and graduated from Yale college in 1706. He was settled as pastor of the town church of Elizabethtown, N.J., in 1708. Though moderately Congregational in persuasion, Dickinson and his people tended toward Presbyterianism. In 1717 he joined with the newly founded (1706) Presbyterian body in the Middle Colonies. He quickly became a leader also in theological thought and debate. When in 1721–29 this Presbyterian body, by that time a synod of three presbyteries, came to adopt a constitution, it was largely through Dickinson's efforts that the undefined ecclesiastical powers were given to the presbyteries and not to the central body, the synod. Also, in the matter of creedal subscription by ministers, a distinction was to be allowed between "essential and necessary points of doctrine" and points "extra-essential and not necessary." The synod was made up of a Scotch-Irish group (the Old Side) and a group of members of mixed origins (the New Side), largely of New England origins. The compromise sponsored by Dickinson soon proved unacceptable to the Old Side, and much controversy ensued. The church was further plagued by differences of opinion on the Great Awakening revival movement of the 1730s and 1740s. Though hesitant at first,

Dickinson joined the backers of the Great Awakening. In 1746 the New Side founded the College of New Jersey (later Princeton university), with Dickinson as president. He died Oct. 7, 1747.

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DICKSON, SIR JAMES ROBERT (1832–1901), Australian statesman, premier of Queensland in 1898–99 and an advocate of federation, was born in England, at Plymouth, on Nov. 30, 1832. He emigrated to Australia in 1854 and continued the career in banking which he had begun at Glasgow. He later settled in Queensland, became an auctioneer and commission agent in Brisbane in 1862, and was elected to the legislative assembly in 1873. In 1876 he was appointed secretary for public works and mines, and then colonial treasurer. He became leader of the opposition in 1881, was again made colonial treasurer in 1883, and served as acting premier in 1887 during the absence in England of Sir Samuel Griffith. Soon afterward he resigned because of a disagreement over land policy and in 1888 lost his seat in parliament. He was once more returned to the assembly in 1892 and supported the movement in favour of importing Asian labour for work in the tropical regions of the colony. He became secretary for railways and postmaster general in 1897 and home secretary in 1898. In Sept. 1898 he succeeded T. J. Byrnes as premier. He resigned at the end of 1899 and after a short-lived intervening ministry, became chief secretary in the government of Robert Philp.

Dickson had represented Queensland in the federal councils of 1886 and 1887, and supported federation in the referendum of 1899. He was one of the Queensland delegates to England in connection with the passage of the commonwealth bill, and on his return to Australia was elected to the federal parliament and appointed minister of defense in the first commonwealth government. He died in Sydney on Jan. 10, 1901, having been knighted a few days before. (J. F. C.)

DICOTYLEDONS, plants of the Dicotyledonae, the larger of the two great groups (the smaller is the Monocotyledonae) of flowering plants, or angiosperms. The majority of common garden plants are dicotyledons. All of the group are characterized by the presence of a pair of seed leaves, or cotyledons, in the embryo contained in the seed. *See* Angiosperms; Seed: *Structure*. *See* also Plants and Plant Science.

DICTATING MACHINES: *see* Office Machines and Appliances.

DICTATOR, in modern usage, a ruler enjoying extraconstitutional power; in ancient times, an extraordinary magistrate in the Roman commonwealth. The earlier official title was *magister populi*, which may mean "head of the host" as opposed to his subordinate, the *magister equitum*, who was "head of the cavalry." Emphasis was thus laid on the military aspect of the dictatorship and, in fact, the office seems to have been instituted for the purpose of meeting a military crisis too serious for the annual consuls with their divided command. The repression of civil discord was one of the motives for the institution of a dictatorship. This function of the office is attested by the internal history of Rome. In the crisis of the agitation at the time of the Licinian laws (367 B.C.) a dictator was appointed, and in 314 B.C. a dictator was created for purposes of criminal jurisdiction (*quaestionibus exercendis*). The dictator appointed to meet the dangers of war, sedition or crime was described as the "administrative dictator" (*rei gerundae causa*). He held office for six months.

The powers of a dictator were a temporary revival of those of the kings, with some limitations. The dictator was never concerned with civil jurisdiction. His military authority was confined to Italy; and his power of life and death was limited. By the *lex Valeria* of 300 B.C. he was made subject to the right of criminal appeal (*provocatio*) within the limits of the city. But all the magistrates of the people were regarded as his subordinates. The dictator was nominated by one of the consuls. But the senate claimed authority over the magistrates, and suggested not only the nomination but also the name of the nominee. After nomination, the *lex curiata* confirmed the dictator's imperium (*see* Comitia).

The first dictator is said to have been created in 501 B.C.; the last of the "administrative" dictators belongs to the year 216 B.C. The epoch of the Second Punic War was marked by experiments with the office, such as the election of Q. Fabius Maximus by the people, and the codictatorship of M. Minucius. The emergency office of the early and middle republic has little in common with the dictatorship as revised by Sulla and by Caesar. Ostensibly to prevent its further abuse, M. Antonius in 44 B.C. carried a law abolishing the dictatorship.

Modern dictators, like the ancient ones, have taken over the reins of government in times of emergency, but they have used the powers thus gained to establish a permanent, autocratic and sometimes despotic rule. In this they resemble the ancient tyrants rather than the ancient dictators. Both Benito Mussolini and Adolf Hitler (*qq.v.*) falsely posed as the defenders of popular rights, used democratic institutions and exploited the techniques of mass communication to cement their power; they became heads of the governments in their respective countries formally in accordance with the existing constitutions, and even enjoyed some popular support in spite of their suppression of freedom. The Communist dictatorship in Russia was proclaimed originally as the temporary dictatorship of a political elite to preserve the revolution; it became permanent and, under Joseph Stalin (*q.v.*) was a personal one.

See Absolutism, Political; *see* also references under "Dictator" in the Index volume.

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DICTIONARY, a book listing words of a language, with their meanings in the same or another language, usually in alphabetical order, often with data regarding pronunciation, origin and usage.

The term "dictionary" in one of its Latin forms (*dictionarius*, a collection of words) was used *c.* 1225 by an English scholar, John Garland, as title for a manuscript of Latin words to be learned by heart. The words were arranged not in alphabetical order but in groups according to subject. This *Dictionarius*, used only for the teacher's classroom work in teaching Latin, contained no English except for a few interlined glosses (translations of single words).

15th and 16th Centuries.—In the 15th century English words did appear in dictionaries, but even then they were used only as an aid to the study of Latin, as in the famous *Promptorium Parvulorum* ("Storehouse for the Little Ones"), a pioneer English-Latin wordbook. This important manuscript, completed in Norfolk *c.* 1440, was the work of a Dominican friar known as Galfridus Grammaticus (Geoffrey the Grammarian). He listed about 12,000 English words, mostly nouns and verbs, with their Latin equivalents, and for some time his dictionary held a place of leadership. The *Promptorium* was written several years before the invention of printing, but in 1499 it was published at the London press of Richard Pynson, an early servant and associate of William Caxton.

The custom of giving colourful titles to dictionaries was followed for many years. In the *Promptorium* we had a "storehouse," and later, in 1500, came a "garden of words"; for that is the meaning of *Ortus Vocabulorum*, printed by another of Caxton's assistants, Wynkyn de Worde. *Ortus*, a Low Latin form of *hortus* (garden), shows that even scholars sometimes omitted the aspirate. In the *Ortus*, Latin words come first, translated by English. The book, like earlier ones, was designed for students of Latin.

What has been called the first real English dictionary, printed in 1552, was the *Abcedarium Anglico-Latinum pro Tyrunculis*, compiled by Richard Huloet. Huloet, sometimes addressed as "Maister Howlet," was a native of Wisbech in Cambridgeshire. *Pro tyrunculis* means "for young beginners," but Huloet seems to have intended his book for beginners of all ages, including adults whose main interest was to learn to read English. Latin study, as usual, was probably the goal of this work, but the Latin translation was not given until the English word had been defined in English; hence the *Abcedarium* can be regarded as an English dictionary.

Huloet's style was informal and sometimes humorous, as may be judged from some of his definitions:

Bachiler, or one unmaried, or havyng no wife, *Agamus, mi.*
Black (or blewe) spotte in the face or bodye, made with a stroke, as when a wife hath a blewe eye, she sayth she hath stombled on hir good man his fyste. *Suggilatio, onis; Livor, uoris.*
Trymme wenche gorgiously decked, *Phalerata foemina.*

Huloet doubtless felt that the resplendent young lady needed no further definition in English; and it should be noted that wench, in 1552, was a very proper word; it meant simply a girl or young woman.

The *Abcedarium*, which contained 26,000 words, was popular, but it was expensive. This fact was recognized by a Yorkshire schoolmaster and physician named Peter Levins, who decided to write a smaller work; then, he said, "the price being little, the poorer sorte may be able to bie it." Comparing Huloet's big book with his own little one, Levins wrote, "His is for greater students, and them that are richable to have it; this is for beginners and them that are poorable to have no better." From that day to this, richable and poorable have needed dictionaries, and generations of publishers have tried to serve them all. Following the custom of using a picturesque title, Levins named his book, published in 1570, *Manipulus Vocabulorum*, "a handful of words," the handful comprising about 9,000 entries. He also called it, "A dictionarie of English and Latine wordes, set forth in suche order, as none heretofore hath ben . . . necessary not only for scholars that want variety of words, but also for such as use to write in English meetre." To help the poets, he arranged his words not according to their initial letters, but by the spelling of their final syllables, which resulted in a sort of rhyming dictionary, the first of its kind in English. The final syllables, however, brought together some strange bedfellows such as casket, suet; bell, chisel; madame, surname; and—most confusing—bough, cough, through, tough, which even in 1570 were probably not more than "eye rhymes."

In 1573 John Baret published a dictionary which he called *An Alvearie*, or "beehive." In this work an English word is given an English definition, and the equivalent in Latin, followed usually by French. Baret, an ingenious and doubtless popular educator, tells us how the book was compiled: "About eyghteene years agone, having pupils at Cambridge studious of the Latin tongue," they "perceyving what great trouble it was to come running to mee for every word they missed . . . I appoynted them . . . every day to write English before ye Latin, and likewise to gather a number of fine phrases out of Cicero, Terence, Caesar, Livie, etc., and to set them under severall tytles, for the more ready finding them againe at their neede." Baret encouraged his pupil-assistants by calling them his busy bees, and "within a yeare or two they had gathered togither a great volume," like "diligent Bees in gathering their wax and hony into their Hive." Here is a sample entry from the *Alvearie:*

A GOAST, an image in man's imagination, *Spectrum, tri,* Cic. Phantasme, vision. La semblense des choses que nostre pensee ha conceue.

17th Century.—The compilers of early dictionaries made no attempt to include all words. They were satisfied to explain or define the hard words of the language, and often so stated. This custom was illustrated in 1604 when Robert Cawdrey issued his dictionary, *A Table Alphabeticall, conteyning and teaching the true writing and understanding of hard usuall English wordes . . . with the interpretation thereof by plaine English words, gathered for the benefit & helpe of Ladies, Gentlewomen, or any other unskilfull persons.* Cawdrey was another schoolmaster, and his explanations of about 2,500 words may have been based in part on his classroom experience. Much of his work, however, was taken without acknowledgment from earlier writers. It was an era of borrowing, adapting and downright plagiarism, often on a scale that by modern standards would seem outrageous. But almost every writer added something of value, and as dictionaries increased in number they tended to increase also in usefulness. Cawdrey, perhaps recalling the informal or complicated groupings of words in some earlier dictionaries, stressed the importance of the word "alphabeticall" in his title. Apparently some "unskilfull persons" in his day (as in ours) had not taken the trouble to learn their ABC's. So, he said, "Thou must learne the Alphabet, to wit, the order of the Letters as they stand."

At long last, in 1623, a work was issued entitled simply *The English Dictionarie.* The author, or compiler, was "H. C., Gent.," who turned out to be Henry Cockeram. Much of his material was borrowed from Cawdrey and others, but for the use of the intelligentsia he added some weird Latinesque words, such as "*Commotrix*, A maid that makes ready and unready her Mistris; *Glaucitate*, To cry like a whelpe; *Torvitie*, Sowrenesse of countenance." An amusing definition of a more familiar word was "*Ovalt*, a long round circle like an Egge, wherein pictures are sometimes drawne in." Always dramatic, Cockeram calls his preface a "Premonition" or forewarning, perhaps having in mind the third section of his book, a fearsome "recitall" of "Gods and Goddesses, Giants and Divels, Birds and Beasts" and signs and wonders miscellaneous. Here we are told that the "*Hiena*" is "a subtil Beast, counterfeiting the voice of a man . . . He is sometimes male and sometimes female."

In 1656 a London lawyer named Thomas Blount published a dictionary entitled *Glossographia*, loosely translated as "an expounding of strange words." The author addresses himself to readers of all classes, including "the more-knowing Women and less-knowing Men." Blount did the best he could to provide etymologies, which was commendable; but some of his derivations were more amusing than accurate, as when he says "*Tomboy*, a girle or wench that leaps up and down like a boy, comes from the Saxon *tumbe*, to dance."

The *Glossographia* was followed in 1658 by *The New World of English Words*, "collected and published by E. P." "E. P." was Edward Phillips, a writer of only moderate ability. His *New World* was a pretentious work, largely copied from his predecessors, notably from Blount. The word "collected" on his title page was hardly frank enough; the truth would have been better expressed by "appropriated."

In 1676 Elisha Coles, teacher of shorthand, Latin and English, issued *An English Dictionary* with brief and generally adequate definitions and a small but interesting selection of cant and slang expressions. Coles was ingenious; in his address "To the Reader" he wrote:

I am no friend to vain and tedious Repetitions; therefore you will often meet with words, explain'd in their Dependence and Relation to one another, and the Sense compleated by taking them together: As for example
Lupa, a She-wolf that nourished *Romulus* in the
Lupercal, a place near *Rome*, where they celebrated the
Lupercalia, feasts in honour of *Pan*, performed by the
Luperci, Priests of Pan.

Coles died in 1680, but his dictionary was often reprinted and survived him by many years.

18th Century.—John Kersey, an open-minded and progressive lexicographer, is credited with a good small wordbook, *New English Dictionary*, issued in 1702 "by J. K. Philobibl." He also edited and revised Phillips' *New World of Words*, enlarging it in 1706 and somewhat abridging the enlarged version in 1708. Kersey was a pioneer in introducing and defining words of everyday use, which his predecessors had not troubled to do.

In 1721 was issued the *Universal Etymological English Dictionary*, a comprehensive work "compil'd and Methodically digested" by "N. Bailey, Philologos." This was Nathaniel Bailey, an ingenious and enterprising London schoolteacher. His book contained more words "than any English Dictionary before extant." In 1730 Bailey followed with his great *Dictionarium Britannicum*, a folio volume "containing not only the Words, and their Explications, but the Etymologies," and "Illustrated with near Five Hundred Cuts." This was enlarged in 1736. Bailey was more than a lexicographer; he was a philosopher, an entertainer and a humorist. When he came to an important word, he was seldom satisfied merely to define it; he used it as an excuse for a little lecture; for example: "*Woman* . . . the female of the human race . . . Women have two Qualities, a good and a bad. This is, they are either a blessing or a curse, according to the use we make of them"; then about 30 more lines of amusing commentary. Bailey was one of

the pioneers in indicating pronunciation, or at least marking the stressed syllables. Bailey's work was revised and reprinted for many years, and when Samuel Johnson was preparing his own dictionary, he kept by his side an interleaved copy of Bailey's *Dictionarium*.

Johnson, a sort of lexicographical giant, undertook, with very little aid, a work which in modern times would be entrusted to a corps of editors, subeditors and departmental experts numbered in the hundreds. In France and in Italy learned academies had been established to preserve the purity of the national languages. Academic concepts of purity involved a tendency to oppose change, in spite of the fact that change is essential to the life and growth of language. Johnson, with the approval of many of his contemporaries, was expected to be a one-man academy, to set forth the English tongue in all its glory and, if possible, to crystallize it in a classic form. He hoped to do it all within three years; it took him nearly eight—little enough for such a mighty task. That the task was mighty could be realized by anyone who saw the two folio volumes, published in 1755, of *A Dictionary of the English Language . . . by Samuel Johnson, A.M.* And when it was all done, Johnson admitted in his preface that no scholar "can embalm his language and secure it from corruption," and that "no dictionary of a living tongue can ever be perfect, since while it is hastening to publication, some words are budding, and some falling away."

Johnson was a skilled definer. He had a way of perceiving the essential character and use of a word, and of explaining it clearly. He pioneered in the illustration of definitions "by examples from the best writers," a work involving long and painstaking research. A few of Johnson's definitions became famous for reasons that had nothing to do with scholarship; as when he wrote: "*Lexicographer*, a writer of dictionaries; a harmless drudge"; and "*Excise*, a hateful tax levied upon commodities, and adjudged not by the common judges of property, but wretches hired by those to whom excise is paid." Johnson's services to the science and art of lexicography were substantial and of lasting value. They set a high standard for later workers to keep in mind.

In 1791 came the *Critical Pronouncing Dictionary and Expositor of the English Language*, by John Walker, a 59-year-old actor with a trained and perceptive ear and a lively interest in all types of English pronunciation. Walker's dictionary is of value even now because of the author's thorough treatment of pronunciation problems. Its influence was felt throughout Britain and America. More than 40 editions were published. Walker, who died in 1807, was regarded as an authority as late as 1837, when Isaac Pitman, himself a famed phonetician, published a system of shorthand "founded on Walker's Principles of English Pronunciation."

Signs of U.S. Initiative.—As the 18th century drew to its close, more than 20% of the world's English-speaking people were inhabitants of the United States. Pledged to a policy of universal education, they felt the need of an English dictionary designed specifically for use in their primary schools. In 1798 this need was recognized by a Connecticut schoolmaster, Samuel Johnson, Jr., who issued in New Haven, Conn., a little book entitled *A School Dictionary*. Although this work was admittedly a "collection from previous authors," it was well received; it was the first English dictionary compiled by an American. In 1800 it was followed by another small book, *A selected, pronouncing and accented Dictionary*, of about 10,000 words, published at Suffield, Conn. Samuel Johnson, Jr., shared its authorship with John Elliott, pastor of the church in East Guilford. This Elliott-Johnson work showed signs of Americanization; it included a few words peculiar to America (tomahawk, wampum, Cincinnati), or considered to have American meanings (Capitol, federal, freshet). It quoted endorsements from 19 educators, clergymen and others, including Noah Webster, then famed as author of a spelling book. The Connecticut pioneers indicated pronunciation, somewhat crudely, by diacritical marks and an occasional footnote.

Now, also in 1800, came *The Columbian Dictionary*, by another New Englander, Caleb Alexander of Massachusetts. In this work, containing about 32,000 entries, American usage was recognized by a few words (cent, dime, dollar, elector, Congress, Congressional, lengthy, minute-man, Presidential, Yanky), and honor, favor, color, Savior, troop, wo, were so spelled. Some alternatives were listed: calendar-kalendar, chequer-checker, screen-skreen, sponge-spunge. Pronunciation was shown by respelling. Whereas the Connecticut pioneers had given much of their space to "choice" or fairly hard terms, Alexander included also the simple words, providing a vocabulary that could reasonably be called complete.

A few weeks before Alexander's work was published, Noah Webster (*q.v.*), of New Haven, Conn., announced that he was planning a series of dictionaries. The first was published in 1806 as *A Compendious Dictionary of the English Language*. It contained about 40,000 words, with brief definitions. Webster spent years in language study and research to prepare for his masterpiece, *An American Dictionary of the English Language*, published in 1828 in two quarto volumes and thereafter in many revised and improved editions. The 1828 edition, which contained about 70,000 entries, earned general acceptance as an authority, even in England. Some of Webster's definitions were faulty, but many of them were confirmed, years later, when language study had become a science.

Still another New Englander, Joseph Emerson Worcester, issued three reputable dictionaries (1830, 1846, 1860), designed to record and not to reform American usage. Worcester's works were in some quarters preferred to Webster's; but Webster, although he died 22 years earlier than his rival, "had the last word," for he is remembered as America's foremost pioneer lexicographer.

Compilers of British dictionaries in the 19th century availed themselves generously of American aid. Sometimes they acknowledged their indebtedness, notably so in the case of the monumental *New English Dictionary on Historical Principles*, later known as the *Oxford English Dictionary*. This great work, conceived 70 years before its completion in 1928, listed and defined all recorded English words from the 7th century to the 20th. It showed each word in all its traceable forms, with dated quotations and with etymologies determined in the light of modern scholarship. Every possible use of a word was considered, with the result that the little word *set*, for instance, was allotted more than 22 large pages of three columns each. Pronunciation was indicated by scientific respelling.

The project involved years of research by hundreds of volunteers on both sides of the Atlantic. Editor in Chief James A. H. Murray stated that most of the co-operation from "men of Academic standing" came from "Professors in American Universities" and their students. In 1860 supervision of the American workers was in the hands of the Hon. G. P. Marsh of Vermont; in 1879 it was taken over by Prof. Francis A. March of Massachusetts, famed for his 50 years at Lafayette college in Pennsylvania. Both gentlemen were noted philologists, both New Englanders in the pioneer tradition and both were eager to help their British confreres in building a monument to their common tongue.

Historically important is *The Century Dictionary: an Encyclopedic Lexicon of the English Language*, first issued in 1889–91 in six volumes and edited by William Dwight Whitney of Yale. This work, which started as an authorized expansion and Americanization of the English *Imperial Dictionary*, was rich in words, etymologies and literary examples.

Modern Dictionaries.—Prominent among large modern American wordbooks is the Funk and Wagnalls *New Standard Dictionary of the English Language*, first published 1893–95 and revised in 1913 and in later issues. Outstanding among works using the name of Noah Webster was *Webster's International Dictionary*, published in 1890 by G. & C. Merriam company. Its second edition, with "New" added to the title, appeared in 1934. Both editions were generally accepted as authoritative, and the second edition became a standard source in libraries and editorial offices and for general use. After publication of the third edition (1961), a lively controversy arose concerning its "permissive" editorial policy, criticized for failure to discriminate adequately in levels of usage. The dictionary emphasized "descriptive" reporting of usage rather than "prescriptive" judgments. It expanded the number of contemporary quotations and examples illustrating usage.

Noah Webster died in 1843, and his name in many dictionary titles today derives from the days when "Webster" was almost a synonym for dictionary—even as "Calepin" in Europe is used for

some modern wordbooks, although the lexicographer Ambrogio Calepino (*q.v.*) died in 1510.

Popular in the second half of the 20th century are medium-size dictionaries, often described as "collegiate." These are designed for business, school, and home use. Examples are *Webster's New World Dictionary of the American Language*, published in 1953 and frequently revised; also *The American College Dictionary* (1947) and later editions and *World Book Encyclopedia Dictionary* (1963); Funk & Wagnalls' *New College Standard Dictionary* (1958); and *Webster's Seventh New Collegiate Dictionary* (1963).

The *Britannica World Language Dictionary*, published first in 1954 with the *New Practical Standard Dictionary* (renamed the *Standard Dictionary*, revised in 1958 and later), has a master list of English words with their equivalents in French, German, Italian, Spanish, Swedish and Yiddish. In addition to the word list proper, this work includes letters of the alphabet, cardinal numbers, days of the week, months of the year and common first names; also data on grammar and pronunciation; there is a separate index for each language. Another edition of *The Britannica World Language Dictionary* was issued with the *Shorter Oxford English Dictionary*, an abridgment of the *Oxford English Dictionary*. *Wyld's Universal Dictionary of the English Language* (*c.* 1932; appendices 1936, 1952) gives modern British usage.

America's contributions to the vocabulary are found in *Dictionary of American English* (1936–44; 2nd edition, 1960); also, notably, in Mitford M. Mathews' *Dictionary of Americanisms* (1951; 2nd edition, 1956). The latter contains about 50,000 words and expressions, a large percentage of which have earned acceptance as normal English. Several hundred of the more picturesque of these are discussed informally by Mathews in his *American Words* (1959).

Johnson's Dictionary: a Modern Selection, by E. L. McAdam, Jr., and G. Milne, was published with Samuel Johnson's famous Preface in 1963.

Foreign-Language Dictionaries.—Lexicography as a science owes much to the researches of Jacob Grimm (*q.v.*), one of the world's master philologists, discoverer of Grimm's law, and his hardly less famous brother Wilhelm Grimm. These eminent scholars, who did not think it beneath them to write the stories known as "Grimm's Fairy Tales," collaborated in launching a German dictionary on scientific principles, the great *Deutsches Wörterbuch*, started in 1852 and completed years later by their followers. In many ways the *Wörterbuch* served as an aid to workers in other languages.

Also of international repute and service in this field was Émile Littré, French dictionarian, philosopher and physician, whose *Dictionnaire de la langue française* (1863–72; new edition, 1958) is one of the monuments of lexicography. The 1958 edition contains the author's useful treatise, *Comment j'ai fait mon dictionnaire*. His work, a one-man task for more than 30 years, is a fascinating blend of science and genius. It served as a treasury on which many later compilers have drawn freely.

Pierre Larousse (1817–75), a distinguished French educator, published the *Grand dictionnaire universel* in 15 volumes, virtually an encyclopaedia, completed in 1876 just after his death. His successors have issued a series of dictionaries to meet varied popular needs, such as the *Larousse du XXe Siècle*, an encyclopaedic dictionary, the *Larousse universel* and the *Petit Larousse*, revised from time to time.

Other foreign dictionaries include the following:

Hebrew: H. F. W. Gesenius, *Hebrew and Chaldee Lexicon to the Old Testament* (Ger. original, 1819; Eng. trans., 1957); M. Jastrow, *Dictionary of the Targumim, Talmud Babli and Yerushalmi, and Midrashic Literature*, 2 vol. (1950).

Greek: H. G. Liddell and R. Scott, *Greek-English Lexicon* (first issued 1843; revised 1958); W. F. Arndt and F. Wilbur Gingrich, *Greek-English Lexicon of the New Testament*, revised and adapted from Walter Bauer's German work (1957).

Latin: C. T. Lewis and C. Short, *Latin-English Dictionary* (1907).

French: J. and W. Bellows, *French-English and English-French Dictionary* (1951).

Italian: B. Reynolds (ed.), *The Cambridge Italian Dictionary*, vol. i, Ital.-Eng. (1962).

Spanish: E. B. Williams, *Spanish and English Dictionary* (and Eng.-Sp.) (1957); A. Cuyas, *Appleton's New English-Spanish and Spanish-English Dictionary* (1956).

German: M. Bellows, *German-English, English-German Dictionary* (1956).

Dutch: J. Cauberghe, *Woordenboek* (Dutch-Eng., Eng.-Dutch) (1952).

Swedish: W. E. Harlock *et al.*, *Svensk-Engelsk Ordbok* (Swed.-Eng. only) (1947).

Danish: J. Magnussen *et al.*, *Ordbog* (Eng.-Dan., Dan.-Eng.) (1954).

Icelandic: (of great value in study of all Scandinavian and Germanic languages) R. Cleasby, G. Vigfusson and W. A. Craigie, *An Icelandic-English Dictionary* (1st ed., 1874; rev. ed., 1957).

Russian: M. A. O'Brien, *New Russian-English, English-Russian Dictionary* (new orthography) (1948).

Chinese: Yuen Ren Chao and Lien Sheng Yang, *Concise Dictionary of Spoken Chinese* (1952).

Japanese: O. and E. E. Vaccari, *Concise English-Japanese and Japanese-English Dictionary* (1958).

See also AMERICAN ENGLISH; CONCORDANCE; ENCYCLOPAEDIA; GLOSS AND GLOSSARY; SLANG.

BIBLIOGRAPHY.—Some of the best essays on the making of dictionaries are found in prefaces of the important modern works of the 19th and 20th centuries mentioned above. Separate works of value are *A Survey of English Dictionaries* by Mitford M. Mathews (1923) and *The English Dictionary From Cawdrey to Johnson* by De Witt Starnes and G. E. Noyes (1946). Important also is a Spanish work, *Introducción a la Lexicografía Moderna*, by Julio Casares (1950). Robert L. Collison's *Dictionaries of Foreign Languages* (1955) is a useful guide to hundreds of wordbooks, some of them little known. (A. McQ.)

DICTUM DE OMNI ET NULLO, the statement that whatever may be predicated (or denied) of all members of a given class may also be predicated (or denied) of all members of any subclass of that class. This statement has often been considered fundamental to the theory of the syllogism, in the sense that the valid moods of the first figure (*Barbara*, *Celarent*, *Darii* and *Ferio; see* LOGIC, HISTORY OF: *Ancient Logic*), to which all the others are reducible, may be "validated" by means of it. For example, one may interpret the premisses of *Barbara* to assert that *A* is predicated of all *B* and that *C* is a subclass of *B;* then the *Dictum* justifies the conclusion that *A* may be predicated of all *C*. Similarly, the first premiss of *Ferio* denies *A* of all *B*, while its second premiss says that *Some C* is a subclass of *B*, and thus *A* may be denied of *Some C*. The moods *Celarent* and *Darii* are treated analogously. Several rather different versions of the *Dictum* exist. There is also a lack of agreement as to which passage in Aristotle's works, if any, is the ultimate source. Most authorities favour the statement in his *Prior Analytics* I, col. 24 b, 28–30: "We use the expression 'predicated of all' whenever no instance of the subject can be found of which the predicate is not true." Others point instead to col. 25 b, 32–35, in the same book and one common version of the *Dictum* appears to be a translation of *Categories*, 1b, 10–12. There is, however, no evidence that Aristotle himself regarded any of these statements as the foundation of his syllogistic. (B. Ms.)

DICTYS CRETENSIS, according to the prologue of the *Ephemeris belli Troiani* which goes under his name, followed Idomeneus to Troy, and at his instigation composed an account of the Trojan War; the manuscript, written in Phoenician characters, was buried in Dictys' tomb at Knossos. discovered in the reign of Nero, and by Nero's command transliterated into Greek script. The Latin *Ephemeris*, a supposed translation of this account by Lucius Septimius (probably 4th century A.D.), was a source of medieval versions of the Troy story equal in importance to the *De excidio Troiae* of Dares Phrygius (*q.v.*), which it resembles in its provision of authenticating detail and in its partisanship (Dictys is pro-Greek, Dares pro-Trojan). A papyrus fragment of a Greek version shows Septimius to have been a translator who closely followed his original in books i–v though book vi, on the return of the Greeks, condenses books vi–x. The origi-

nal Greek text probably dates from the 1st or 2nd century A.D.

See edition, with papyrus fragment, by W. Eisenhut (1958).

(D. R. Br.)

DICUIL (fl. 825), Irish monk, grammarian and geographer, whose work, important to the historian of science, is a monument of Irish learning in the 9th century. Much of his astronomical knowledge was gained in calculating dates to regulate the calendar for religious festivals. His *De mensura orbis terrae*, finished in 825, contains the earliest notice of a European discovery of and settlement in Iceland and the most definite western reference to the old fresh water canal beween the Nile and the Red sea, blocked up in 767.

In 795 Irish hermits had visited Iceland, where they marveled at the perpetual day of midsummer. Relics of their settlements were found by the permanent Scandinavian colonists of Iceland in the 9th century. Of the old Egyptian fresh water canal Dicuil learned from one "Brother Fidelis," probably another Irish monk, who, on his way to Jerusalem, sailed along the "Nile" into the Red sea—passing on his way the "Barns of Joseph" or pyramids of Gizeh, which are well described. Dicuil's reading was wide; he quotes from, or refers to, 30 Greek and Latin writers and his contemporary, the Irish poet Sedulius; he professes to utilize the alleged surveys of the Roman world executed by order of Julius Caesar, Augustus and Theodosius.

A short astronomical treatise written between A.D. 814 and 816 was edited by Mario Esposito in the *Proceedings of the Royal Irish Academy*, vol. xxvi, s. C (1907). The best edition of the *De mensura* was made by G. Parthey (1870).

See also C. R. Beazley, *Dawn of Modern Geography*, vol. i (1897).

(E. E. E.)

DIDACHE (Teaching of the [Twelve] Apostles), an early Christian document known from references in early writers but not discovered in manuscript until 1875, in Constantinople, by Philotheos Bryennios. It comprises 16 short chapters dealing with morals and church practice. *See* Apostolic Fathers; Constitutions, Apostolic (for the seventh book of which it forms the basis).

DIDEROT, DENIS (1713–1784), French man of letters and philosopher, was one of the most brilliant and original thinkers of his age and the chief editor of the *Encyclopédie*, the magnificent testament of the age of Enlightenment.

He was born Oct. 5, 1713, at Langres, where he received his early education, and was tonsured at the age of 13, but he did not in fact enter the church. His father, a master cutler, was much respected in his own milieu and by his son. In 1729 Diderot moved to Paris where he attended classes at the Jansenist Collège d'Harcourt, or at the Jesuit Lycée Louis-le-Grand or most probably at both these institutions. It is known that he was awarded the degree of master of arts in the University of Paris on Sept. 2, 1732. He proceeded to study law, as an articled clerk, in the office of Maître Clément de Ris, but he was more interested in mathematics and in languages, in which he showed exceptional proficiency. From 1734 to 1744 he led a penurious existence as a publisher's hack, writing sermons for missionaries at 50 *écus* each and seeking relaxation in the coffee houses, particularly the "Régence" and the "Procope," where he became acquainted with Jean Jacques Rousseau. There is evidence that Diderot intended, about 1741, to take up an ecclesiastical career but none that he actually entered the seminary of St. Sulpice. In 1741 he met Antoinette, daughter of Mme Champion, a linen draper, and in 1743 was married secretly to her, since his father disapproved. The marriage, at first romantic, was unhappy, since the couple had little in common. Of their four children only Angélique, born in 1753, survived, and she became one of his deepest attachments. He took great pains over her education and later arranged her marriage.

Mme de Puisieux, for whose financial advantage he published the *Pensées philosophiques* (1746) and *Les Bijoux indiscrets* (1748), was his mistress for a time; and with Sophie Volland, whom he met in 1755 or 1756 and to whom he remained attached until her death in 1784, he enjoyed an intimate friendship. His correspondence with Sophie, which has been preserved, forms, with his other letters, one of the most fascinating documents on Diderot's personality, enthusiasms and ideas, as well as on his social connections, the milieu of Mme d'Épinay and his close friend Baron F. M. Grimm, of the baron d'Holbach, the *abbé* Ferdinando Galiani (*q.v.*) and many *philosophes*. The letters are written in a vivid, colloquial style and are highly prized for their entertaining qualities and for their insight into the life of the period. They reveal the exuberant conversationalist, the gifted narrator and the emotional lover. Through his friendship with Rousseau, which lasted for 15 years, Diderot met the philosopher the *abbé* E. B. de Condillac (*q.v.*), and for a time the three friends dined together once a week at the "Panier fleuri." Diderot broke with Rousseau in 1758 over the three-cornered entanglement involving J. F. de Saint-Lambert, Mme d'Houdetot and Rousseau, but there is considerable controversy over differing accounts of the quarrel.

In 1745 Diderot was approached by the publisher André le Breton with a view to bringing out an encyclopaedia. It was originally to have been a French translation of Ephraim Chambers' *Cyclopaedia* (which in turn owed much to the Dictionnaire de Trévoux), entrusted in 1743 to John Mills and Godefroy Sellius. But Diderot soon changed the whole nature of the undertaking, turning it into an important organ for mobilizing radical and revolutionary forces. He had already had some experience of translation work, having rendered into French the 3rd earl of Shaftesbury's *Inquiry Concerning Virtue or Merit* (in 1745), Temple Stanyan's *Grecian History* (in 1743) and Robert James's *A Medicinal Dictionary* (in 1746–48). He seized the opportunity of broadening the scope of the project and gathered together a team of active and devoted workers, among them littérateurs, scientists and even priests, some well established, others at the beginning of their careers, but all fired with a common purpose: to further knowledge and by so doing strike a resounding blow against reactionary forces in church and state. Diderot outlined his program in a *Prospectus* (1750), leaving it to his co-editor Jean d'Alembert (*q.v.*) to expand and systematize it in his momentous *Discours préliminaire* (1751). They saw knowledge as an organized whole and stressed the interconnections between the sciences in a genealogical tree which owes something to Francis Bacon. As a *dictionnaire raisonné*, the *Encyclopédie* was to bring out the essential principles and applications of every art and science. The underlying philosophy was rationalism and faith in the progress of the human mind. The history of the *Encyclopédie* (*see* Encyclopaedia), from the publication of the first volume in 1751 to the distribution of the final volumes of plates in 1772, was checkered but ultimate success was never in doubt. Diderot was undaunted by the cabals of enemies and the desertion of friends. A critical moment occurred in 1758 on the publication of the seventh volume, when d'Alembert resigned on receiving warning of trouble and reading Rousseau's attack on his article *Genève*. It was at this time that Helvétius's book *De l'Esprit*, said to be a summary of the *Encyclopédie*, was condemned to be burned by the parliament of Paris and the *Encyclopédie* formally suppressed. Diderot's most devastating experience, however, was to discover in 1764 that Le Breton had secretly removed compromising material from the corrected proof sheets of about ten folio volumes. Three hundred pages of proof, with corrections in Diderot's hand, were found in 1933 by D. H. Gordon in A. Rau's catalogue, the documents emanating from the Leningrad collection of Diderot books and manuscripts. The censored passages, of considerable interest, are not such as to have made an appreciable difference on the impact of the work. In fact, nowhere in the *Encyclopédie* is there an overt attack on articles of faith or on the government. This makes the unbridled wrath of the ecclesiastical party surprising unless one remembers the historical context of polemical controversy. To the 17 volumes of text and 11 volumes of plates (1751–72), Diderot contributed innumerable articles, especially on the history of philosophy (the article "Eclectisme," which is a book in itself), social theory ("Droit naturel"), aesthetics ("Beau") and the mechanical arts. He was, moreover, an energetic general editor and supervised the illustrations for 3,000 to 4,000 plates of exceptional interest.

In addition to his work for the *Encyclopédie*, Diderot published the *Lettre sur les aveugles* (1749), which emphasizes our dependence on sense impressions and marks an important step toward atheism. He was arrested because of its daring and irreligion and imprisoned at Vincennes for three months. His *Lettre* is also important for its proposal to teach the blind to read through the sense of touch and for its presentation of the first step in his evolutionary theory of survival by superior adaptation. In 1751 he published the *Lettre sur les sourds et muets*, which studies the function of language and deals with points of aesthetics, and in 1754 the *Pensées sur l'interprétation de la nature*, acclaimed as the *Discours de la méthode* of the 18th century and herald of the new experimental approach to science. Diderot published few other works in his lifetime. His manuscripts were known only to intimates and the privileged correspondents of Grimm's *Correspondance littéraire*. Among his philosophical works special mention may be made of *Le Rêve de d'Alembert*, the *Entretien entre d'Alembert et Diderot* which precedes it (both written 1769, published 1830) and the *Eléments de physiologie* (1774–80). In all these works Diderot developed his materialist philosophy, foreshadowing the evolutionary doctrine and evolving the first modern theory of the cellular structure of matter. But though his speculations in the field of science are of great interest, it is the dialectical brilliance of their presentation that is exceptional. Diderot successfully exploited a manner initiated by Bernard de Fontenelle, but unlike Fontenelle he was more concerned with deepening and developing his thought for its own sake and giving rein to his astonishing imagination, than with popularizing his argument for the benefit of the contemporary reader. His ideas, often propounded in the form of paradox and invariably in dialogue, stem from a sense of reality and a profound understanding of the complexities and contradictions inherent in human nature. All his works reveal his penetrating mind and show him to be an original thinker with flashes of intuitive insight.

His essays, among them *Regrets sur ma vieille robe de chambre* (1772) and *Entretien d'un père avec ses enfants* (1773), share the same qualities of form and style as his short stories, *Les Deux Amis de Bourbonne* (1773) and *Ceci n'est pas un conte* (1772, published 1798), and his novels: *La Religieuse* (1760, published 1796), *Jacques le Fataliste* (1773, published 1796) and *Le Neveu de Rameau* (written between 1761 and 1774), which Goethe so greatly admired and translated in 1805 (French edition in 1823, authentic text in 1891). *Jacques le Fataliste*, which owes something to Laurence Sterne and has been considered as a kind of "anti-*Candide*," is in the tradition of the picaresque novel and of the *conte philosophique*. Jacques, who believes in Fate, is involved in an endless argument with his master, who does not, as they journey along retelling the story of their lives and loves. Diderot's philosophical standpoint is ambivalent, as is his ethical standpoint in *Le Neveu de Rameau*. The latter work may properly be called a satire. It challenges the cant of contemporary society and the hypocrisy of conventional morality. It offers a vigorous dramatic sketch of a parasite and an eccentric, a musician who is gifted yet unable to make his mark through insufficient talent and is shamelessly selfish. The dialogue between Diderot and Rameau's nephew is spontaneous and witty, the comments are pungent, bitter and ironic; the arguments are well sustained and wholly convincing because they are related to character, personality and idiosyncrasies of expression and movement. There are digressions, a lengthy disquisition on contemporary musical controversies and diatribes against Diderot's own enemies. This brilliantly conceived, highly original and entertaining *divertissement* cuts deep. It has authenticity and reveals the complexity of Diderot's nature and of his philosophical ideas. In the *Supplément au voyage de Bougainville* (1772, published 1796), Diderot emphasized his conception of a free society based on tolerance and developed his views on sexual liberty.

Diderot, who was deeply interested in the theatre, had many of the qualities necessary for the successful playwright. His delightful play *Est-il bon? Est-il mechant?* (1781, published 1834), which was not staged, is a small masterpiece. Yet neither of his major plays, *Le Fils naturel* (1757) and *Le Père de famille* (1758), was truly successful. However, his theories, which are to be found in *Entretiens sur le Fils Naturel* (1757) and *De la poésie dramatique* (1758), are important to the history of drama. Taking as his starting point the *comédie larmoyante*, which he admired, he stressed the need for greater realism on the stage and favoured the serious, dramatic, bourgeois drama of real life. Characters should be presented against their milieu and belong to specific professions, so that the moral and social implications of the play, which he considered to be of primary importance, should have greater impact. He urged modifications in stagecraft and décor and was convinced that *tableaux vivants*, reminiscent of canvasses by J. B. Greuze, would deeply move the audience. His theories exercised a determining influence on G. E. Lessing, whose *Hamburgische Dramaturgie* appeared in 1767–68. It was not until the 19th century, however, that certain of Diderot's suggestions were adopted on the French stage by such playwrights as Émile Augier and Dumas *fils*. In his best-known writing on the theatre, the *Paradoxe sur le comédien* (1773–78, published 1830), which is in dialogue form, Diderot argues that great actors, like great poets, are insensitive. The great actor must possess judgment and penetration without sensibility, which would impede his interpretation. His definition of the actor is interesting: "un pantin merveilleux dont le poète tient la ficelle et auquel il indique la véritable forme qu'il doit prendre" ("a fabulous puppet, for whom the poet holds the strings, and determines the essential shaping of his part"). As well as writing on the theatre and his literary criticism—*Réflexions sur Terence* (1762) and *Éloge de Richardson* (1761)—Diderot became an art critic, covering the *salons* or annual art exhibitions of his day for the *Correspondance littéraire* edited by Baron Grimm (1759–81). His analysis of art, artists and the technique of painting is remarkable for a critic without practical experience of painting, yet his approach is a literary one, and the subject of a canvas, its meaning or message, of primary importance. His *Salons* have set a standard for all subsequent art criticism, mainly because of the natural excellence of his taste and the vigour of his writing. They were handsomely edited and illustrated in 1957. Diderot's aesthetic, first expressed in the article "Beau" in the *Encyclopédie*, is to be found in *Essai sur la peinture*, which may be read in conjunction with the *Salons*.

The completion of the *Encyclopédie* left Diderot without a regular source of income. To relieve him of financial worry, Catherine the Great of Russia first bought his library for a substantial sum through an agent in Paris, with a request that he retain the books in Paris until she required them; she then appointed him librarian with a yearly salary for the duration of his life. Diderot went to St. Petersburg in 1773 to thank her and was received with great honour and warmth. He wrote for her the *Plan d'une université pour le gouvernement de Russie* (published 1813–14). After his death his books, and copies of all his manuscripts, were dispatched to Catherine the Great by his daughter Mme de Vandeul. The set of manuscripts which the latter retained with a view to their ultimate publication was preserved, because of the prompt action of H. Dieckmann (*cf. Inventaire du Fonds Vandeul et Inedits de Diderot*, 1951) and deposited in the Bibliothèque Nationale.

In 1774 Diderot returned home. Now old and ill, he completed his *Réfutation de l'ouvrage d'Helvétius institulé L'Homme* (published 1875), and in 1778 published an *Essai sur les règnes de Claude et de Néron*, known as *Essai sur Sénèque*, which may be regarded as an apologia. His intimate circle was dwindling. When Rousseau died in 1778 (in the same year as Voltaire) Diderot, who had long been estranged from him, expressed no regret. Mme d'Épinay and d'Alembert died before him. Only Grimm and Baron d'Holbach remained. Slowly Diderot retired into the shell of his own personal and family life. He was now on better terms with his wife and took pleasure in the company of his friend Belle, a jeweler, whom he visited at Sèvres. The death of Sophie Volland in 1784 was a great grief to him. He survived her by only five months, dying of coronary thrombosis on July 30, 1784, in the house in the Rue de Richelieu which Catherine the Great had put at his disposal. Apocryphally his last words were: "Le premier pas vers la philosophie, c'est l'incrédulité" ("The first step toward philosophy is incredulity"), a ghostly reiteration of a statement

made in the early *Pensées philosophiques*. It was because of the intervention of his son-in-law that he was buried in consecrated ground at St. Roch.

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DIDINGA, a small Negro tribe of the southeastern Sudan numbering about 2,000 people. Very little is known about them or their ethnical affiliations except that they are closely related to the Murle, Beir and Longarim (who live in the same locality). Despite difference in language and origin, however, their culture is otherwise very similar to the Nilo-Hamitic peoples who surround them. The Didinga are pastoralists, keeping cattle. The men go naked; the women wear aprons and skin mantles. The tribe has a powerful rainmaker, who also officiates for the Longarim and the Nilo-Hamitic Topotha, but in other matters political and ritual authority is exercised by local elders. The Didinga have a reputation as fierce raiders and are a perpetual cause of disturbance to the Sudan administration.

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DIDIUS JULIANUS, MARCUS, Roman emperor in A.D. 193 (March 28 to June 2), came from one of the most prominent families of Mediolanum (Milan). His mother was a close relative of Salvius Julianus, the great lawyer and statesman of Hadrian's reign. Born *c.* 135, Didius Julianus had a long public career of distinction. After commanding the legion at Moguntiacum (Mainz), *c.* 167, he governed northeastern Gaul, Dalmatia, the lower Rhine, Bithynia and his mother's native province of Africa. During the political disturbances of Commodus' reign, he was banished to Milan. He was about 60 yr. old when Commodus was murdered on the eve of Jan. 1, 193. His successor Pertinax was assassinated by the imperial guards at the end of March. Backed by a group of senators with some Milanese connections, Julianus competed with the late emperor's father-in-law, T. Flavius Sulpicianus, in offering the guards a substantial donative (accession bounty), and when Sulpicianus outbid him, he raised his own figure, also promising to restore the memory of Commodus, which the senate had condemned. His offer accepted, he was escorted to the senate house by the guards, to be met by angry demonstrators denouncing the auction and invoking the intervention of the army in Syria. The legions of the Danube, however, marched on Rome and killed him, proclaiming their principal commander P. Septimius Severus as emperor.

DIDO (ELISSA), the reputed founder of Carthage (*q.v.*), daughter of the Tyrian king Mutton, wife of Acerbas. Her husband having been slain by her brother Pygmalion, Dido fled to Cyprus, and thence to the coast of Africa where she purchased from a local chieftain, Iarbas, a piece of land on which she built Carthage.

The city soon began to prosper and Iarbas sought Dido's hand in marriage, threatening her with war in case of refusal. To escape from him, Dido constructed a funeral pile, on which she stabbed herself before the people.

Virgil, in defiance of the usually accepted chronology, makes Dido a contemporary of Aeneas, with whom she fell in love after his landing in Africa, and attributes her suicide to her abandonment by him at the command of Jupiter. Dido was identified with the Virgo Caelestis; *i.e.,* Tanit, the tutelary goddess of Carthage. Timaeus is the oldest authority for the story; the meaning of the name Dido is uncertain.

DIDOT, the name of a family of French printers, publishers, type founders and papermakers. The founder of the family business and its various later ramifications was FRANÇOIS DIDOT (1689–1757), who began business as a printer and bookseller in Paris in 1713. Among his important productions was a collection of the travels of his friend, the Abbé Prévost, published (1747) in 20 volumes. FRANÇOIS AMBROISE DIDOT (1730–1804), son of François, is noted mainly for important improvements in type founding and is thought to have been the first to attempt printing on vellum in 1780. Among the works that he published was a collection of French classics prepared by order of Louis XVI. PIERRE FRANÇOIS DIDOT (1732–1795), his brother, was especially adept at type founding and papermaking. Among the works printed on his press was an edition in folio of the *Imitatio Christi* (1788). HENRI DIDOT (1765–1852), son of Pierre François, is remembered chiefly for his editions of various standard works printed with microscopic types; he engraved these small types when almost 70 years of age. LÉGER DIDOT (1767–1829), second son of Pierre François, was the inventor of a papermaking machine. PIERRE DIDOT (1761–1853), eldest son of François Ambroise, is noted mainly as the publisher of especially beautiful editions of Virgil (1798), Horace (1799), Racine (1801–05) and other classics.

FIRMIN DIDOT (1764–1836), another son of François Ambroise, was credited with inventing stereotyping and was noted as a publisher, printer, type founder and author. He was the author of two tragedies—*La Reine de Portugal* (1824) and *La Mort d'Annibal* (1817). AMBROISE FIRMIN DIDOT (1790–1876), eldest son of Firmin Didot, published many important works with his brother HYACINTHE FIRMIN DIDOT (1794–1880). When the father retired in 1827, the two brothers took over the business. Their most important publishing venture was a new edition of the *Thesaurus Graecae linguae* compiled by Henri Estienne (9 vol., 1855–59). Among numerous other important works published by the two brothers were the 200 volumes forming the *Bibliothèque des auteurs grecs, Bibliothèque latine* and *Bibliothèque française.* In 1875 Ambroise Firmin Didot published a learned, elaborate monograph on Aldus Manutius, Venetian printer of the 15th century. At the time of his death, his collection of manuscripts was said to have been worth 2,000,000 francs.

The Didot business was operating in Paris in the 1960s as F. Didot and Company. (W. V. HA.)

DIDYMA (DIDYMI or BRANCHIDAE), an ancient sanctuary of Apollo in Ionia, *c.* 15 mi. S. of Miletus (by road), in the Aydin *il* (province) of Turkey. The name Branchidae derived from the priestly caste, which claimed descent from Branchus, a youth beloved by Apollo. As the seat of an oracle, the archaic Ionian temple attracted offerings from the pharaoh Necho and the Lydian Croesus, but was plundered and burned either (according to Herodotus) by Darius the Great of Persia or (according to Strabo and others) by Xerxes I early in the 5th century B.C. The Branchidae, willing exiles to Bactria, were massacred there by Alexander the Great. The famous cult statue of Apollo, by Canachus, familiar from reproductions on Milesian coins, was also carried off to Persia, there to remain till restored by Seleucus I. The oracle revived under Alexander, and the extant temple was begun about 300 B.C. Still incomplete under Caligula, who wished

to appropriate it, the structure was never wholly finished. But, even as it was, Strabo considered it the greatest Greek temple, and Pliny placed it among the four most splendid, second only to the Artemisium at Ephesus.

The first excavation, by E. Pontremoli and B. Haussoullier, cleared the front parts and discovered some of those building inscriptions now surmised to cover a century and a half of the temple's erection. The whole building was finally cleared by T. Wiegand and H. Knackfuss between 1905 and 1930. The noble remains reveal it as a decastyle dipteral Ionic structure, standing on seven steps and with outer columns 60 ft. high, 21 in each row on the flanks. It is remarkable not only for its great size but also for its large, sunken, hypaethral cella with free-standing *naiskos* (shrine); its complicated *pronaos* (hall), the rear of which is in two stories; the staircases, or labyrinths (a very early example of vaulting), down to the lower *pronaos* (*prodomos*) and cella; the elaborate external order, with varied bases, figured "eyes" to the volutes and Medusa heads in the frieze; and the antae and engaged Corinthian columns of the cella.

There survive some carved pieces from the earlier temple, and also some archaic statues removed from the Sacred Way by C. T. Newton and now in the British museum.

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DIDYMIUM, originally regarded as a chemical element, was found by C. A. von Welsbach in 1885 to be a mixture of the two elements praseodymium (*q.v.*) and neodymium (*q.v.*). *See* also RARE EARTHS.

DIDYMUS THE BLIND (*c.* 313–*c.* 398), head of the catechetical school of Alexandria, where he was born and died, supported the Council of Nicaea and commented on various books of the Bible. His works, but not his person, were condemned at the fifth ecumenical council (553) for teaching Origenist doctrine. His biblical commentaries survive in fragments only; those on the Catholic Epistles are of dubious authenticity. He wrote treatises on the Trinity, the Manichees (his authorship of both has been questioned) and the Holy Spirit (extant in Latin translation).

See J. P. Migne, *Patrologia Graeca,* vol. xxxix (1858) for most of his works; *see* also A. Van Roey in A. Baudrillart (ed.), *Dictionnaire d'histoire ecclésiastique et de géographie,* vol. xiv (1960).

DIDYMUS CHALCENTERUS (*c.* 83–10 B.C.), Greek scholar and grammarian and one of the chief channels through which ancient learning was transmitted to modern times. Born at Alexandria, he taught there and later perhaps at Rome. His surname, which means "of the brazen guts," came from his industry; he was said to have written more than 3,500 books, most of them compilations from earlier authors. Later commentators, scholiasts and lexicographers drew freely on his vast store of information. His works comprised: (1) an attempt to recover the lost editions of Homer by Aristarchus from later copies and Aristarchus' other Homeric writings; (2) commentaries on many other Greek poets and prose writers which seem to have aimed particularly at illuminating the subject matter; (3) numerous lexicographical works, the most important being his collections of phrases from tragedy and comedy; (4) grammatical writings; (5) miscellaneous contributions to literary history, on myths and legends, the Greek lyric poets, the tablets of the laws of Solon, proverbs, etc.

See M. Schmidt (ed.), *Didymi Chalcenteri grammatici Alexandrini fragmenta* (1854); J. E. Sandys, *A History of Classical Scholarship,* vol. 1, 140–143, 3rd ed. (1921). (E. A. B.)

DIEBITSCH, HANS KARL FRIEDRICH ANTON, COUNT (1785–1831), called by the Russians IVAN IVANOVICH DIBICH-ZABALKANSKI, Russian field marshal, was born of a German family at Grossleipe, Silesia, on May 13, 1785. He was educated at the Berlin cadet school, but passed into the service of Russia in 1801. He served in the campaign of 1805, was wounded at Austerlitz and fought at Eylau and Friedland, after which he was promoted captain. He distinguished himself in Count P. K. Wittgenstein's campaign, in particular at Polotsk (Aug. 17–18, 1812), and was promoted major general. In the latter part of the campaign he served against the Prussian contingent of Gen. J. D. L. Yorck von Wartenburg, with whom, through Karl von Clausewitz, he negotiated the convention of Tauroggen, serving thereafter with Yorck in the early part of the War of Liberation. After the battle of Lützen he served in Silesia and took part in negotiating the secret treaty of Reichenbach. He fought at Dresden and Leipzig. At the crisis of the campaign of 1814 he urged the march of the allies on Paris. In 1815 he attended the congress of Vienna, and was afterward made adjutant general to the emperor Alexander I, who had great confidence in him and showed him special favour. In 1824 he had become chief of the general staff, and in 1825 he assisted in suppressing the rising of the Dekabrists (*q.v.*) in St. Petersburg. He was made count in 1827. His greatest exploits were in the Russo-Turkish War of 1828–29, which was decided by Diebitsch's brilliant campaign of Adrianople, which surrendered to him on Aug. 20, 1829; this won him the rank of field marshal and the designation "Zabalkanski" to commemorate his march across the Balkans. In 1830 he was appointed to command the army destined to suppress the insurrection in Poland. He won the terrible battle of Grochow on Feb. 25 and was again victorious at Ostroleka on May 20, but soon after he died of cholera (or by his own hand) at Kleszow near Pultusk, on June 10, 1831.

DIE CASTING (PRESSURE CASTING). Die casting is the manufacture of a metal object by injection of molten metal under high pressures into molds (dies) of metal. The molds, or dies, are the inverse shape of the object (casting) being made. Die casting differs from the English gravity die casting and its American counterpart, permanent mold casting, in which reusable molds made of metal are fed by gravity pressure or centrifugal force only (*see* FOUNDING: *Methods of Molding*). Die casting employs injection pressures on the liquid metal up to 100,000 lb. per square inch (p.s.i.) with forces for locking large die faces in position reaching as much as 4,000,000 lb. Although die casting is not a 20th-century development (the Mergenthaler Linotype machine invented in 1884 is one of the earliest applications of this process), it was not used industrially to any great extent until World War I. The process, as well as the casting made, is called die casting in America and pressure die casting in England.

The development and adoption of the automotive assembly-line technique of manufacturing opened up a huge consumer outlet for die castings and provided the necessary stimulus for mass production needed to make die casting an economical method of manufacturing. Castings produced by this process vary from tiny pieces, such as carburetors or sewing-machine parts, to single-piece aluminum engine-block castings weighing up to 45 lb. By means of high injection pressures it is possible to make thin, satin-smooth castings of such well-known items as vacuum-cleaner heads, automobile grills, sewing-machine heads and bases, lawn-mower bodies and thousands of less well-publicized engineering parts. Linear dimensional accuracies of 0.001 in. per inch make it possible to use mating interlocking parts without expensive machining; also, inserts can be used in the metal dies (such as cast-iron cylinder walls or threaded mounting pins) to produce castings requiring little or no machining. The high production rate (up to 500 cycles per hour) and adequately high strength of die castings make the

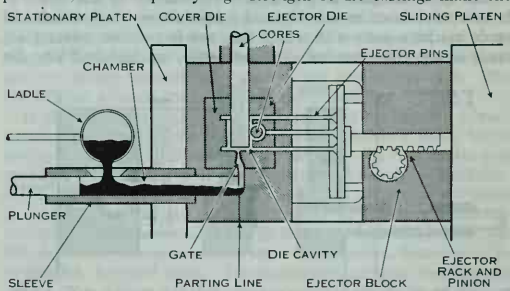

FIG. 1.—CROSS-SECTION VIEW OF A COLD-CHAMBER DIE-CASTING MACHINE SHOWING METAL BEING LADLED INTO A CHAMBER

process attractive to production-minded engineers. One or several die castings can be made for each injection by use of multiple impression dies.

The two basic die-casting processes are identifiable by their names; the cold-chamber machine employs a water-cooled cylinder into which metal is ladled as in fig. 1, and the piston or gooseneck type (submerged plunger) which has the pot of metal mounted directly to the machine. Both types are identical, except for the method of injecting molten metal into the dies. In both, a movable die half opens and closes by hydraulic or mechanical force or by a combination of hydraulic and mechanical mechanisms. To each die there are two main parts which separate for removal of the casting. One part, called the ejector die (incorporating ejector pins for pushing the casting from the die), and an ejection-pin block with a geared mechanism, is mounted on the movable end of the machine. The other part, the cover die, remains stationary and contains the hole, or sprue, through which metal is fed into the casting cavity. It is at this end that the two machines differ fundamentally. The sequence of operations is shown in fig. 1–4.

The cold-chamber machine provides a cylinder, usually horizontal, into which metal is ladled. The close-fitting water-cooled plunger is positioned at rest in the cylinder behind the pouring slot. After the metal is fed into the cylinder, the plunger is forced forward by hydraulic pressure, which confines the liquid metal suddenly and forces it into the mold cavity. The liquid metal solidifies quickly because the dies are also water-cooled; the dies are then opened and the ejector pins force the casting from the die. The casting cycle is now complete, and the machine is ready for the next cycle. This sequence is repeated in a cadence regulated by electronic timers, solenoids and limit switches.

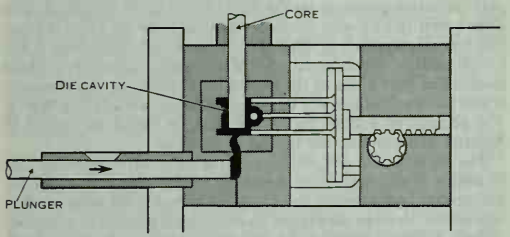

FIG. 2.—LIQUID METAL FORCED INTO THE MOLD CAVITY BY PLUNGER

In the submerged plunger type, both the plunger and the shot cylinder are submerged vertically in the molten metal. With the plunger in the open (retracted) position the metal flows into the cylinder through a hole in its side near the top. On the initial stroke of the plunger the hole is closed by the passing plunger and the metal is forced into the die cavity. The cycle then continues as in the cold-chamber machine. The gooseneck machine may also be designed to dip alternately into the metal and to slide into position against the die sprue before pressure is applied.

The type machine used is usually determined by the metal to be cast; aluminum, magnesium and copper alloys which attack and erode machine parts with which they are in constant contact are made in the cold-chamber machine, while tin, lead and zinc die

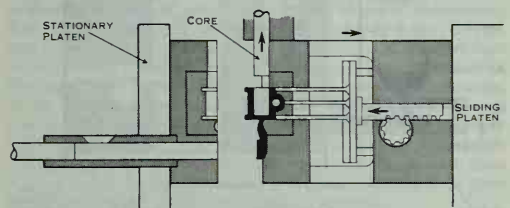

FIG. 3.—CORES WITHDRAWN AND CASTING MACHINE OPENED AFTER SOLIDIFICATION OF LIQUID METAL

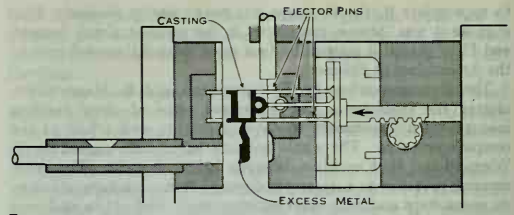

FIG. 4.—CASTING AND EXCESS METAL FORCED OUT OF THE DIE-CASTING MACHINE BY EJECTOR PINS

castings are produced in the submerged plunger or gooseneck type.

Prolonged die life is ensured by elaborately controlled water cooling; this rapid cooling also improves casting properties and accelerates the casting cycle. Metal cores for making precision holes or recesses in the casting may be loose (knockouts) or fixed; positioning and withdrawing cores may be activated manually or automatically. Dies are made of carbon and alloyed steels, and those for higher melting-point castings require heat treatment. The sprue and flash (excess metal, forced between the dies beyond the die cavity) are removed by grinding or by shearing (blanking). Frequently this is the only finishing operation required.

Die design is a highly specialized field, requiring extensive training and experience. Integrating sprues, gates (channels for distributing metal throughout the mold) and ejection mechanisms, with complex design features, is an assignment challenging the ingenuity and empirical knowledge of a capable designer. Each new design presents a new problem. However, by using small dies, mechanically keyed into the cover die or the ejector die like pieces in a jigsaw puzzle, the design may be altered without a major machining operation. Such a procedure reduces die maintenance and alteration expense and facilitates repair.

Since World War II die casting has expanded more rapidly than any other casting process. As metals have been developed for dies that will withstand higher temperatures and that are more resistant to erosion by molten metal, it has become possible to die-cast metals of higher melting points, such as the copper-base alloys. Also, as techniques have been improved and problems solved, more intricate and more accurate engineering castings have been made. *See* also METALLURGY: *Cast and Wrought Metal;* ZINC: *Applications.*

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(H. F. TR.)

DIEFENBAKER, JOHN GEORGE (1895–), Canadian statesman, Conservative party leader and prime minister, was born on Sept. 18, 1895, in Grey county, Ont. He received an M.A. degree from Saskatchewan university in 1916 and, after serving overseas in World War I, returned to acquire a law degree in 1919. While practising law in Saskatchewan he was active in political affairs; elected to the house of commons in 1940, he won the leadership of the Progressive Conservative party in Dec. 1956. In the election of June 10, 1957, his party won an unexpected victory over the Liberals, who had held power for the preceding 22 years, and on June 21 he succeeded Louis St. Laurent as prime minister. In Sept. 1957 Queen Elizabeth II appointed him a member of her privy council. In the election of June 18, 1962, his party lost the majority it had won March 31, 1958, and on April 8, 1963, was defeated by Lester B. Pearson's Liberals; he resigned April 17, to lead the opposition.

DIEFFENBACHIA, a genus of tropical American plants of the arum family (Araceae), much grown indoors for their handsome leaves that are variously spotted with white, cream or yellow markings. They bear minute flowers crowded on an erect fleshy spike that is sheathed by the leaflike spathe. *See* also ARACEAE.

DIÉGO-SUAREZ, the name of a large bay in northern Malagasy Republic (Madagascar), now applied to Antsirana (pop. [1956] 38,305), the town on a promontory at the south of the bay

which developed as a result of the French naval base there. The climate is very hot, with dusty winds injurious to the lungs. West of the town is the Port de la Nièvre, with wet and dry docks; north is the Dordogne basin; and east (the side that opens to the Indian ocean) is Melville basin. The town, of an old colonial style, has no buildings of interest but has slowly been modernized. One main street, the Rue Colbert, crosses it from north to south.

A modern road links Antsirana with Majunga on the west coast and runs on to Antananarivo (Tananarive), capital of the Malagasy Republic. The airport of Arrachart (6½ mi.) is served by internal air services. There is no agriculture, the mountains behind the town being covered with forest. The town's economy is based on the naval yards and on transshipment of cargoes between coasters and larger vessels from outside. Industries include ironworks, soap- and brickmaking and rice milling; salt pans supply the island.

The bay was discovered in 1500 by Diogo Dias, the Portuguese navigator. At the end of the 17th century Misson, a French pirate, founded there the short-lived republic of Libertalia. At the time of the first war with the indigenous Hova (Merina) people (1883–85), French naval forces took possession of the bay, which became French by treaty (1885) ten years before the conquest of the island. Col. (later Gen.) J. J. C. Joffre installed the first heavy coastal batteries there. (J. Ar.)

DIELECTRIC, a relatively poor conductor, or nonconductor, of electricity. The term now is applied to any electrical insulating material. In alternating-current fields, the dielectric characteristics of some materials vary with the frequency, so that a material may be a poor dielectric at low frequencies. The dielectric constant of any material is the ratio of the capacitance of an electrical capacitor (condenser), with that material as the insulating material between the conducting plates, to the capacitance of the same capacitor with vacuum as the insulating medium. The dielectric constant of vacuum is taken as 1.00; that of air, 1.00060, is so nearly unity that it usually is assumed to be the same as that of a vacuum. *See* Capacitor; Electricity; Insulating Material (Electrical).

DIELECTRIC HEATING: *see* High-Frequency Heating.

DIELS, OTTO PAUL HERMANN (1876–1954), German organic chemist who with Kurt Alder was awarded the Nobel prize for chemistry in 1950 for their joint work on the diene synthesis. Diels was born on Jan. 23, 1876, at Hamburg, Ger. He studied chemistry in the University of Berlin under Emil Fischer (*q.v.*) and after various appointments was made professor of chemistry in the University of Kiel in 1916, becoming emeritus in 1945.

In 1906 he discovered the remarkable and highly reactive substance, C_3O_2, carbon suboxide or malonic anhydride, and determined its properties and chemical composition. He devised an easily controlled method of removing some of the atoms of hydrogen from the molecules of certain organic compounds containing much hydrogen by the use of metallic selenium.

His most important work was concerned with the so-called diene synthesis, in which dienes, organic substances containing two double-bonded carbon atoms, such as for example, 1,3-butadiene, $H_2C{:}CHCH{:}CH_2$, were used to effect the syntheses of many organic substances under conditions that threw light on the molecular structure of the products obtained. This method was developed (1928) in collaboration with Kurt Alder, his pupil, later professor of chemistry in Kiel and afterward in Cologne, and is known as the Diels-Alder reaction.

They had taken simple dienes, such as butadiene or its alkyl derivatives, or cyclic dienes, and had combined them with 1,4-naphthoquinones and had obtained a whole series of homologues of anthraquinone without the intervention of any other reagent; complicated molecules were produced by merely putting the reactants together, no great heat being necessary and no great heat being produced; the reactions proceeded in conditions of temperature resembling those in the living organism. Simple dienes such as isoprene give a synthetic rubber on polymerization, and diene syntheses have proved specially important in the production of plastics. Diels died in Kiel on March 7, 1954. (D. McK.)

DIEMEN, ANTONIO VAN (1593–1645), Dutch merchant and colonial administrator, who, as governor general of the Dutch East Indian settlements, greatly extended his country's influence in the far east, was born at Culemborg, Neth., in 1593. After an unsuccessful start as a merchant in Amsterdam, he went in 1618 to Batavia where he had a highly successful career in the Dutch East India company. He was appointed director of the commercial department in 1626 and became governor general in 1636. His rule saw the crushing of a revolt in the Moluccas, the capture of Malacca and Portuguese possessions in Ceylon, the signature of advantageous treaties with the princes of Atjeh, Ternate and Tidore, and the establishment of commercial relations with Tongking, China and Japan. Van Diemen introduced the legal code known as the Batavian statutes and founded at Batavia a Latin school, several Protestant churches, a hospital and an orphanage. The expeditions of Abel Tasman and F. Visscher in 1642 and 1644, which led to the discovery of Tasmania (at first called Van Diemen's Land), New Zealand and other Australasian islands were due to Van Diemen's initiative. He died at Batavia on April 19, 1645. (E. H. K.)

DIEPPE, a seaport of northern France in the *département* of Seine-Maritime, is on the English channel, 58 km. (36 mi.) N. of Rouen and 167 km. (104 mi.) N.W. of Paris by road. Pop. (1954) 25,983. It stands at the mouth of the Arques river in a valley bordered on each side by steep white cliffs. The main part of the town lies to the west and the fishing suburb of Le Pollet to the east of the river and harbour. The sea front of Dieppe consists of a pebbly beach backed by a handsome marine promenade. The port and docks were destroyed and one-third of the town was damaged in World War II. Dieppe has a modern aspect; two squares side by side and immediately to the west of the outer harbour form the nucleus of the town. The church of St. Jacques, founded in the 13th century, consists largely of later workmanship and was restored in the 19th century. The castle, overlooking the beach from the summit of the western cliff, was built in 1435; it houses the museum. The church of Notre Dame de Bon Secours on the opposite cliff and the church of St. Remy, of the 16th and 17th centuries, are noteworthy. A well-equipped casino stands near the sea front and there are golf links. Two miles to the northeast of the town is the ancient camp known as the Cité de Limes.

Dieppe has one of the safest and deepest harbours on the English channel. A curved passage cut in the bed of the Arques and protected by an eastern and a western jetty gives access to the outer harbour, which communicates at the east end by a lock gate with the Bassin Duquesne and at the west end with an inner tidal harbour and two other basins. Vessels drawing 20 ft. can enter at neap tide. A dry dock and a gridiron are among the repairing facilities of the port. The harbour railway station is on the northwest quay of the outer harbour.

The distance of Dieppe from Newhaven, Eng., with which there are daily services except in winter, is 64 mi. Imports include bananas, silk and cotton goods, thread, oilseeds, timber, coal, iron, patent fuel, cement, china clay, machinery, tobacco, mineral oil and motorcars; leading exports are wine, silk, woolen and cotton fabrics, vegetables and fruit, and flint pebbles. The industries comprise shipbuilding, oil refining, steam sawing, the manufacture of machinery, rope, textiles, porcelain briquettes and articles in ivory and bone, the production of which dates from the 15th century. The fishermen of Le Pollet, traditionally of Venetian origin, are among the main providers of the Parisian market. The sea bathing attracts many visitors in the summer.

It is suggested that Dieppe owed its origin to Norman adventurers, who found its *diep* or inlet suitable for their ships, but it was unimportant till the late 12th century. Its first castle was probably built about 800 by Charlemagne and was called Bathaille. Philip Augustus attacked it in 1195 and in 1197 it was bestowed by Richard I of England on the archbishop of Rouen in return for territory at Les Andelys. In 1339 it was plundered by the English, but soon recovered and, in spite of opposition from the lords of Hautot, fortified itself. Its commercial activity was already great. It is believed that its seamen visited the coast of Guinea and founded there a Petit Dieppe in 1365; they were in the bay

of New York in 1543. The town was occupied by the English from 1420 to 1435. A siege undertaken in 1442 by John Talbot, 1st earl of Shrewsbury, was raised by the dauphin, afterward Louis XI, and the day of the deliverance continued for centuries to be celebrated by a great procession and miracle plays. In the beginning of the 16th century Jean Parmentier, a native of the town, made voyages to Brazil and Sumatra, and a little later its merchant prince, Jacques Ango, was able to blockade the Portuguese fleet in the Tagus. Francis I began improvements, continued under his successor. Its inhabitants in great number embraced the reformed religion, and they were among the first to acknowledge Henry IV, who fought one of his great battles at the neighbouring village of Arques, now called Arques-la-Bataille. Few cities suffered more than Dieppe from the revocation of the Edict of Nantes in 1685, and this blow was followed in 1694 by a terrible bombardment on the part of the English and Dutch. The town was rebuilt after the peace of Rijswijk, but its modern prosperity dates only from the 19th century, partly because Marie Caroline, duchess of Berry, brought it into fashion as a watering place, and also because the railway, built in 1848, gave an impetus to its trade.

During the Franco-German War the town was occupied by the Germans from Dec. 1870 till July 1871. Dieppe was a hospital centre for British troops in Sept. 1939 and was occupied by the Germans in June 1940. The Dieppe raid, a sea-borne assault across the channel made mainly by Canadian troops on Aug. 19, 1942, was a costly reconnaissance in force with heavy casualties. It taught valuable lessons stressing the need for teamwork, beach reconnaissance, naval support bombardment and improvements in landing craft.

DIESEL, RUDOLF (1858–1913), German engineer noted for his work on the oil-fuel engine that bears his name, was born in Paris on March 18, 1858, and died by drowning in the English channel on Sept. 29, 1913. He spent his early years in Paris and later studied engineering at Augsburg and Munich. Having learned that the thermal efficiency of an internal-combustion engine was very low, he was inspired to carry out many experiments in order to raise it and thereby reduce the running costs. He had in mind an improved engine with a cycle of operations approaching that of the ideal cycle described by N. L. S. Carnot in 1824. He was convinced by results he obtained that he would arrive at a higher efficiency if he were to compress the air in the cylinder to a greater extent than was customary at that time. The higher temperature thus achieved would suffice to ignite the charge introduced into the cylinder, and no fuel-ignition equipment would be required. After four years of experimental work he completed in Augsburg his first commercially successful diesel engine (1897), which operated according to the principles stated in his German patent specifications of 1892 and 1893. The success of this 25-h.p. four-stroke single-cylinder vertical oil engine attracted world-wide attention, although it was not the first compression-ignition oil engine ever to be constructed; Akroyd Stuart had patented an oil engine which worked at lower pressures in 1890. Diesel published two papers: *The Theory and Construction of a Rational Heat Motor* (Eng. trans., 1894) and *The Genesis of Diesel Motors* (1913). *See* also DIESEL ENGINE. (C. ST. C. B. D.)

DIESEL ENGINE, an internal-combustion engine in which the fuel is sprayed into the cylinders after the air charge has been so highly compressed that it has attained a temperature sufficient to ignite the fuel. All other internal-combustion engines induct and moderately compress an inflammable mixture of air and vaporized or gaseous fuel, and then ignite it by an electric spark. The diesel engine compresses a noninflammable charge (usually air) to so small a volume that the resulting temperature is above the ignition point of an appropriate fuel. The fuel is then sprayed into the highly compressed air and ignited by the high temperature of the air, without a spark. No ignition devices are employed in diesel engines and they might be called compression-ignition engines as a more descriptive name than diesel.

The diesel engine is the predominant source of industrial power throughout the world for units up to about 5,000 h.p., principally because it can burn a low-grade fuel at a lower rate of consumption per horsepower per hour, thus producing cheaper power than other internal-combustion or steam power plants in this horsepower range Low fuel consumption results principally from the higher compression ratio used. A greater fuel saving is effected at partial load than at full load because it is not necessary to throttle the inlet air, as is the case with spark ignition, in order to maintain an inflammable air-fuel mixture. Approximately two-thirds as much fuel is required.

Relatively unrefined fuels can be burned because of the nature of the fuel-injection system and the combustion process. This economic advantage has lessened because processes for making gasoline from the heavy constituents of crude oil have increased the value of fuel oils. High-speed diesel fuels sell for relatively little less than regular gasoline.

Four broad classes of fuels are burned in diesel engines: crude oil, distillates, residuals and natural or by-product gases. Crude oil can be burned in large slow-speed diesel engines after merely centrifuging it to remove sand and water. The distillates, called gas oils by the petroleum industry, are taken from crude oil after the volatile fractions used in gasoline are removed. They range from light fuel oils, differing little from kerosene, to the heavier distillates that have boiling points within the approximate range of 350° to 650° F.

Residuals include all of the ingredients of crude oil remaining after the gasoline and distillate fuels are removed. They are cheaper than the distillates but cannot be burned in high-speed diesels and may cause operating difficulties in larger engines. Natural gas is burned in practically all large, stationary, power-plant diesel engines. The resistance of gases to self-ignition necessitates pilot injection of fuel oil, but cheaper power is produced than with any other fuel.

Specifications for diesel fuels include only those restrictions necessary to prevent impaired performance or damage to the engine. Cleanliness is essential to the life of the injection system. Ignition quality or cetane number affects starting and roughness of running in high-speed diesels (cetane number is the measure of ignition quality of diesel fuels; it is derived from the percentage of cetane in a mixture of cetane and alpha-methyl-naphthalene that has the same ignition quality as the fuel being tested). The viscosity or body of the fuel must not be so high that spraying is difficult or so low that the fuel does not provide lubrication for the injection system. A maximum boiling point is specified for distillate fuels to avoid difficulty in vaporizing the heavier components.

Diesel engines are built so ruggedly that operational failures are uncommon. There is less fire hazard in storage and handling of the relatively nonvolatile diesel fuels. These factors are especially important for marine and other transportation applications.

The diesel engine is handicapped by its higher first cost and greater weight per horsepower, by its exhaust smoke and odour under certain load conditions and by its greater operating noise and vibration. Good progress has been made, however, in minimizing these faults.

HISTORICAL DEVELOPMENT

The first diesel engine was built in Germany in 1897. Spark-ignition engines had then been built commercially for 37 years. The possibility of compression ignition appears to have been first mentioned by the French scientist N. L. S. Carnot, who in 1824 published his *Reflections on the Motive Power of Heat,* in which he discussed the possibility of igniting fuel by compressing air to one-fourteenth of its original volume.

The principle on which the modern automobile engine operates was conceived in 1862 by Alphonse Beau de Rochas, also in France, but was not applied to a practical engine until 1876 when Nikolaus Otto built the first engine in which the charge was compressed in the cylinder before burning. This was the engine that Rudolf Diesel (*q.v.*) undertook to improve when he started the experiments that led to the diesel engine.

After several years of studying the problems involved, Diesel applied for and was granted a patent in Feb. 1892 under the title "Working Processes for Internal-Combustion Engines," and a second patent, granted a year later, that modified the cycle de-

scribed. These patents were not for engine designs, but merely for a thermodynamic cycle to be followed by the gases in the engine cylinder.

The processes described in Diesel's patent claims made up a cycle differing from the theoretical or ideal cycle followed by existing engines only in the rate of combustion of the fuel-air charge. He proposed to burn the fuel during the first portion of the power stroke of the piston so slowly that no pressure rise occurred. As a means of slowing down combustion to avoid the almost instantaneous explosion of the spark-ignition engine, he proposed to induct air alone into the cylinder, instead of a fuel-air mixture, and compress it so highly that it would attain a temperature sufficient to ignite the fuel that would be gradually sprayed into the combustion chamber during the descent of the piston. This method of igniting the fuel requires that the air be compressed to a pressure of about 500 lb. per square inch, which produces a temperature of about 1,000° F.

Diesel presumably thought that any fuel would be suitable for an engine operating in the manner he described. He proposed to build an engine that would burn pulverized coal, the cheapest conceivable fuel, and obtained financial backing for the venture from the Krupp industrial organization which had extensive interests in the coal-mining industry. The coal-burning project was soon abandoned, but work was continued at the plant of Maschinenfabrik Augsburg on an oil-burning engine and, after several failures, the engine ran in 1897.

The fuel economy of Diesel's engine proved to be better than that of any other existing power plant. His engine attracted considerable interest at an industrial exposition in Munich the following year, where Adolphus Busch, a U.S. brewer, saw it. Realizing its possibilities, he purchased a licence from Diesel for manufacture and sale in the United States and Canada. A diesel engine built for his company in 1898 was the first to be placed in regular industrial service.

The diesel engine was not rapidly adopted. Until his death in 1913, Diesel insisted that all engines manufactured under his licences be made to operate with combustion at practically constant pressure, as described in his 1893 patent. This restriction meant that the engines had to run at very low speed and thus possible design improvements were delayed. The early engines were so large and heavy in proportion to their power output that they had no application other than as stationary power plants. The original diesel engine weighed 450 lb. per horsepower.

The first marine installation of a diesel engine was made in 1910, very successfully, and the diesel engine became the predominant power plant for submarines during World War I. The first diesel engine that was small enough and light enough for automotive application was built in Germany in 1922, and opened up numerous fields of application that had previously been closed to diesel engines because of their low specific power output. The higher-speed diesel engines do not follow the slow-burning cycle originated by Diesel. Fuel is injected into the cylinder near the end of the compression stroke and burned rapidly, with sharply rising pressure, while the piston is near its dead-centre position. Only the compression-ignition and fuel injection of Diesel's original engine are retained in the modern high-speed diesel engine.

Although many diesel engines had been in operation for years in motor ships, highway trucks, farm tractors and as industrial power units, public awareness of diesel engines was first heightened when diesel locomotives were introduced on railway trains in 1934. These diesel-powered trains quickly established new records for fast nonstop runs and started a rapid dieselization of all U.S. railroads. Production of diesel engines in the United States the following year, 1935, exceeded 1,000,000 h.p. and this figure was doubled in 1937.

The diesel engine was the most prevalent power plant for military equipment on the ground and at sea during World War II. After that war the diesel engine became the conventional power plant for all railway purposes in the U.S., all heavy construction machinery, a large portion of the trucks and buses operating on the highways and most of the higher-powered farm and construction tractors. The diesel engine has had only limited use in passenger automobiles and other applications where its greater weight and cost combine with its less smooth running qualities to partially offset its lower cost of operation.

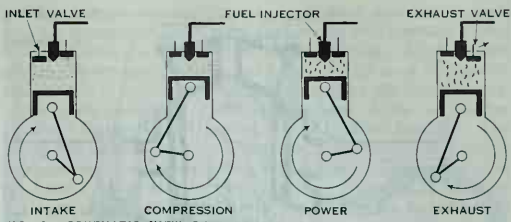


FIG. 1.—SCHEMATIC VIEW OF A FOUR-STROKE-CYCLE DIESEL ENGINE ILLUSTRATING THE SEQUENCE OF CYCLE EVENTS

FUNDAMENTAL PRINCIPLES

Certain operating fundamentals are common to all internal-combustion engines of the reciprocating-piston type. (*See* INTERNAL-COMBUSTION ENGINE.)

The operating cycle or series of events carried out in succession, over and over again, to make an internal-combustion engine run are as follows:

1. A charge of atmospheric air is introduced into the cylinders through intake valves or ports.
2. A proper amount of fuel is introduced into the air charge, either as the air enters, as in the carburetor engine, or sprayed into the cylinder later, as in the diesel engine.
3. The charge is compressed, ignited and burned.
4. The piston is pushed downward by the pressure of the expanding hot gases.
5. The products of combustion are exhausted from the cylinder through the exhaust valves or ports.

These processes require four strokes of the piston if the air is drawn into the cylinder through the open inlet valve by a downstroke of the piston and the exhaust gases are forced out through the open exhaust valve by an upstroke of the piston (fig. 1). The other two strokes, the compression and power strokes, are the basic and necessary strokes of the cycle.

The inlet and exhaust strokes are eliminated in the two-stroke-cycle engine by compressing the fresh charge slightly outside the cylinders so that it will flow in through ports uncovered as the piston approaches the end of the power stroke (fig. 2). Exhaust gases are pushed out through a second set of cylinder ports or valves in the cylinder head by the incoming charge. This process is called scavenging. The two-stroke cycle can be followed more effectively by the diesel engine than by the spark-ignition engine because air alone is used in scavenging the cylinders and no fuel is lost during the process.

Modern two-stroke-cycle diesel engines usually employ Roots-type blowers to supply scavenging air. These are positive-displacement rotary blowers that operate on the principle of the gear-type pump and have two intermeshing impellers with either two or three lobes. Blowers with air capacity considerably exceeding the piston displacement of the engine are used to flush the spent gases thoroughly from the cylinders.

Crossflow and loop-scavenged engines have two sets of cylinder

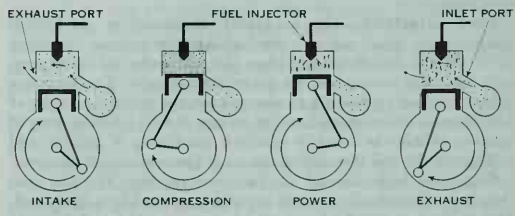


FIG. 2.—SCHEMATIC VIEW OF A TWO-STROKE-CYCLE DIESEL ENGINE ILLUSTRATING THE SEQUENCE OF CYCLE EVENTS

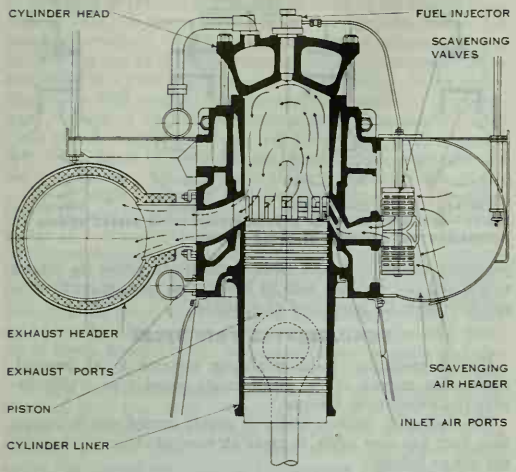


FIG. 3.—SECTIONAL VIEW OF A TWO-STROKE-CYCLE, PORT-SCAVENGED ENGINE. ARROWS INDICATE SCAVENGING AIR PATH

ports, one for entering air and one for the outflow of spent gases. Crossflow ports are on opposite sides of the cylinder and the inlets are inclined upward to oppose the tendency for air to short-circuit across the top of the piston. Loop-scavenged engines have the exhaust ports above the inlets or between two sets of inlets on the same side of the cylinder. Uniflow-scavenged engines have poppet-type valves in the cylinder heads and inlet ports entirely around the cylinder wall. A so-called blowdown period must be provided by timing the exhaust valves to open earlier than the inlet ports to relieve the cylinder pressure and prevent backflow into the air-charging system. Backflow is prevented in the engine of fig. 3 by the use of spring-loaded scavenging valves that permit flow only toward the cylinders.

The size, weight and cost of the engine per horsepower are reduced because the two-stroke engine completes a power stroke during each turn of the crankshaft instead of during each second turn. Most extremely large diesel engines use the two-stroke cycle.

It can be proven by a thermodynamic analysis that the efficiency of an internal-combustion engine operating on either the two-stroke or the four-stroke cycle depends principally upon the ratio by which the charge is compressed before its combustion. The compression ratio is found by dividing the volume in the cylinder when the piston is at its lowest point by the volume of the combustion chamber when the piston is at its highest point. The range of compression ratios at which diesel engines operate is from 12 to 18, which is considerably higher than knock-limited compression ratios for spark-ignition engines.

Analyses also show that combustion should be as rapid as is practical, limited by rough running, and that a high ratio of air to fuel increases thermal efficiency. The diesel engine meets these requirements for maximum efficiency more effectively than other type engines.

Fuel Injection.—The important distinguishing mechanical feature of the diesel engine is the fuel-injection system, consisting of the pumps that meter and place the fuel under injection pressure, the spray nozzles and the governing controls. The functions of the injection system are to measure out the minute quantity of fuel for each injection, to time the instant at which fuel is sprayed into the cylinder in order to establish the timing of ignition and to disperse the fuel throughout the air in the combustion chamber.

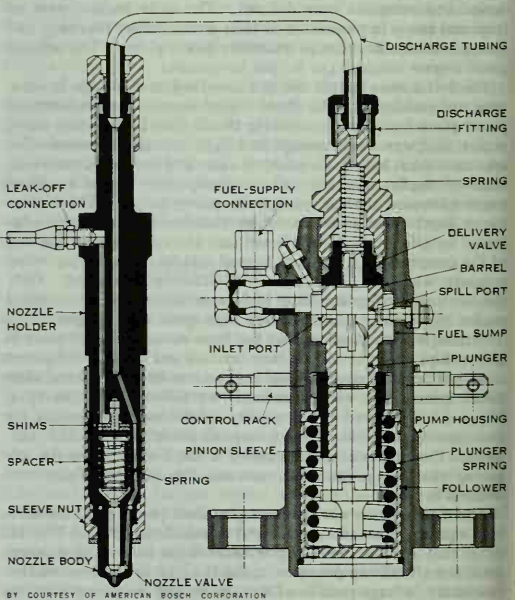
Originally, high-pressure air was used to carry the fuel into the combustion chamber, much as paint is sprayed by a spray gun. This method required a large air compressor and was inherently limited to low-speed-method operations. James McKechnie devised a mechanical or solid injection system in England in 1910 that eliminated the compressed air. This solid-injection principle has been adopted for all diesel engines and has taken two general forms, the common-rail type and the jerk-pump type.

The common-rail system has a continuously operating pump that maintains a pressure of several thousand pounds per square inch on a quantity of fuel in a manifold that serves as a fuel reservoir and connects together all of the injectors. Cam-operated injector valves admit fuel from this manifold to each of the spray nozzles in proper succession, and control the timing and the amount of fuel injected.

The jerk-pump system employs a type of plunger pump that delivers fuel under high pressure for only a brief instant during a small portion of each delivery stroke. Usually there is a separate pump for the injector in each cylinder of the engine, but there are also distributor systems that supply two to four cylinders from a single pump element that completes as many cycles as there are spray nozzles served by it. The pump plunger is rotated to act as a distributor to deliver each successive charge to the proper cylinder.

The various jerk-pump systems differ principally in the relative locations of the pump units and the spray nozzles. The unit injector has the pump and nozzle combined to form a single unit for each cylinder of the engine. Multipump systems comprise as many pump elements in a single central pump unit as there are cylinders to be served. In separate-pump systems each pump is independent of the others and located adjacent to each cylinder head. This type of pump is illustrated in fig. 4.

The most widely used method of fuel metering is by a plunger-controlled spill port. The pump barrel of fig. 4 is filled with fuel through the inlet port on the downstroke of the plunger, and fuel is returned to the supply chamber on the discharge stroke until the upper edge of the plunger covers the port. Fuel is then pushed out through the delivery valve until the helical upper edge of the groove that is cut around the plunger surface uncovers the spill port, thus permitting fuel to return to the supply chamber for the remainder of the stroke. The point in the upward stroke at which the cutaway region on the plunger encounters the spill



BY COURTESY OF AMERICAN BOSCH CORPORATION

FIG. 4.—SECTIONAL VIEW SHOWING THE COMPONENTS OF A JERK-PUMP SYSTEM

port is adjusted by rotating the plunger in the stationary barrel. The relationship between the plunger helix and the spill port is established by the control rack that engages a pinion on the sleeve guiding the plunger. The control rack is moved by a speed-sensitive governor in response to changes in throttle position and load on the engine. The effective portion of the plunger stroke, during which fuel is delivered, may be varied from zero to about the middle one-fourth of the total plunger stroke by rotating the plunger to appropriate positions.

The nozzle holder is an adapter that permits the spray nozzle to be installed in the cylinder head and connects to the injection pump by the discharge tube. Because of the extremely high fuel pressure during injection, the discharge tube must be of heavy-walled steel tubing with an outside diameter usually one-fourth inch or more and an inside diameter of about one-sixteenth inch. A spring-loaded nozzle valve is seated behind the spray tip to prevent fuel flow until sufficient pressure is built up by the pump, thus cutting off initial and final delivery that would otherwise occur at low velocity. Fuel leaking past the valve stem is returned to the fuel system by the leak-off connection.

Theoretically, each volume of liquid diesel fuel requires approximately 10,000 vol. of air to provide the oxygen necessary for complete combustion. Actually, this ratio must be increased to supply about 25% excess air in most diesel engines to avoid exhaust smoke. The dimensions of the fuel-injection-pump plunger and barrel are consequently only a tiny fraction of those of the power cylinders served by the pump. High-speed diesel engines, such as those used in highway vehicles, have injection-pump plungers as small as one-fourth inch in diameter with strokes of perhaps one-half inch.

The fuel-injection system is designed to be capable of delivering more fuel per cycle than the engine requires at its rated output because the rated horsepower is not the maximum horsepower that the engine can develop. A continuous rating is established by the engine builder at the point above which exhaust smoke becomes noticeable and internal temperatures rise. Intermittent-overload ratings permit additional power to be developed for short periods at slightly decreased fuel economy and darker exhaust.

Combustion.—Diesel combustion differs fundamentally from spark-ignition combustion in that the entire air charge is at a temperature sufficient to ignite fuel, and each particle of fuel receives the energy that ignites it directly from the hot air. Ignition occurs at many places throughout the combustion chamber as each tiny droplet in the fuel spray finds oxygen and attains ignition temperature. The spark-ignition engine must have an inflammable mixture of fuel and air that will support a flame front originating at the spark plug and traveling across the chamber. The fuel must be thoroughly mixed with from 12 to 16 times its weight of air to make this possible. The fuel-air mixture is heated to ignition temperature only as the flame front reaches it. This flame travel is not necessary in the diesel combustion chamber because each fuel particle ignites itself, and the mixture proportions need not be maintained within inflammability limits by throttling the intake air at reduced loads. The diesel engine inducts a full charge of air at all times, about 18 lb. for each pound of fuel at full load and about 100 lb. per pound of fuel when idling.

The diesel fuel does not ignite instantaneously because time is required for spray disintegration, heating and vaporizing the fuel, mixing the vapour to the ignition point, and for chemical prereactions that precede the actual combustion of the fuel. The elapsed time after the start of fuel spray until the chamber pressure starts to rise is called ignition lag and is usually about one-thousandth of a second. During this brief interval, the crankshaft of an engine running at 2,000 r.p.m. turns through 12° and at least half of the fuel is injected. Instead of each fuel droplet igniting and burning as it emerges from the spray nozzle, a considerable portion of the fuel charge accumulates during the ignition lag and then may burn almost instantaneously. The resulting rate of pressure rise may be so rapid as to cause rough running or combustion knock in high-speed engines.

The large low-speed diesel engine has no combustion-roughness problem because injection takes a much longer time and the ignition lag occupies so small a fraction of the fuel-injection period that very little fuel accumulates before igniting. After ignition occurs the remainder of the fuel burns as fast as it is injected, and the rate of combustion can be controlled by the injection rate.

All large, slow-speed diesel engines have simple combustion chambers that are called open or direct-injection chambers. The entire combustion-chamber volume is concentrated in a single compartment formed between a flat or slightly concave cylinder head and a flat or recessed piston crown. This type of chamber has been adapted to higher speeds by creating air turbulence to speed up the mixing of fuel and air. The fuel-injection nozzles for these engines are centrally located and of the multihole type with from six to ten holes drilled into the sides of protruding tips so that the paths of the several jets of fuel are along the ordinates of a very flat cone. The piston-crown profile combines with that of the cylinder head to form a space that matches the fuel-spray pattern as nearly as is practical.

More elaborate combustion-chamber designs were introduced to ensure smooth and complete combustion when diesel engines were made to run at higher speeds. Divided combustion chambers are employed in some high-speed diesel engines as a means of decreasing the initial rate of pressure rise and providing more positive mixing of fuel and air. The first of these to be used was the precombustion chamber, a small compartment comprising about one-fourth of the total combustion-chamber volume and connected to the main chamber by a small orifice or throat. The fuel-spray nozzle is located in this antechamber and delivers the entire fuel charge into the small portion of the air charge that is located there. Combustion of a small amount of the fuel in the precombustion chamber builds up a pressure and discharges the burning mass of fuel rapidly into the main chamber where it finds the air to complete its combustion. The rate of cylinder pressure rise is not overly rapid because the greater portion of the fuel does not contact air for combustion until it is transferred to the main chamber. Excellent mixing, attained by the violence of the blowoff from the precombustion chamber, assures completed combustion.

A major advantage of this device is the simplification of the fuel-injection system that it permits. The spray nozzle can have a single hole of .025- to .030-in. diameter instead of several holes as small as .005 in. in diameter required in nozzles for open chambers, and fuel pressure can be much lower. The dispersion of the fuel into the air is accomplished by the blowoff process, not by the fuel spray. The precombustion chamber is used extensively in tractor diesel engines because of easier injection-system maintenance, less exacting fuel requirements and more complete combustion.

The turbulence chamber is another of the divided-chamber designs for improved mixing of fuel and air. The cylinder head and piston crown are both flat, with only the necessary mechanical clearance between them at top dead centre. The combustion-chamber volume is largely concentrated in an auxiliary chamber of circular cross section connected to the cylinder by a tangential passage. On the compression stroke, the rising piston forces the air charge through this passage at high velocity and causes it to spin rapidly in the turbulence chamber.

The fuel is sprayed into the swirling air as it moves past the spray nozzle, and each successive portion of the fuel enters a different portion of the air. A spray nozzle of the pintle type is used which has a pin protruding from the end of the spray valve through the nozzle opening to form a narrow circular slit. Pressure built up after ignition forces the burning mass to flow back through the tangential passage and reverses the direction of rotation in the swirl chamber.

Mixing is thus carried out in two stages and is equally effective at all engine speeds because the swirl velocity is proportional to piston speed.

Supercharging.—The amount of fuel that can be burned per cycle and the resulting power produced by an engine are limited by the weight of air inducted into the cylinder. A supercharger supplements the pumping action of the pistons by the use of a blower that increases the inlet air pressure. Blowers of the Roots type,

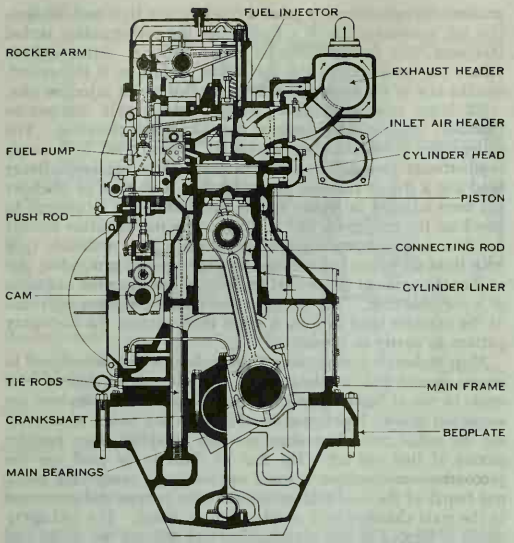


FIG. 5.—SECTIONAL VIEW OF A MEDIUM-SPEED, FOUR-STROKE-CYCLE DIESEL ENGINE

driven from the crankshaft, were used extensively to supercharge automotive-type diesel engines before the development of the gas turbine made the turbosupercharger possible.

The turbosupercharger consists of a centrifugal blower that is driven by a small gas turbine deriving its power from otherwise wasted energy in the exhaust gases from the engine cylinders. The power developed by the engine can be increased 50% to 150% by burning more fuel with the additional air supplied to the cylinders. The air from the supercharger is frequently passed through a heat exchanger to reduce its temperature and specific volume so that a more dense charge results.

Turbosupercharging has done much to overcome the disadvantages of large size, great weight and high cost in proportion to power output of the earlier diesel engines. Supercharging also improves ignition by increasing the air temperature and density. Four-stroke-cycle diesel engines are seldom built unsupercharged because the additional power capacity of the turbosupercharged engine is attained with very little increase in size, weight and cost. The competitive position of the diesel engine has been greatly strengthened by the improved performance attained by supercharging.

Starting.—Automotive diesels for use in highway vehicles are equipped with electric starters similar to those for automobiles except that greater cranking power is needed. The systems operate at a minimum of 12 v., with 24 v. commonly used, and battery capacity must be several times that needed for gasoline engines of the same horsepower.

Engines that are directly connected to electric generators, as in electric power stations, diesel locomotives and ships with electric propulsion, are cranked by motoring the generator; *i.e.*, supplying it with current so that it operates as a motor. Marine and railway units have special generator windings to permit motoring from batteries of 36 to 64 v. Generating-station engines receive their cranking power from other units with which they are electrically interconnected.

Large stationary engines and direct-drive marine engines are started by compressed air. Air pressure of several hundred pounds per square inch is maintained in storage tanks by built-in or separate compressors. Cam-operated valves that open as each piston starts downward distribute the air to the cylinders through check valves in the cylinder heads, and the engine is motored until the injected fuel ignites.

Diesel engines that must be started at low temperatures are frequently equipped with small rope-start gasoline engines that are geared to the flywheel. The water jackets of the cranking engine are connected to the diesel cooling system to heat it as it is cranked. Cranking can be continued for an indefinite time if necessary under severe conditions.

Some tractor diesels are started by conversion to gasoline fuel and spark ignition. The compression ratio is reduced by opening the poppet valve communicating with the clearance pocket in which the spark plug is located. The engine can then be cranked more easily and should start more readily than with compression ignition. After warming up briefly, the clearance valve is closed and fuel injection started to convert to diesel operation.

Starting aids may be needed to preheat the diesel engine at extremely low temperatures. Electric glow plugs in the combustion chambers or immersion heaters in the cooling jackets may be used. Diethyl ether sprayed into the inlet air from capsules promotes ignition at low temperatures.

DESIGN FEATURES

High-Speed Diesel Engines.—These range in cylinder bore from 3.5 to 6 in., in number of cylinders from 1 to 16 and in crankshaft speed from 1,200 to 4,000 r.p.m., but seldom exceed 3,000 r.p.m. The cylinders of these engines were originally arranged in line, but the later trend was toward the V type. The engines are largely intended for use in highway vehicles, farm tractors and earth-moving machinery. Both two-stroke- and four-stroke-cycle designs are built, and divided combustion chambers are sometimes used.

A typical engine of this class is a 12-cylinder, two-stroke-cycle model of 4.25-in. bore and 5-in. stroke, with a maximum capacity of 482 h.p. at 2,100 r.p.m. As is customary in all diesel engines, the cylinders are fitted with alloy-iron cylinder liners of the dry type that are pressed into the water-jacketed cylinder block. Air is supplied by a Roots blower located between the cylinder banks, and a unit injector in each cylinder head supplies the fuel. Pistons are cooled by oil sprayed against the crowns from the drilled connecting rods. Aluminum-alloy blocks are available for applications where weight limitation is an important factor, making a 12-cylinder model weigh 6.7 lb. per horsepower at maximum output. Units with from 2 to 6 in-line cylinders and from 6 to 16 cylinders in the V type are built in this size.

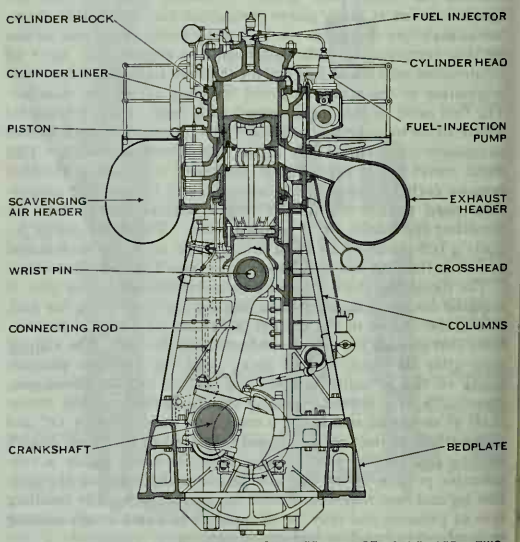


FIG. 6.—SECTIONAL VIEW OF A LOW-SPEED, PORT-SCAVENGED, TWO-STROKE-CYCLE DIESEL ENGINE

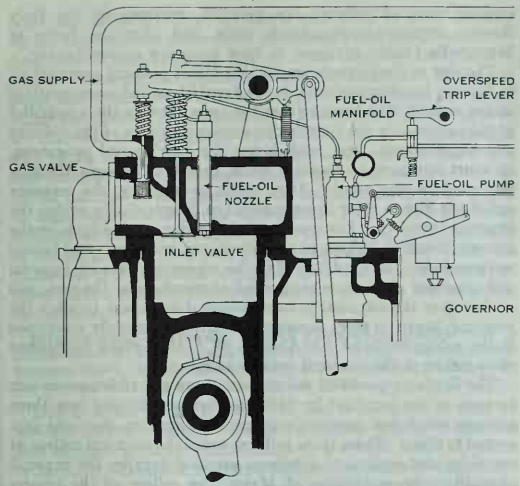


FIG. 7.—SECTIONAL VIEW OF A FOUR-STROKE-CYCLE, DUAL-FUEL DIESEL ENGINE

Medium-Speed Diesel Engines.—Operating at speeds from 500 to 1,200 r.p.m., engines of this class are used extensively for marine, stationary and locomotive applications. Engines delivering about 2,000 h.p. have been developed to meet the severe requirements of railway use. Space limitations favour V-type engines of greater width and less length than the in-line engine. High specific power requirements dictate two-stroke-cycle engines or turbosupercharged four-stroke-cycle engines, and the rough service makes steel frames mandatory. Cylinder bores in the range from eight to nine inches prove adequate at crankshaft speeds up to 800 r.p.m.

The most extensively used locomotive diesel engine is a 45° V-type, two-stroke-cycle engine with uniflow scavenging for which air-inlet ports extending entirely around the circumference of the water-jacketed cylinder liner and four poppet-type exhaust valves in the cylinder head are provided. The pistons are of malleable cast iron and have several distinctive features. The crown thickness is decreased at the outer edge to form a heat dam that reduces the temperature of the piston-ring belt, thereby minimizing the possibility of piston rings sticking. The piston pin is attached to the connecting rod by two cap screws and is carried in an insert that fits into the piston and is retained by a steel snap ring at the bottom. The piston assembly is cooled by lubricating oil sprayed into the cavity between the piston-pin insert and the piston crown.

Fuel is injected by a unit injector in the centre of the cylinder head through a multihole spray nozzle. The unit injector and the exhaust valves are actuated by rocker arms directly from the crankshaft that is carried in bearings above the cylinder heads. These engines are usually built with 12 or 16 cylinders.

Fig. 5 is a sectional view of a four-stroke-cycle, in-line engine in the same size and speed range. This engine is of conventional construction, with separate fuel-injection pumps located above the camshaft which operates the inlet and exhaust valves in the cylinder heads through push rods and rocker arms.

Low-Speed Diesel Engines.—The low-speed designs are in regular production, both in the United States and European countries, with cylinder diameters up to 29 in. These engines operate on the two-stroke cycle at crankshaft speeds as low as 115 r.p.m. and develop up to 12,500 h.p.

The largest diesel engine ever built is in the H. C. Orsted Central Electricity works in Copenhagen, Den. It has eight double-acting cylinders of 33-in. bore and 59-in. stroke and is rated at 22,500 h.p.

Fig. 6 is a sectional view of a typical low-speed engine. Engines of this size and type are intended for stationary and marine applications. Structurally, they do not employ the cylinder-block castings of the smaller engines but are built up from a bedplate with separate cylinder castings supported by A-frame structural members. A crosshead, operating in vertical slides, is connected to the oil-cooled piston and relieves it of side thrust. A marine-type connecting rod is bolted to a separate lower bearing block. Lubricant is pumped directly to each component of the engine. Wet cylinder liners form the inner walls of the cylinder water jackets.

Gas Diesels.—These engines induct an appropriate amount of gas with the air charge and inject a small amount of diesel fuel, about 5% of the total fuel, at the proper time to act as a pilot charge to produce ignition. The amount of fuel oil injected is the minimum that can be dispersed throughout the lean gas-air mixture in the combustion chamber to ensure ignition at many scattered points, and is constant for all loads. The amount of gas inducted is varied by a governor to meet the load requirement. A second type of gas-burning diesel is called dual-fuel diesel; it differs from the gas diesel in that provision is made to inject more fuel oil and induct less gas when the supply of gas is inadequate.

A governor automatically increases the fuel oil injected from the minimum 5% to as much as 100% of the total fuel as the available gas decreases.

Fig. 7 is a sectional view of a four-stroke-cycle, dual-fuel diesel, showing the timed valve for introducing gas into the air stream just outside the inlet valve and the injection system for spraying fuel oil into the combustion chamber. Two-stroke-cycle gas diesels are equipped with timed gas valves in the cylinder heads to admit the gas immediately after scavenging has been completed, thus preventing its escape with the exhaust gases.

All large stationary-power-plant diesels are built to burn gas because the cost per unit of energy supplied is much less for natural and by-product gases than for even the cheapest fuel oils.

See also references under "Diesel Engine" in the Index volume.

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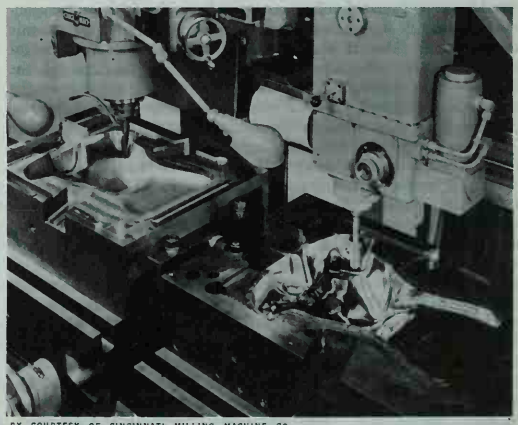
DIESEL LOCOMOTIVE: *see* RAILWAY.

DIESINKING, a process of machining a cavity in a steel die block to be used for plastics molding, hot and cold forging, up-



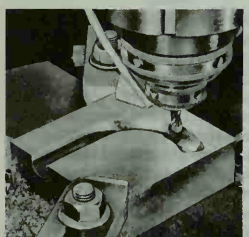
BY COURTESY OF CINCINNATI MILLING MACHINE CO.

FIG. 1.—HYDRO-TEL, HYDRAULIC-OPERATED DIESINKING AND VERTICAL MILLING MACHINE, SHOWING (LEFT) A SINGLE CUTTER SINKING A FORMING DIE AND (RIGHT) THE PILOT GUIDE AND DIE PATTERN

setting, die casting and coining. The process uses end-cutting milling cutters in a vertical-spindle milling machine with the die block mounted on the table. In some simple machines, the movement of the cutter is controlled by the manual operation of the transverse, horizontal and vertical feeds. A pantograph is sometimes used to cause the cutter to follow a layout. Celluloid or sheet-metal patterns are also used as guides.

Most diesinking is done in machines which operate automatically. The movement of the cutter against the die block is controlled by the tracing of a finger of the cutter size and shape in contact with a previously made model of soft metal, plaster of paris, wood, etc. The model or template is attached to the bed beside the die block. The movement of the finger over the template is transmitted to the cutter by hydraulic or electrical controls. The surface of the sunk die is finished to desired size and surface quality by hand scrapers, files, small grinding wheels and polishing cloth. Large dies for automobile body parts are often cast to the shape of prepared patterns, after which they are ground and polished to size. When the die cavity extends through the block it may be roughed out by oxyacetylene torch or jig saw and finished on a slotting machine, shaper or filing machine which reciprocates the tool against the surface of the die as it is held on the table and moved about as required.

Die hobbing (hubbing) is a process of producing the die cavity by pressing a hardened and polished male master plug, called a hob, into the soft steel die block by the slow, forceful stroke of a hydraulic press. This method of diesinking is simpler than that described above, since it is easier to make the male master than to machine the cavity. The hob may be used for producing a number of duplicate cavities or dies. Hob dies are limited in their use to formed parts which can be drawn readily from the cavity. This process is frequently used for making dies for limited production or for making parts of low-strength materials such as molding plastics.



BY COURTESY OF KEARNEY AND TRECKER CORP.

FIG. 2.—DIESINKING ON THE MILWAUKEE ROTARY HEAD, VERTICAL MILLING MACHINE

(O. W. B.)

DIES IRAE (Lat., "Day of wrath"), the opening words of a Latin hymn on the Last Judgment, ascribed to Thomas of Celano (d. 1256) and forming part of the office for the dead and requiem mass. The impressive plainsong melody to which it was sung was used by composers of religious works from the 16th century onward, either in its original form or as the basis of a polyphonic composition. Mozart and Verdi were among the composers of religious works who wrote original music on the text of the hymn. The original melody made a strong appeal during the romantic period and was used, often in the form of a parody or to suggest the supernatural or the macabre, in many secular compositions by Berlioz, Saint-Saëns, Vaughan Williams and others.

See R. Gregory, "Dies Irae" in *Music and Letters* (April 1953).

DIET, a term denoting an assembly or council in certain countries; *e.g.,* Sweden, Denmark, Poland, Hungary, Japan. This article is concerned with the diet (*Reichstag*) of the German empire which lasted from the 12th century to 1806, and its later successors from 1871.

To understand what happened to the diet between the 12th century and the 17th century it should be remembered that the period 1100–1500 marks the continuing decline in the powers of the emperor, due, among other causes, to the long conflict between empire and papacy and the rise of sovereign states. The conception of the "Holy Roman empire," used by papal and imperial chancelleries and apologists, had in practice little effective political significance. The Habsburgs, particularly Charles V, revived the conception as useful political propaganda to aid in covering over the diverse political and religious groups in the Habsburg dominions. During the Reformation period, and the ensuing wars of religion, the political weakness of the Holy Roman empire was abundantly plain, and after the Peace of Westphalia (1648) it ceased to have authority or significance.

The diet of the German empire, the oldest political organization in Europe, was foreshadowed in the Frankish period when meetings of the nobility had been held at the same time as the assemblies of the people. In the Carolingian empire meetings of the nobility and higher clergy were held during the king's royal progresses, or court journeys, as occasion arose, to make decisions affecting the good of the state. After 1100, definitively, the emperor called the diet to meet in an imperial or episcopal city within the imperial frontiers. The members of the diet were originally the princes, including bishops of princely status, but counts and barons were included later. After 1250 the representatives of imperial and episcopal cities were recognized as members of the diet, and at this time the electoral princes, whose duty it was to elect the emperor, began to meet separately, a division formally confirmed in the golden bull (*q.v.*) of Charles IV (1356) which established the number of the electoral princes as seven.

The declining power of the emperor from the 12th century can be seen in the fact that by 1489 the diet was divided into three colleges which met separately to give decisions on questions presented to them. These three colleges were: the electoral college of seven lay and ecclesiastical princes presided over by the imperial chancellor, the archbishop of Mainz; the college of the princes presided over by the archbishop of Salzburg, or the archduke of Austria; the college of the cities presided over by the representative of the city in which the diet met. This last group was a new departure and was not formally acknowledged until the peace of Westphalia, although it had been prominent since the end of the 15th century. The college of princes consisted of 94 princes, 33 ecclesiastical and 61 lay, who had individual votes (*Virilstimme*), and were divided into six groups which had group votes (*Kurialstimme*). The college of cities was separated eventually into the Rhine and Swabian divisions, the former having 14 towns and the latter 37.

The decisions taken separately by the three colleges were combined in an agreed statement the text of which was sent to the emperor as "the resolution of the empire" (*conclusum imperii*). All the decisions of the diet forming the resolution were called the "recess of the empire" (*Reichsabschied*). The emperor could ratify part of the recess or the whole of it, but he could not modify the words of the recess. The ratification of a recess required in law that all tribunals of the empire should conform to it. Until the 17th century the diet had possessed effective legal power, including the decision of war or peace, but after 1648 this legislative authority disappeared. The last recess was that of Regensburg in 1654; the next diet, that of 1663, was never dissolved and so published no recess.

The peace of Westphalia meant the final breakdown in the conception of one German empire united by its members' common aims. This was replaced by an assembly of sovereign princes, usually represented by envoys, indifferent to the emperor's wishes, divided in religious and political aims, and confined in practice to long-drawn lawsuits. The diet of Regensburg of 1663 prolonged itself indefinitely into permanent session. The emperor was now represented by a prince of the empire as his commissioner, a jurist was appointed as subcommissioner, and the elector of Mainz, arch-chancellor of the empire, had charge of the business of the meetings of the diet. This assembly of representatives without legislative power disappeared when the Holy Roman empire collapsed under Napoleon's attack in 1806. After 1806 the diet was succeeded by the *Bundesrat* or federal diet of the German confederation (1815–66) to which came representatives from the various German principalities, but it had no legislative powers and was as ineffective as the diet had been prior to 1806. A new diet or *Reichstag* was constituted under the German empire of 1871–1918. Together with the emperor, and in association with the *Bundesrat* (which resembled the old diet in being a council of representatives from the various states of the empire), it constituted the new unity of the empire. The empire was divided into constituencies where by secret ballot 397 members

were elected for the diet. At first it was called to meet annually by the emperor who alone could adjourn or close the diet, but this brief session was extended first to three then, by 1885, to five years. When the diet dissolved so did the *Bundesrat,* if the emperor had agreed to the dissolution. After the collapse of the imperial constitution in 1918, the new *Reich,* the Weimar republic of 1919–33, was considered to represent the sovereign people, and voting to the diet was by proportional representation and now included female suffrage. But a major weakness of the republic was that its diet gradually lost political power by its failure to make effective decisions and enforce them. The Reichstag building in Berlin was burned down on Feb. 27, 1933, probably at the instigation of the Nazi party under Adolf Hitler which was victorious in the elections to the diet later that year, disbanded all other parties and made the diet merely a platform for its public declarations.

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DIET AND DIETETICS. A diet is the kind of food on which a person or group lives and a dietary usually means the diet supplied in an institution, such as a school, hospital, prison or barracks. Dietetics is defined as the application of the science of nutrition to the feeding of human beings in health and disease and it involves a knowledge of foods, their composition, preparation and contribution in essential nutrients for tissue repair and growth, for heat and energy and for the normal functioning of the body. A dietitian, or dietist, is one who practises in any branch of dietetics. The training of dietitians, their responsibilities and the scope of their work vary widely in different countries. In most countries dietetics started as a therapeutic service, but in many countries it subsequently broadened, as the importance of good nutrition came to be recognized, to the catering, education, public health and research services. In most countries dietetics is a female profession and the existence of suitable basic education for women is a decisive factor in its development.

Functions of Foods.—Food nourishes the body in three ways: it provides the substances necessary for the building and maintenance of the structure and tissues of the body, for oxidation to supply energy for the body's activities and for the regulation of the conditions and processes of the body. The chemical substances that take part in any of these nutritive functions are termed nutrients. The nutrients needed for building and maintaining the body's tissues are, in brief: the proteins, which are essential components of all living cells; mineral elements, such as calcium and phosphorus, which as calcium phosphate are largely responsible for giving bones and teeth their strength, rigidity and relative permanence; and iron, a necessary component of hemoglobin. Those nutrients that are oxidized to provide energy are the carbohydrates and the fats and, to a lesser extent, the proteins. Alcohol can also supply some energy. The nutrients needed for the regulation of the conditions and processes of the body include the vitamins (a chemically unrelated group of substances, each with a specific function) and some mineral elements, such as iodine (necessary for the proper functioning of the thyroid gland) and chlorine, which, in the form of its salts the chlorides, is important in the maintenance of normal conditions in the body, particularly concerning the passage of water into and out of the tissues. In total, the body contains 19 principal mineral elements derived from food. It is not usual to include oxygen and water among the nutrients, although by strict interpretation of the above definition they would be so classified.

Nutrients and Their Sources.—For a more detailed discussion of the biochemistry and metabolism of these nutrients, *see* NUTRITION.

Proteins.—The proteins (*q.v.*) are widely distributed in nature and no life is known without them. They are made up of relatively simple organic compounds, the amino acids, all of which contain nitrogen and some of which contain sulfur. Man and animals build the proteins they need for growth and repair of tissues by breaking down the proteins obtained in food into their component parts, the amino acids, and then building up these components into proteins of the type needed. Plants, on the other hand, build their proteins from the simpler inorganic materials found in the soil and air. The ultimate source of man's protein is the plant; he may obtain it directly by eating plant foods or indirectly by eating the flesh, milk or eggs of animals, birds or fish that have fed on plants. The protein-rich foods from animal sources contain complete proteins, which supply all the amino acids necessary in the human diet, but vegetable proteins vary in their biological value because they supply varying amounts of the essential amino acids. Combinations of protein of plant and animal origin work well together in supplying man's protein needs. Of the vegetable proteins the chief source is grain, other sources including soybeans, peas, beans and other pulses and nuts. Fruits and vegetables contribute little to the total protein intake.

A protein allowance of one gram per kilogram of body weight per day for the normal adult used to be the widely accepted standard known to provide a good margin of safety. A preliminary attempt has been made by the committee on protein requirements of the Food and Agricultural organization to assess protein requirements in terms of the amino acid composition of the protein consumed: a smaller consumption is required of proteins of high than of those of low biological value. For a country eating a western type of diet the allowance of one gram per kilogram is generous because of the high biological value of the protein consumed.

Carbohydrates.—The most abundant and least expensive food sources of heat and energy are the carbohydrates (*q.v.*), of which there are a great variety. Important dietary carbohydrates are divided into two groups, starches and sugars. The starches, which may be converted into utilizable sugars in plants or in the body, are supplied in the grains (wheat, rice, maize or corn, oats, rye and others), the pulses (such as peas and beans), tubers (such as potatoes) and some rhizomes and roots. The sugars occur in many plants and fruits, the most important as a food commodity being sucrose, which is obtained from the sugar cane or the sugar beet. Sucrose is an isolated nutrient, a pure carbohydrate, which can be oxidized to supply energy but which supplies no other nutrient. In fruits starches tend to be converted into sugars with ripening; *e.g.*, most of the starch originally present in a banana has been changed to sugar by the time it is fully ripe.

Fats.—The fats, which are widely distributed in nature, are a concentrated food source of heat and energy and are glyceryl esters of fatty (carboxylic) acids (*see* CARBOXYLIC ACIDS). When broken down by hydrolysis fats yield many different fatty acids and glycerol. The so-called essential fatty acids, which are derived in the main from vegetable fats that have not been hydrogenated, are thought to fulfill specific biochemical functions, the precise mechanism of which has not been elucidated. After digestion and absorption, fats are either used as sources of heat and energy or they may be stored in the body. Carbohydrates, if taken in excess, can be converted into fat and likewise stored as fat deposits. The foods that contain fats are—in addition to butter, margarine and other edible fats—milk, fatty fish, eggs, nuts, grains, seeds and some fruits such as olives and avocado pears.

As the standard of living in a population or group rises there is a tendency for fat consumption to increase at the expense of carbohydrate and probably also of protein. In the early 1960s about 40% of the calorie supplies in countries enjoying a western type of diet was derived from fat. Many authorities hold that such a percentage is too high and that this increasing consumption of the types of fat available in western countries is associated with an increasing incidence of ischemic heart disease and other degenerative diseases.

Minerals.—Of the many minerals eaten in foods calcium and iron have received much attention mainly because of the danger of dietary shortage: if these two are in adequate supply, it is likely that other mineral elements will be, too. Thus phosphorus, which, with calcium, is an important component of bones and teeth, is more widely distributed than calcium and is not likely to be lacking in any diet. In all western types of diet milk and its products constitute the chief source of calcium, but in the diets of tropical

or eastern countries the necessary calcium may be obtained from a variety of sources such as the bones of small fish, some cereals such as ragi in India, some vegetables and even by the use of crude sea salt in cooking and by adding lime water to maize (corn) in the preparation of the tortilla of Mexico. Iron is also fairly widely distributed but can be short in some diets. The chief sources are meat, egg yolks, vegetables, high extraction cereals or cereals to which the iron removed in milling has been restored. The dietary intake of iodine depends largely on the consumption of sea foods and of vegetables grown on soils containing sufficient iodine; a common public health measure is the provision of iodized salt where iodine is in short supply. The need for chlorine is usually fully met by adding common salt (sodium chloride) in the preservation, preparation and service of food.

Vitamins.—The foods that contain vitamins (*q.v.*) are often called the "protective" foods. This term was first proposed by E. V. McCollum to mean milk and leafy vegetables. As a result of his early studies he had reached the view that the two nutritional shortages most often encountered in U.S. diets were of calcium and vitamin A and that milk and leafy vegetables were "protective" against these deficiencies. Further research showed that a "protective" diet should also provide other nutrients. H. C. Sherman mentioned, particularly, vitamin C and riboflavin and discussed the confusion on the meaning of the term, which could clearly cover any food that contains protein, mineral salts and vitamins in useful quantities, concluding that the term had become so ambiguous that it was better not to use it.

Probably the simplest classification of vitamins is one based on whether they are soluble in water or fats (oil). Vitamins A, D, E and K are insoluble in water but soluble in fats and are therefore provided by fatty foods. Milk fat is a good source of vitamin A and contains a little vitamin D; egg yolk contains good supplies of both vitamins; the fat of fish and the livers of fish and animals are abundant sources of both. Vegetable fats, including the fats in grains, usually contain vitamin E but no vitamin A or vitamin D, so that it is usual to fortify margarine made from vegetable fats with vitamins A and D. Both vitamins E and K occur in green leaves. Vitamin A may be obtained either from foods containing the vitamin itself or its precursor, carotene, the yellow colouring matter of carrots and many other plant materials, such as green vegetables and tomatoes. Both vitamin A and carotene are present in milk fat and egg yolk. Vitamin D is not widely distributed in foods but is produced by the action of sunlight on ergosterol in the body. The vitamins of the B complex and vitamin C are soluble in water and thus can be leached out of foods during processing and cooking and, in addition, vitamin B_1 and vitamin C are both fairly easily destroyed by heat. The vitamins of the B complex are widely distributed among foods. In most countries the most important source of vitamin B_1 (or thiamine) is the germ and the outside parts of the staple cereal and this makes the method of milling cereals a decisive factor in the adequacy of the supply of this vitamin. In many countries the vitamin B_1, which is known to be lost in the milling of wheat, is restored before the flour is baked, and throughout the rice-eating world possible methods of restoring vitamin B_1 to polished rice were under consideration in the early 1960s. Milk and its products, meat, potatoes, and other vegetables also supply the vitamin and are sources of other members of the B complex. Milk is particularly important for riboflavin and meats and the outside parts of cereals for nicotinic acid (or niacin). The only important sources for vitamin C are fresh fruits, particularly citrus and some soft fruits and tomatoes, and vegetables, particularly green vegetables and potatoes. Fresh milk and fresh animal liver supply a little vitamin C.

Energy Requirements.—The caloric need of an individual, supplied largely by carbohydrates in most diets but also by fats and proteins (and also by alcohol), usually in that order of importance, is that amount of energy that will maintain body weight over a prolonged period at an optimal level; for a growing child the caloric need is the amount that will maintain a satisfactory rate of growth.

Nutritional Requirements.—The assessment of the nutritional value of foods is of practical value only in relation to the nutritional needs of the consumers. In the development of any kind of agricultural or food policy it is essential to be able to assess the nutritional needs of the population in quantitative terms and it becomes even more important to be able to check the nutritional adequacy of food supplies when these are restricted for any reason. Several tables giving estimates of nutritional requirements or allowances, most of which include generous margins of safety, have been compiled. One, as recommended by the Food and Nutrition board of the National Research council of the United States, may be found in the article NUTRITION. Another is that given in the *Report* of the Committee on Nutrition of the British Medical association (1950).

Pregnancy and Lactation.—Infants are best fed on their mother's milk, but this alone does not necessarily ensure good growth and development of the baby. H. C. Stuart of Boston, Mass., and F. F. Tisdall of Toronto and their associates independently showed that an adequate diet and good hygiene during pregnancy are essential to the well-being of both mother and baby. The supply of milk can be maintained even if the mother's diet is inadequate, but at the expense of her own stores of nutrients and possibly of her health. During pregnancy and lactation women require a moderate increase in calories and a definite increase in the protein as well as in the vitamin and mineral contents of their diets. For example, the recommended allowance for calcium is 50%–100% greater and that of iron 25% greater than for other adult women and the requirements for vitamins are also increased.

Infants.—Infants need food for rapid growth in addition to their other body needs. On the basis of weight they require about four times as much protein as an adult. During the first year of life milk should be the main food and special methods of feeding are required. When the mother's milk is not available, cow's milk, usually dried or evaporated, is the normal substitute, but goat's milk or a vegetable protein substitute such as soybean milk are used in some places. Extra calories can be supplied by adding sugar to the milk. To ensure an ample supply of vitamin C, orange juice or some other suitable source of the vitamin, in small amounts at first, is started at an early age. To provide an adequate vitamin D intake for the prevention of rickets and for the normal growth of bones, 400 international units of vitamin D should be supplied daily. A supplementary source of vitamin A is also necessary. As the baby grows, cereals are added to supply extra calories as well as minerals and vitamins and these are supplemented by strained fruits and vegetables. Eggs are a good weaning food, particularly for their content of iron, and strained or scraped meat may be added at about the same time as other solid foods. Meats supply protein, minerals, particularly iron, and vitamins of the B complex.

The protein content of the diet after weaning is particularly important for the child's health, and in countries where milk supplies are sparse or nonexistent a nutritional deficiency disease, usually called kwashiorkor, occurs among toddlers who have been weaned onto a diet of cereals or starchy roots. The disease can be severe and lead to death or so mild as hardly to be noticed. Its prevention and cure are theoretically simple: the provision of an adequate supply of protein at weaning and in early childhood. The most convenient food to supply is milk, but success has been achieved with mixtures of vegetable proteins.

Of particular importance in the feeding of babies is strict cleanliness. Foods, particularly milk, provide excellent media for the growth of bacteria, and milk should be sterilized or pasteurized before feeding. (*See* also INFANTS, CARE OF: *Infant Feeding.*)

Older Children.—As children grow their need for more food becomes apparent. Healthy children need never be forced to eat and it is a good rule never to do so. If an adequate supply of foods that are not too bulky and are of good nutritional value is placed before a child hunger will cause him to eat adequately. Children need concentrated nutritional value.

Adolescents.—During adolescence there is a period of rapid growth and adjustment, both physical and psychological, and the need for food is increased even above that of the average adult.

Adults.—The nutrient needs of adults depend on their body size,

their age and their activity. Energy needs decrease with increasing age and if food intake is not reduced as the pace of energy expenditure slackens weight will increase. It seems that with advancing years appetite is not always an infallible guide to food requirements.

The Aged.—The food needs of the elderly require more study than they have been given. It is likely that the requirements of protein, minerals and vitamins are not less than those of younger adults, but fewer calories are needed. Thus it seems that the composition of the diet should be changed as a person grows older. In addition, lack of teeth, or other similar handicaps, may make it necessary to pay special attention to the form in which food is supplied.

The Sick.—The use of diet to maintain health or to treat disease is as old as recorded history. The importance of adequate nourishment for the sick was fully recognized by Florence Nightingale, who wrote in her *Notes on Nursing* (1860), "Every careful observer of the sick will agree in this that thousands of patients are annually starved in the midst of plenty, from want of attention to the ways which alone make it possible for them to take food." She then gave her views, surprisingly in accord with modern knowledge, on desirable food for invalids. Since then the dietitian has devoted the major part of her skill to providing food for the sick, both by maintaining the nutritional adequacy of hospital meals in general and by designing special diets used therapeutically in certain illnesses. In special diets that may be made from a limited range of foods it is particularly important to guard against the lack of essential nutrients.

Education in Nutrition.—By satisfying hunger with a reasonable variety of foods the normal individual in a country with a varied food supply is provided with sufficient essential nutrients to maintain the body in a good state of health. If an individual or a family is not taking a nutritionally satisfactory diet this is due either to national or personal poverty or to ignorance. It is generally accepted that proper nourishment is one of the secrets of human well-being and that if the foundations of good health are laid in early life by adequate feeding there will be a greater chance in maturity of living a full and active life. It is not, however, easy for individuals to know what is the nature of a well-balanced diet. It is not even easy to know to what processes foods have been subjected. There is, therefore, a need in all countries for more information among the consuming public on food values and requirements. The view that knowledge of nutrition and dietetics is an essential part of education is slowly being accepted throughout the world but the question remains how best to spread this knowledge.

It is generally accepted that no program of nutrition teaching should be started without an assessment of the nutritional value of the food supplies available and of the nutritional needs of the groups or population to be taught, and that a system of teaching that has produced successful results in one country may be quite wrong for a country with different food problems.

To those with sufficient scientific knowledge nutrition can be taught in chemical and physiological terms, but it often has to be taught to those without scientific education. This can best be done in practical terms, that is, in terms of preparation of attractive well-cooked meals that are dietetically well-balanced and good to eat. Teaching in these terms was being conducted successfully under the South Pacific Health service, and in many countries the practice of serving nourishing and palatable school meals provides another example.

Two basically different systems of teaching simple nutrition are in operation in various countries. One, the more ambitious, aims to teach in terms of the functions of foods and to give the learner a sound enough knowledge of nutrition to enable him to select a well-balanced diet without detailed instructions on precisely which foods to eat. During World War II the United Kingdom used this system and taught that foods belong to three groups—body-building foods, regulating and protective foods and foods for fuel or energy. Subsequently F. J. Stare and his colleagues suggested that, for countries where food supplies are limited and even calories may be short, teaching might be effective in terms of two groups, energy foods and protective foods.

Other countries adopted systems essentially similar to each other, though different in detail. Foods are classified according to their nutritional value but the groups are arranged with the aim of increasing the consumption of nutrients known to be short in the diets of those being taught. Probably the most celebrated system of this kind was the Basic Seven Food Groups of the United States devised during World War II as a guide to the selection of protective foods. This was later simplified to a Daily Food Guide, shown in the table, which may be supplemented with other foods

Milk group	Meat group	Vegetable-fruit group	Bread-cereal group
8-oz. cups Children . . 3—4 Teen-agers . . 4 or more Adults . . . 2 or more Pregnant women . 4 or more Nursing mothers . 6 or more Cheese and ice cream can replace part of the milk	2 or more servings of beef, veal, pork, lamb, poultry, fish or eggs. As alternatives: dry beans, dry peas, nuts	4 or more servings to include: a citrus or other fruit or vegetable important for Vitamin C; a dark-green or deep-yellow vegetable for vitamin A, at least every other day; other vegetables and fruits, including potatoes	4 or more servings of whole grain, enriched or restored

to complete meals and to provide additional food energy and other food values.

The Quality of Foods.—Quality depends on the composition and condition of the food eaten and on the reactions of the person eating it but, since nutritive value cannot be detected by taste or smell, it is not a directly nutritional matter. Quality and nutritional value, however, are often related; for example, most fruits and vegetables are richest in nutritive value when freshly picked, when their flavour is also at its most delicious. Efforts are constantly made to improve foods through the selection of better varieties of plants and breeds of animals and by controlling the conditions of food processing, storage and transport. To feed the rapidly growing and increasingly urban population of the world it is necessary to preserve foods in a condition as similar as possible to their fresh state and to retain that condition while they are being stored or transported from the areas of production to the towns.

Cool or cold storage and transport temperatures are important considerations for foods marketed fresh because nutrient losses and adverse changes in quality are accelerated by high storage temperatures, but modern controlled methods aim to conserve the nutritive value and other qualities present in the foods at the time of processing (*see* FOOD PRESERVATION).

Foods must be clean. Much contamination usually cannot be recognized by the consumer, who must thus depend for protection upon the technical ability and vigilance of food manufacturers and government inspectors. Foods must also be free from harmful bacteria. Milk, particularly, is likely to be the carrier of harmful organisms unless especially protected. Some communities require that all cheese either be made from pasteurized milk or aged for a sufficient length of time to ensure that harmful bacteria have been rendered innocuous. In certain parts of the world where the soil is contaminated with the eggs of intestinal parasites it is usually necessary to scrub, wash, peel or cook vegetables carefully to ensure their safety.

Chemical substances may be added to foods either by accident or intent. During and after World War II a large number of pesticides and other chemical aids to agriculture and horticulture have been developed. Similarly, a number of antibiotics and hormones have been used experimentally in animals to improve milk production or the quality of meat. The health hazards of residues of these substances in foods have led to intensive investigation and the establishment of means of control. *See* FOOD PREPARATION; NUTRITION; *see* also references under "Diet and Dietetics" in the Index.

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DIETRICH, CHRISTIAN WILHELM ERNST (1712–1774), German painter and engraver, was born at Weimar on Oct. 30, 1712. He was taught by his father, Johann George, painter of miniatures to the court, and in 1724 was sent to Dresden to work under Alexander Thiele, the landscape painter, with whom he remained three years. Augustus II, king of Saxony, sent him to the Netherlands where he learned to imitate the masters of the previous century with amazing fidelity. Many of Dietrich's works in the manner of Rembrandt, Ostade, Watteau, Salvator Rosa, Castiglione, Ruisdael and Berghem have been falsely attributed to these artists. In 1741 he was appointed court painter to Augustus III at Dresden, and in 1743 traveled in Italy, where he studied and became closely associated with the painters Ismael and A. R. Mengs. Linck accredits Dietrich with over 180 prints, many of which reveal both spirit and skill. After his return from Italy he generally signed himself "Dietericij."

In 1748 he became keeper of paintings at the Dresden gallery. He was also director of painting at the Meissen porcelain factory and in 1764 became professor at the Dresden academy of arts. He died in Dresden on April 23, 1774.

DIETRICH VON BERN is a heroic figure of Germanic legend, apparently derived from Theodoric the Great (*q.v.*). His exploits are related in a number of south German songs preserved in the *Heldenbuch* (*q.v.*)—*Dietrichs Flucht, Die Rabenschlacht* and *Alpharts Tod*—and, more fully, in the Icelandic prose *Thidrekssaga*. This 13th-century version may be based either on the German sources or represent an independent Gothic tradition. References to Dietrich in the Anglo-Saxon records are few and obscure.

Dietrich's story begins when he was driven by Ermanaric from his kingdom of Berne (*i.e.*, Verona). After years of exile at Attila's court he returned with a Hunnish army and defeated Ermanaric at the battle of Ravenna (Rabenschlacht). Attila's two sons fell in the fight, and Dietrich returned to Attila to answer for their death. Later he had his revenge by slaying Ermanaric (Ermenrichs Tod). Dietrich's long stay with Attila represents Theodoric's youth spent at the Byzantine court. The period of exile was as usual adorned with amazing exploits most of which had no connection with the cycle. Through Attila, Dietrich enters the Nibelung cycle as the avenger of the Amelungs, who finally vanquishes Hagen and delivers him to Kriemhild (*see* NIBELUNGENLIED). There are brief references to him in the *Hildebrandslied* also.

Dietrich typifies the wise and just ruler as opposed to Ermanaric the tyrant. Much of the incident told about him has no basis in the story of Theodoric: some could be related to the experiences of his father Theudemir, but the rest is purely fictional. The chief heroes of the Dietrich cycle are his weaponmaster Hildebrand with his nephews the Wolfings Alphart and Wolfhart; Wittich, who renounced his allegiance and slew Attila's sons; and Heime and Biterolf.

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(W. W. Cs.)

DIETZGEN, JOSEPH (1828–1880), German socialist who won fame as the "philosopher of the proletariat," was born at Blankenberg near Cologne on Dec. 9, 1828. Of humble origin, he became a tanner by trade and had little formal education. He nevertheless managed to study philosophy, read socialist literature and write several philosophical works. After the revolution of 1848 he emigrated to the United States. In 1863 he went to Russia where he worked in a tannery at St. Petersburg until 1869; he returned to Germany and then to the United States, where he spent the rest of his life.

Attracted to Marx's historical materialism, Dietzgen endeavoured to develop a new proletarian philosophy that would be consistent with Marxian principles. His first and most important work, *Das Wesen der menschlichen Kopfarbeit*, appeared in 1869. It set forth an empirical and relativistic epistemology, holding all knowledge to consist of grasping the general in individual objects. A volume published posthumously, *Die Religion der Sozialdemokratie* (1895), urged that religion be replaced by the concepts of democratic socialism.

Dietzgen died in Chicago, Ill., on April 15, 1880. His son Eugen Dietzgen published three volumes of Dietzgen's collected works in 1911, a single volume of selected writings in 1915 and in 1921 a volume entitled *Materialismus oder Idealismus?*

See H. Roland-Holst, *Joseph Dietzgens Philosophie* (1910) and A. Hepner, *Joseph Dietzgens philosophischen Lehren* (1922).

DIEZ, FRIEDRICH CHRISTIAN (1794–1876), German philologist, the founder of Romance philology, was born at Giessen, Hesse-Darmstadt, on March 15, 1794. A visit to Johann von Goethe in 1818 decided the direction to his studies. Goethe had been reading François Raynouard's *Choix de poésies originales des troubadours*, and advised the young scholar to explore the rich mine of Provençal literature which the French savant had opened up. Henceforth Diez devoted himself to Romance literature. He moved in 1822 to Bonn, where he held the position of *Privatdozent*. His *Poesie der Troubadours* (1826) and *Leben und werke der Troubadours* (1829), of both of which there are later editions edited by Karl Bartsch, were his earliest important studies. In 1830 he became professor of modern literature at Bonn. The rest of his life was mainly occupied with the composition of the two great works on which his fame rests, the *Grammatik der romanischen Sprachen* (3 vol., Bonn, 1836–44; 5th ed., 1882) and the *Etymologisches Wörterbuch der romanischen Sprachen* (2 vol., Bonn, 1853; 5th ed., 1887); in these two works Diez did for the Romance group of languages what Jacob Grimm did for the Germanic family. He died at Bonn on May 29, 1876. He also wrote works on the Spanish and Portuguese languages and early literature.

DIFFERENTIAL, in the sense of pertaining to, or involving the difference between, two or more motions, is a term applied to the mechanism that drives the rear (or any pair of powered) wheels of a motor car; *i.e.*, the system of gears (usually situated in the back axle) by means of which one driving wheel may revolve with increased speed while the other is checked (in turning corners, for example). In physics, differential apparatus (*e.g.*, a differential thermometer) is designed in such a manner that extraneous effects which may affect two readings or two different phenomena equally are eliminated and errors thereby are somewhat reduced or avoided altogether. (H. B. Lm.)

DIFFERENTIAL CALCULUS, ABSOLUTE: *see* VECTOR ANALYSIS.

DIFFERENTIAL EQUATIONS, ORDINARY. In any

scientific or technological field, such as astronomy, chemistry, engineering, physics, etc., the formulation of a natural law is regarded as completely precise and definitive only when it is expressed as a mathematical equation. This equation effectively relates the quantity, or function (*q.v.*), upon which the attention is focused, with the independent variables such as time, position, etc., upon which it may depend. Now it is frequently—even prevalently—the case that the equation which does this involves, besides the function itself, also one or more of its derivatives. (For a definition and discussion of derivatives, *see* CALCULUS, DIFFERENTIAL AND INTEGRAL.) Such an equation, specifically one in which a derivative or derivatives occur, is called a differential equation. The following are examples of such equations:

$$\frac{dy}{dt} = -ky \tag{1}$$

$$m\frac{d^2y}{dt^2} = -k^2y \tag{2}$$

$$\left[1 + \left(\frac{dy}{dx}\right)^2\right]\frac{d^3y}{dx^3} - 3\frac{dy}{dx}\left(\frac{d^2y}{dx^2}\right)^2 = 0 \tag{3}$$

In these y stands for the function, and either t or x is the independent variable. The symbols k and m are used here to stand for specific constants.

Classification.—Differential equations are classified into several broad categories, and these are in turn subdivided into many subcategories. Of the former the most important are the category of the so-called ordinary differential equations and the category of the so-called partial differential equations. When the function involved in the equation depends upon only a single variable its derivatives are ordinary derivatives, and the differential equation is classed as an ordinary differential equation. If, on the other hand, the function depends upon several independent variables, so that its derivatives are partial derivatives, then the differential equation is classed as a partial differential equation.

Whichever the type may be, a differential equation is said to be of the nth order if it involves a derivative of the nth order but no derivative of an order higher than this. Equations (1), (2) and (3) are all ordinary differential equations. They are respectively of the first, second and third orders. The equation

$$\frac{\partial u}{\partial t} = k^2\left[\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right] \tag{4}$$

is an example of a partial differential equation. It is of the second order. The theories of ordinary and partial differential equations are markedly different, and for this reason the latter are treated separately (*see* DIFFERENTIAL EQUATIONS, PARTIAL). In almost all respects the former is the simpler.

Instead of a single differential equation, the object of study may be a simultaneous system of such equations. The formulation of the laws of dynamics frequently leads to such systems. In many cases a single differential equation of the nth order is advantageously replaceable by a system of n simultaneous equations each of which is of the first order. (R. E. L.)

Historical Background.—The theory of differential equations is practically as old as the infinitesimal calculus. Sir Isaac Newton started working on differentials (which he called "fluxions") in 1665. He wrote a treatise on fluxional equations in 1671, dividing them into three classes according to the number of fluxions and fluents (flowing quantities) involved. In modern notation his first class contains the equations in which dy/dx is a function of x alone or of y alone, while the second class is formed by the equations

$$\frac{dy}{dx} = f(x,y)$$

and the third by the first-order partial differential equations. He developed the method of power series with indeterminate coefficients with the aid of which he claimed that all equations could be solved. Newton's treatise, which was published in 1736, had little or no influence on the development of the theory.

A greater share of credit was given to the second discoverer of the calculus, Gottfried Wilhelm Leibniz, who started his work in 1673 and who initiated the basic notation dx and $\int$ by the end of 1675. Leibniz' first publications in the *Acta Eruditorum* (1684, 1686) made no impression in Germany, but he found two eager followers in Switzerland in the brothers Jakob (Jacques) and Johann (Jean) Bernoulli. This gifted Basel family produced eight mathematicians in the course of a century and several of them took a part in the development of differential equations. In May 1690 Jakob Bernoulli published a new method of finding the isochrone; that is, the curve in a vertical plane followed by a mass particle when its vertical velocity component is constant (*see* CURVES, SPECIAL). These conditions gave him the equation

$$dy\cdot(b^2y - a^2)^{\frac{1}{2}} = dx\cdot a^2,$$

and from the equality of the differentials he concluded the equality of the integrals and found the equation of the curve. This is the first time that the term "integral" occurs in the literature. In the 1690s much work on differential equations was done by Leibniz and by the Bernoullis. In 1691 Leibniz found that a differential equation in which $f(x,y) = f(x)g(y)$ could be solved by quadratures (see *Solutions*, below). A year later Leibniz was able to integrate the so-called homogeneous differential equation of the first order and still later also the linear equation of the first order (*see* equation [17] below). What later became known as the Bernoulli equation was proposed by Jakob Bernoulli in 1695 and solved by Leibniz and Johann Bernoulli using different methods. Thus in a few years most of the known elementary methods of solving first-order equations had been found.

Numerous applications of the new methods to geometrical problems were published prior to 1720, such as the problem of orthogonal trajectories and the problem of finding curves whose curvature is a known function of position. Some of these problems led to equations of the second or the third order. Besides the Bernoullis, the Italian mathematician Count Jacopo Riccati, who solved equations of the form

$$F(y, y', y'') = 0$$

in 1712, should be mentioned. What later became known as Riccati's equation goes back to 1723; some younger members of the Bernoulli family, notably Daniel, participated in the discussion of this equation. Important work on differential equations by A. C. Clairaut dates from 1734.

Leonhard Euler, also from Basel, made important contributions to the theory of differential equations starting in 1728. Various methods of lowering the order of an equation; the notion of an integrating factor; the discussion of linear equations; series solutions and the discovery that the equation

$$(1 - x^4)^{-\frac{1}{2}}\,dx + (1 - y^4)^{-\frac{1}{2}}\,dy = 0$$

has an algebraic solution are all due to Euler.

This special case of Abel's theorem played an important role in the theory of elliptic functions (*q.v.*) created by N. H. Abel and K. G. J. Jacobi in the 1820s.

At this time the function concept received its first airing during the debate between Daniel Bernoulli, Euler and Lagrange concerning the solutions of the so-called wave equation and the notion of an "arbitrary" function. The important questions of what is a function and what constitutes a solution of a differential equation had now been raised; they were often repeated and the answers that satisfied one generation of mathematicians were revised by their successors.

The first great revision of the principles of mathematical analysis took place in the 1820s, pioneered by Abel and Augustin Louis Cauchy. Cauchy gave an entirely new direction to the theory of ordinary differential equations. He showed that, within certain generous limits, all differential equations are solvable and he gave methods of finding the solutions through limiting processes. The theory of analytic functions, also created by him, led to a new theory of differential equations in the complex domain (*see* FUNCTIONS, ANALYTIC). Subsequent historical developments are relatively specialized and are beyond the scope of the present article. They may be found in several of the works listed in the bibliography. (E. H.)

Formulation of Natural Laws.—The way in which differential equations are utilized for the expression of natural laws is indicated in some small measure by the following examples.

Radioactivity.—A radioactive material is constantly disintegrating, the rate of this process being at each instant proportional to the amount of the material which is then left. If the amount of material is designated by y, and t stands for the time, the rate of the disintegration is $-dy/dt$. The stated law asserts that this value is always proportional to y; namely, that it is always equal to ky, k being an appropriate constant. The law is, therefore, expressed by the differential equation (1) above.

Mass Suspended From a Spring.—If a heavy article is suspended from a coiled spring, the position in which it will hang in a continued state of rest is called its position of equilibrium. On a vertical y-axis this position can be taken as the point $y = 0$. If the particle is vertically displaced from this position it will be subject to a restoring force that is always proportional to its coordinate of position y, and is opposite to y in sign. The formula for this force is, therefore, $-k^2y$, where k is a constant of the spring. By Newton's second law of motion, the product of the mass m of the particle by its acceleration d^2y/dt^2 is equal to the force. The law of motion in accordance with which the particle oscillates up and down is, therefore, expressed by the differential equation (2) above.

Curvature.—It is shown in the calculus that the curvature K of a curve $y = f(x)$ is given by the formula

$$K = \left[1 + \left(\frac{dy}{dx}\right)^2\right]^{-\frac{3}{2}} \frac{d^2y}{dx^2}$$

The fact that a certain curve is a circular arc may, therefore, be expressed by the assertion that along it K does not change; namely, by the equation $dK/dx = 0$. This is found to be given explicitly by the differential equation (3) above. That equation thus formulates mathematically the law of the circular nature of the given arc.

Solutions.—An ordinary differential equation in which, for example, the function and the independent variable are denoted by y and x, is in effect an implicit summary of the essential characteristics of y as a function of x. These characteristics would presumably be more accessible to analysis if an explicit formula for y could be produced. Such a formula, or at least an equation in x and y (involving no derivatives) which is deducible from the differential equation, is called a solution of the differential equation. The process of deducing a solution from the equation by the applications of algebra and the calculus is called that of solving or integrating the equation. Some methods that serve for the integration of certain classes of differential equations will be explained below. It should be noted, however, that the differential equations which can be integrated form but a small minority. The chances are large, in the instance of a differential equation selected at random, that the equation is itself the simplest mode of summarizing the characteristics of the function, and that even theoretically no solving formula in the usual sense exists. In such instances the function must be studied by indirect methods. Even its existence must be proved when no possibility of producing it for inspection maintains. These subjects find their place in the more advanced theory.

Quadratures.—As an example of ordinary differential equations which are of so simple a type that their integration depends only upon an obvious application of the calculus, consider the equations of the form

$$\frac{dy}{dx} = f(x), \tag{5}$$

in which $f(x)$ is a given function. The solution of this equation, namely

$$y = \int f(x)dx + c, \tag{6}$$

affords the occasion for some remarks which are of rather general applicability. In the relation (6) the indicated integration calls for some (any) indefinite integral of the function $f(x)$. For many types of functions such integrals are to be found in tables of integrals, which are contained in many mathematics textbooks and in scientific and engineering handbooks. Not all functions $f(x)$, however, and not even all simple ones, have integrals that can be expressed by elementary closed formulas. Hence an indicated integration is not always replaceable by an expression that is more explicit. For this reason a relation in the form (6) is generally regarded as a satisfactory solution of equation (5), just as it stands. The term "quadrature" is frequently used in the place of "indefinite integral," the relation (6) being called a solution in terms of an indicated quadrature.

The General Solution; Other Solutions.—The final term of the relation (6), being a constant of integration and hence being able to assume any value whatever, is called an arbitrary constant. For each specific value of this constant equation (6) defines a curve in the (x,y) plane, and while the constant remains arbitrary the equation refers to the whole aggregate or family of these curves. This family is the solution of the differential equation. What is thus observed in the simple case of equation (5) is generally true of differential equations. The process of solution brings one or more arbitrary constants into the relations, and these as a result represent a family of curves. A solution which includes the maximum possible number of arbitrary constants is called the general solution of the differential equation. It can be shown that this maximum number is precisely equal to the order of the differential equation; namely, that the general solution of an ordinary differential equation of the nth order involves n arbitrary constants.

For any set of specific values of the constants the solving relation still yields a solution. Such a solution is called a particular solution. Obviously the general solution includes all the particular solutions. In the case of some differential equations still other solutions, called singular solutions, exist. A discussion of singular solutions is contained, for example, in the book by L. M. Kells listed in the bibliography.

Initial and Boundary Conditions.—The presence of arbitrary constants in the general solutions of ordinary differential equations is a matter of fundamental significance for the application of these equations to scientific problems; for such problems ordinarily call not merely for *a* solution of the equation, but for *the* solution which fulfills also certain other relations that are pertinent to it. These auxiliary relations must, therefore, be fulfilled by the appropriate assignment of values to the arbitrary constants. Some examples will illustrate this.

It was shown above how the disintegration of a radioactive substance is formulated by the differential equation (1). The general solution of this equation is

$$y = ce^{-kt}, \tag{7}$$

in which the constant c is arbitrary. Now in any specific case the substance is of a definite amount, say 20 g., at some definite time, say at $t = 2$ seconds. These values, upon being substituted for y and t in the equation, impose upon c the relation $20 = ce^{-k2}$, in accordance with which

$$c = 20e^{2k} \tag{8}$$

The solution which fits the case is, therefore,

$$y = 20e^{k(2-t)} \tag{9}$$

It was also shown above how the motion of a particle suspended from a spring is formulated by the differential equation (2). The general solution of this equation (obtained by a method involving the use of an auxiliary equation, described below) is

$$y = c_1\cos\frac{kt}{\sqrt{m}} + c_2\sin\frac{kt}{\sqrt{m}} \tag{10}$$

Now in any specific case the particle is at a definite place, say at $y = 1$, and is moving with a definite velocity, say $dy/dt = -\frac{1}{2}$, at a definite time, say at $t = 0$. These values substituted into (10) and the equation for dy/dt derived from (10) impose upon c_1 and c_2 the relations $1 = c_1$, and $-\frac{1}{2} = c_2k/\sqrt{m}$. Thus it is required that $c_1 = 1$, $c_2 = -\sqrt{m}/2k$, and accordingly the solution that fits the problem is

$$y = \cos\frac{kt}{\sqrt{m}} - \frac{\sqrt{m}}{2k}\sin\frac{kt}{\sqrt{m}}$$

Auxiliary conditions that are imposed upon the solution of a differential equation at some one value of the independent variable, as in the examples above, are called initial conditions. If the auxiliary conditions apply at two or more values of the independent variable, they are usually called boundary conditions. Problems leading to such conditions are called differential boundary problems. The work by R. V. Churchill listed in the bibliography is primarily concerned with such problems.

FIRST-ORDER EQUATIONS

Equations With Separable Variables.—The ordinary differential equation of the first order, when it is solved for the derivative, is of the form

$$\frac{dy}{dx} = f(x,y), \tag{11}$$

in which $f(x,y)$ is an explicit function. A form which is obviously equivalent to this, but which is in some respects more convenient, is

$$M(x,y)dx + N(x,y)dy = 0 \tag{12}$$

The case to which attention is to be given first is that in which equation (12) is of the more special form

$$P(x)dx + Q(y)dy = 0, \tag{13}$$

or in which it can be brought into this form by multiplying it through by appropriate factors that are functions of x or of y. The salient specialization which distinguishes (13) from the general form (12) is that P, the coefficient of dx, does not involve y, and Q, the coefficient of dy, does not involve x. In equation (13) the variables are said to be separated, and a differential equation which can be reduced to such a form is classed as an equation with separable variables. When the variables have been separated the integration of the differential equation reduces to a mere matter of quadrature. Thus the general solution of the differential equation (13) is given by the relation

$$\int P(x)dx + \int Q(y)dy = c, \tag{14}$$

with c denoting the arbitrary constant.

By way of example consider the differential equation

$$dy + kydt = 0$$

This will be recognized as equation (1) above. In this equation the variables are separable, for upon multiplication by $1/y$ the form is changed to

$$\frac{1}{y}dy + kdt = 0,$$

in which the variables are separated. Integration yields the solution

$$\log y + kt = c$$

The differential equation

$$y^4dx + (4y - 3)\cos^2 xdy = 0,$$

if multiplied through by the factors y^{-4} and $\sec^2 x$, takes the form

$$\sec^2 xdx + \left(\frac{4}{y^3} - \frac{3}{y^4}\right)dy = 0,$$

in which the variables are separated. Integration of this yields the solution

$$\tan x - \frac{2}{y^2} + \frac{1}{y^3} = c$$

The differential equations

$$y^2 + 5y\frac{dy}{dx} = 3 + xy\frac{dy}{dx},$$

$$y^2dx + \sqrt{1 - x^2}\,dy = 4dx$$

are of this type. Their solutions are respectively

$$\log(x - 5) - \tfrac{1}{2}\log(y^2 - 3) = c,$$

$$4\sin^{-1}x + \log\left(\frac{y-2}{y+2}\right) = c$$

Exact Equations.—It is shown in the calculus that if two functions $M(x,y)$, $N(x,y)$ fulfill the relation

$$\frac{\partial}{\partial y}M(x,y) \equiv \frac{\partial}{\partial x}N(x,y) \tag{15}$$

then there exists a function $\varphi(x,y)$ of value such that $\partial\varphi(x,y)/\partial x = M(x,y)$ and $\partial\varphi(x,y)/\partial y = N(x,y)$. In accordance with this it is clear that if the differential equation (12) is one whose coefficients fulfill the identity (15), then the equation can be written in the form

$$\frac{\partial\varphi(x,y)}{\partial x}dx + \frac{\partial\varphi(x,y)}{\partial y}dy = 0$$

This may, however, be more concisely written as $d\varphi = 0$, and thus it must be concluded that $\varphi(x,y) = c$, a constant. This is, then, the general solution of the given equation. It remains only to describe the means by which the function $\varphi(x,y)$ may be found. This may be done as follows: Treating y as though it were a constant, evaluate the integral $\int M(x,y)dx$. Then treating x as though it were a constant, evaluate the integral $\int N(x,y)dy$. The sum of all unlike terms in these two evaluations (*i.e.*, including no repetitions) is the function $\varphi(x,y)$.

As an example consider the differential equation

$$(\cos y - y + 1)dx + (3y^2 - x\sin y - x)dy = 0$$

In this case the two members of the identity (15) are each $(-\sin y - 1)$, and thus the equation is exact. Regarding y as a constant, the first member of the equation integrates into $x\cos y - xy + x$. Regarding x as a constant, the second member integrates into $y^3 + x\cos y - xy$. Setting the sum of unlike terms equal to an arbitrary constant gives as the general solution

$$x\cos y - xy + x + y^3 = c$$

The differential equations

$$y(e^{xy} - \sin x)dx + (\cos x + xe^{xy})dy = 0,$$

$$(2xy^3 - 3)dx + \left(3x^2y^2 + 8y - \frac{1}{y}\right)dy = 0$$

may be shown to be exact. Their solutions are respectively

$$y\cos x + e^{xy} = c,$$

$$x^2y^3 - 3x + 4y^2 - \log y = c$$

Although a differential equation may not be exact in the form in which it is encountered, it is possible to prove that by multiplication with a suitable factor it may be made exact. Thus the differential equation

$$\left(2y + \frac{1}{xy}\right)dx + \left(x - \frac{1}{y^2}\right)dy = 0 \tag{16}$$

is not exact, but if it is multiplied through by the factor x it becomes so. A multiplier, such as x in this instance, which makes a differential equation exact is called an integrating factor. Other integrating factors for equation (16) are $y/(xy^2 + 1)$ and $x^2\left(xy + \frac{1}{y}\right)$. It can be proved that for every differential equation of form (12) an unlimited number of integrating factors exists. In some simple cases it is possible to guess an integrating factor. Many textbooks point out earmarks to be sought in the differential equation as guides to such guessing. In most actual cases, however, integrating factors are not easily found.

Linear Equations.—A differential equation which can be written in the form

$$\frac{dy}{dx} + Py = Q, \tag{17}$$

in which the coefficients P and Q may be constants or functions of x but do not involve y, is called a linear differential equation

of the first order. This is a type of equation which is of considerable importance in many different connections. When the equation is given the alternative form

$$[yP(x) - Q(x)]dx + dy = 0,$$

the remarks of the section just preceding apply to it, and it is, in fact, found that the multiplier $e^{\int P(x)dx}$ is an integrating factor. By the method of exact equations outlined above, the general solution of the equation is thus found to be

$$ye^{\int P(x)dx} - \int Q(x)e^{\int P(x)dx}dx = c \tag{18}$$

As an example consider the differential equation

$$\frac{dy}{dx} + \left(1 + \frac{1}{x}\right)y = \frac{5}{x}$$

The integrating factor is $e^{x + \log x}$, a function which is more briefly written xe^x, and the solution of the equation is

$$xye^x - 5e^x = c$$

The differential equations

$$\frac{dy}{dx} + 2y \tan x = 2x \cos^2 x,$$

$$(xe^{2x} - 2y\sqrt{1 + x^2})dx + \sqrt{1 + x^2}dy = 0$$

are of this type. Their solutions are respectively

$$y \sec^2 x - x^2 = c,$$

$$ye^{-2x} + \sqrt{1 + x^2} = c$$

Solution by Change of Variable.—When no convenient method for the integration of a differential equation suggests itself, a procedure which is frequently resorted to is the following one. Some combination of the variables x and y is taken as a new variable, say s, and the differential equation is then expressed in terms of this new variable and one or the other of the original variables. In its new aspect the differential equation may be of a form quite different from its original one. New possibilities for its integration may thus present themselves. It is not always possible to foretell how such a change of variable may profitably be made.

In some instances certain combinations of the variables are obviously prominent in the differential equation, and the clue as to a desirable change may therein be seen. Some examples will serve to illustrate the procedure.

Consider the differential equation

$$(x + 3y + 2)dx + (2x + 6y + 3)dy = 0 \tag{19}$$

The combination $x + 3y$ appears with some prominence in this equation. Set $s = x + 3y$, namely $x = s - 3y$, so that $dx = ds - 3dy$. On substituting these values for x and dx in equation (19), the latter becomes

$$(s + 2)(ds - 3dy) + (2s + 3)dy = 0$$

This is found to be an equation with separable variables. By the method of same it may be integrated into the relation

$$s - \log(s + 3) - y = c$$

On replacing s by its value in terms of the original variables, it is found that

$$x + 2y - \log(x + 3y + 3) = c,$$

and this is the solution of the given differential equation.

As a second example consider the differential equation

$$2x^2ydx + (xy^2 + x^3)dy = 0$$

In this all terms are of the same degree (the third) in x and y, and a multiplication of the equation by x^{-3} changes it to the form

$$2\left(\frac{y}{x}\right)dx + \left[\left(\frac{y}{x}\right)^2 + 1\right]dy = 0$$

The change $s = y/x$, namely $y = xs$, is strongly suggested. In accordance with this change, $dy = xds + sdx$, and with the substitution of these values of y and dy the equation becomes

$$2sdx + (s^2 + 1)(xds + sdx) = 0$$

This has separable variables, and has the solution $\log x + \log(s^3 + 3s) = c$. Upon replacing s by its value in terms of x and y the solution of the given equation is obtained, namely

$$\log x + \tfrac{1}{3}\log\left(\frac{y^3}{x^3} + \frac{3y}{x}\right) = c$$

A standard form of differential equation which yields to this method of integration is the equation

$$\frac{dy}{dx} + P(x)y = Q(x)y^k, \tag{20}$$

in which the coefficients P and Q do not involve y. If $k = 1$ the variables are separable, and if $k = 0$ the equation is linear. The integration in these cases has, therefore, already been discussed. In the remaining cases, namely $k \neq 0$, $k \neq 1$, the change of variable $s = y^{1-k}$ reduces the equation to the linear form.

SECOND-ORDER LINEAR EQUATIONS

The differential equation of the nth order which is of the form

$$a_0\frac{d^ny}{dx^n} + a_1\frac{d^{n-1}y}{dx^{n-1}} + \ldots + a_{n-1}\frac{dy}{dx} + a_ny = f(x), \tag{21}$$

in which the coefficients $a_0, a_1, \ldots, a_n$, may be functions of x but do not involve y or any of its derivatives, is called the linear differential equation of the nth order. The equation which differs from this only by having zero as its right-hand member in the place of $f(x)$ is called the corresponding reduced or homogeneous equation. Certain facts concerning equations of this type greatly facilitate the construction of their solutions. These are primarily the following: If $y_0(x)$ is any particular solution of the differential equation (21), and $y_1(x), y_2(x), \ldots, y_p(x)$ are any linearly independent solutions of the corresponding reduced equation, then the relation

$$y = y_0(x) + c_1y_1(x) + c_2y_2(x) + \ldots + c_py_p(x), \tag{22}$$

in which the coefficients $c_1, c_2, \ldots, c_p$ are arbitrary constants, is also a solution of equation (21). If, in particular, the number p is equal to n, the solution (22) is the general solution since it involves n arbitrary constants. In view of these facts the integration of an equation of the form (21) is achievable by the determination, in any manner, of a particular solution of that equation, and of n functionally distinct particular solutions of the reduced equation.

Insofar as the applications of differential equations to physics and engineering are concerned, the linear type of equation is of extremely great importance. Since by far the largest number of applications lead, moreover, to differential equations of the second order, the remaining discussion will be confined to these. Such equations are solvable by elementary methods, as will be shown, whenever the coefficients are constants. When these coefficients are more general functions of x, on the other hand, explicit solutions in simple closed formulas usually do not exist. Because of their great importance a number of equations of this kind have been endowed with proper names, such as the Bessel equation, the Legendre equation, the Mathieu equation, etc., and volumes have been written about them.

When the differential equation (21) is of the second order, it is explicitly

$$a_0\frac{d^2y}{dx^2} + a_1\frac{dy}{dx} + a_2y = f(x), \tag{23}$$

and its reduced equation is

$$a_0\frac{d^2y}{dx^2} + a_1\frac{dy}{dx} + a_2y = 0 \tag{24}$$

If a_0 is a constant, it is assumed to be different from zero, since the equation would otherwise be of a lower order than the second.

Applications to Physics.—In an earlier section the physical problem of a weight suspended from a coiled spring and oscillating in the vertical direction about the point $y = 0$ was shown to be

formulated by the differential equation (2). It will be observed at once that this equation is of type (24). Had the position of equilibrium been chosen to be some value of y different from zero, the resulting differential equation would have been of type (23). In the following, some other formulations from the field of physics are shown to lead to differential equations of these types.

If a body of mass m and weight w is permitted to fall in a vacuum, the pull of gravity exerts upon it a force equal to its weight. By Newton's second law of motion this force is equal to the product of the body's mass by its acceleration, the latter being d^2y/dt^2, where y denotes the distance through which it has fallen. The motion is thus formulated by the differential equation

$$m\frac{d^2y}{dt^2} = w,$$

and this is of the form (23). For the case of a fall not in a vacuum but in a medium such as air, which resists the motion with a force that is at any instant a constant k^2 times the velocity, the effective downward force is $w - k^2dy/dt$. The law of motion is accordingly

$$m\frac{d^2y}{dt^2} = w - k^2\frac{dy}{dt},$$

and this is again a differential equation of the type (23).

The discharge of an electrical condenser through an inductive coil of wire may also be readily formulated in symbols. The potential difference V between the terminals of the condenser is at each instant proportional to the charge Q upon it, the constant C in the relation $Q = CV$ being called the condenser's capacitance. The current I of the discharge is the rate $-dQ/dt$ at which the charge diminishes, and thus $I = -CdV/dt$. The counter e.m.f. interposed by the coil is equal to the coil's inductance L times the rate of change of current, and thus the effective voltage is $V - LdI/dt$. This is equal to the current times the resistance R; namely, $V - LdI/dt = RI$. Upon substituting the value of I above, this equation becomes

$$V + LC\frac{d^2V}{dt^2} = -RC\frac{dV}{dt},$$

and this differential equation is of the form (24).

Solution by Use of Auxiliary Equation.—When the coefficients of the equation (24) are constants, as in the case of each of the equations which were derived in the section immediately preceding, the substitution

$$y = e^{rx}, \tag{25}$$

with r standing for a constant, leads to the relation

$$(a_0r^2 + a_1r + a_2)e^{rx} = 0$$

This is fulfilled if r is a root of the equation

$$a_0r^2 + a_1r + a_2 = 0, \tag{26}$$

this being called the auxiliary equation of (24). When this auxiliary equation has two unequal roots, say $r = r_1$ and $r = r_2$, formula (25) with either one of these values of r solves the differential equation (24). The same is true of the formula

$$y = c_1e^{r_1x} + c_2e^{r_2x}, \tag{27}$$

irrespective of the values of the constants c_1, c_2. Since the relation (27) involves two arbitrary constants, it is the general solution of the differential equation (24).

The reasoning obviously requires some modification when the auxiliary equation (26) has a multiple root when, in effect, it has only one root, say $r = r_1$. The exponentials on the right of (27) are then the same, and that relation involves only one arbitrary constant, namely $(c_1 + c_2)$. It is, however, easily verified that in this case the formula $y = xe^{r_1x}$ is also a solution of the differential equation (24). The general solution is, therefore, in this instance given by the relation

$$y = c_1e^{r_1x} + c_2xe^{r_1x} \tag{28}$$

Consider now equation (23). If a particular solution $y_0(x)$ of this equation is in any way obtainable, the general solution is given at once by the addition of this $y_0(x)$ to the right-hand member of the appropriate relation (27) or (28). This was observed above, and was formulated in relation (22). The matter at issue is, therefore, only the deduction of a particular solution $y_0(x)$. There are a number of procedures commonly used for achieving this.

One such is the following:

The differential equation (23) may be written in the form

$$\frac{d}{dx}\left(\frac{dy}{dx} - r_2y\right) - r_1\left(\frac{dy}{dx} - r_2y\right) = \frac{1}{a_0}f(x) \tag{29}$$

If the symbol $\varphi(x)$ is introduced with the relationship

$$\frac{dy}{dx} - r_2y = \varphi(x), \tag{30}$$

equation (29) appears in the form

$$\frac{d\varphi}{dx} - r_1\varphi = \frac{1}{a_0}f(x) \tag{31}$$

This, however, is a linear differential equation of the first order for the value of $\varphi(x)$, and by the relation (18) (with $c = 0$) it is fulfilled if

$$\varphi(x) = e^{r_1x}\int\frac{f(x)}{a_0}e^{-r_1x}dx$$

The function $\varphi(x)$ has thus been made known, and, this being so, the solution $y_0(x)$ sought is shown by (30) to be obtainable by the integration of that equation. This is again a linear equation of the first order. As applied to it the relation (18) (with $c = 0$) yields

$$y = e^{r_2x}\int\varphi(x)e^{-r_2x}dx,$$

and this is the evaluation of the desired particular solution $y_0(x)$.

An example may not be amiss. Consider the differential equation

$$2\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 4y = e^{-3x}$$

The auxiliary equation has the roots $r_1 = 1$, $r_2 = 2$, and thus the general solution of the reduced equation is

$$y = c_1e^x + c_2e^{2x}$$

Equation (31) is in this case

$$\frac{d\varphi}{dx} - \varphi = \tfrac{1}{2}e^{-3x},$$

and a solution of it is $\varphi(x) = \frac{-1}{8}e^{-3x}$. Equation (30) is accordingly

$$\frac{dy}{dx} - 2y = \frac{-1}{8}e^{-3x},$$

and this admits as a solution $y = \frac{1}{40}e^{-3x}$. The general solution of the equation considered is, therefore,

$$y = \frac{1}{40}e^{-3x} + c_1e^x + c_2e^{2x}$$

Solution by Method of Undetermined Coefficients.—A procedure for finding a solution $y_0(x)$ of equation (23) which is in wide practical use, although it is not always applicable, is the following one. Suppose the right-hand member $f(x)$ is expressible in terms of the functions of a set $\varphi_1(x)$, $\varphi_2(x)$, . . . , $\varphi_p(x)$, in the manner

$$f(x) = k_1\varphi_1(x) + k_2\varphi_2(x) + \ldots + k_p\varphi_p(x), \tag{32}$$

with constant coefficients k_1, k_2, . . . , k_p, the functions of this set being such that the derivative of each one of them can also be so expressed. Then if $y_0(x)$ is assumed to be of the form

$$y_0(x) = b_1\varphi_1(x) + b_2\varphi_2(x) + \ldots + b_p\varphi_p(x), \tag{33}$$

the coefficients b_1, b_2, . . . , b_p may be determined. The fol-

lowing example illustrates this method.

Consider the differential equation

$$\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = 4x + 11\cos x$$

In this case the right-hand member is expressible in the form (32) with $\varphi_1 = x$, $\varphi_2 = 1$, $\varphi_3 = \cos x$, $\varphi_4 = \sin x$, and the derivative of each of these can also be so expressed. Hence if it is assumed that

$$y_0 = b_1x + b_2 + b_3\cos x + b_4\sin x,$$

the result of substituting this into the differential equation is the relation

$$2b_1x + (3b_1 + 2b_2) + (b_3 + 3b_4)\cos x + (b_4 - 3b_3)\sin x = 4x + 11\cos x$$

Equating coefficients of similar terms shows that $2b_1 = 4$, $3b_1 + 2b_2 = 0$, $b_3 + 3b_4 = 11$, $b_4 - 3b_3 = 0$. These equations determine the evaluations $b_1 = 2$, $b_2 = -3$, $b_3 = 11/10$, $b_4 = 33/10$, and thus

$$y_0 = 2x - 3 + 11/10\cos x + 33/10\sin x$$

Solution by Power-Series Method.—When the coefficients of the differential equation (23) are not constants but are continuous functions of x, the character of the solutions near any specific point x depends significantly upon whether the leading coefficient $a_0(x)$ is or is not zero at this point. In the former case the point is called a singular point. It is assumed in the following discussion that for the values of x in question $a_0(x) \not\equiv 0$, and that this and the other coefficients, as well as the function $f(x)$, are either polynomials or are representable in power series (*see* SERIES). The method is one of assuming a solution to be given by an infinite series

$$y = c_0 + c_1x + c_2x^2 + c_3x^3 + \ldots, \tag{34}$$

and then, by the substitution of this form into the equation, determining the coefficients. The following example elucidates this procedure.

Consider the differential equation

$$(1 - x)\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + \frac{2}{1 - x}y = 0 \tag{35}$$

Since from (34)

$$\frac{dy}{dx} = c_1 + 2c_2x + 3c_3x^2 + 4c_4x^3 + \ldots,$$

$$\frac{d^2y}{dx^2} = 2c_2 + 6c_3x + 12c_4x^2 + \ldots,$$

whereas

$$\frac{2}{1 - x} = 2 + 2x + 2x^2 + 2x^3 + \ldots,$$

the terms of the differential equation (35) are respectively

$$(1 - x)\frac{d^2y}{dx^2} = 2c_2 + (6c_3 - 2c_2)x + (12c_4 - 6c_3)x^2 + \ldots,$$

$$-4\frac{dy}{dx} = -4c_1 - 8c_2x - 12c_3x + \ldots,$$

$$\frac{2}{1 - x}y = 2c_0 + (2c_0 + 2c_1)x + (2c_0 + 2c_1 + 2c_2)x^2 + \ldots$$

The result of substituting the form (34) into the differential equation (35) is thus the relation

$$(2c_2 - 4c_1 + 2c_0) + (6c_3 - 10c_2 + 2c_1 + 2c_0)x + (12c_4 - 18c_3 + 2c_2 + 2c_1 + 2c_0)x^2 + \ldots = 0$$

This is fulfilled if the coefficient of each power of x is zero; namely, if

$$2c_2 - 4c_1 + 2c_0 = 0,$$
$$6c_3 - 10c_2 + 2c_1 + 2c_0 = 0,$$
$$12c_4 - 18c_3 + 2c_2 + 2c_1 + 2c_0 = 0,$$

If any choice is made of c_0 and c_1 these equations serve in turn to give evaluations for $c_2, c_3, c_4, \ldots$. Specifically, let the choice $c_0 = 0$, $c_1 = 1$ be made. The values $c_2 = 2$, $c_3 = 3$, $c_4 = 4, \ldots$ are found to result, and the series

$$y_1 = x + 2x^2 + 3x^3 + 4x^4 + \ldots$$

is accordingly a solution. The alternative choice $c_0 = 1$, $c_1 = 0$, leads to the values $c_2 = -1$, $c_3 = -2$, $c_4 = -3, \ldots$, and the series

$$y_2 = 1 - x^2 - 2x^3 - 3x^4 - \ldots$$

is a second solution. When combined with arbitrary constants as multipliers these yield the general solution. The values of x for which solutions are thus obtained are, of course, only those for which the infinite series are convergent.

See also references under "Differential Equations, Ordinary" in the Index volume.

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DIFFERENTIAL EQUATIONS, PARTIAL.

An equation involving several independent variables and one or more dependent variables and their partial derivatives (with respect to the independent variables) is called a partial differential equation. The order of such an equation is the largest of the orders of any of the partial derivatives (of the dependent variables) which occur in the equation. Such an equation is called linear if the dependent variables and their various partial derivatives occur only linearly; the coefficients of these derivatives and dependent variables may, however, be functions of the independent variables. The examples given in equations (1) through (9) and (42) and (44) are all linear.

Applications.—Many physical quantities satisfy partial differential equations, as shown in the following examples:

1. If $u(x,t)$ denotes the lateral displacement at time t of the point of a vibrating string which is at a distance x from one of the fixed ends, then u satisfies the differential equation

$$\frac{\partial^2u}{\partial t^2} = c^2\frac{\partial^2u}{\partial x^2} \quad (c \text{ constant}) \tag{1}$$

2. If $u(x,y,t)$ denotes the vertical displacement at time t of the point at position (x,y) of a horizontal vibrating membrane (such as a drumhead), then u satisfies

$$\frac{\partial^2u}{\partial t^2} = c^2\left(\frac{\partial^2u}{\partial x^2} + \frac{\partial^2u}{\partial y^2}\right) \tag{2}$$

3. If $u(x,y,z,t)$ denotes the temperature at time t and position (x,y,z) within a homogeneous conducting solid, then u satisfies the diffusion equation

$$\frac{\partial u}{\partial t} = a^2\left(\frac{\partial^2u}{\partial x^2} + \frac{\partial^2u}{\partial y^2} + \frac{\partial^2u}{\partial z^2}\right) \tag{3}$$

4. If, in (3), various parts of the surface of the solid are held at various fixed temperatures, the resulting solution of (3) will tend as $t \to \infty$ to the solution u of Laplace's equation

$$\frac{\partial^2u}{\partial x^2} + \frac{\partial^2u}{\partial y^2} + \frac{\partial^2u}{\partial z^2} = 0 \tag{4}$$

that has the given boundary values. The determination of the solution (or solutions if more than one) of (4) with given boundary values is known as the Dirichlet problem. If part of the boundary of the solid is insulated instead of being held at some temperature, then the directional derivative in the direction normal (*i.e.*, perpendicular) to that part of the boundary surface is zero and the problem of determining the solution of (4) with such

boundary data is said to be a mixed problem. The Neumann problem is that of finding the solution of (4) with the normal derivative given; this corresponds roughly to prescribing the rate of flow of heat across the various portions of the boundary.

5. The Newtonian gravitational potential $u(x,y,z)$ at a position (x,y,z) away from the celestial bodies which exert the force also satisfies (4); at a position within one of the celestial bodies, u satisfies Poisson's equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = k\rho(x,y,z) \tag{5}$$

where ρ is the density of matter at (x,y,z) and k is a constant. The electric potential due to the presence of electric charges also satisfies Laplace's equation (4) at positions (x,y,z) away from any charges and satisfies Poisson's equation (5) at positions where the distribution of charges has a continuous volume density ρ; however, electric charges often concentrate on surfaces, in which case the volume density is not defined.

6. If a disturbance (not too large) is propagated through a homogeneous medium, the deviation $p(x,y,z,t)$ of the pressure from normal and the velocity potential $U(x,y,z,t)$ at position (x,y,z) at time t satisfy the so-called wave equation

$$\frac{\partial^2 U}{\partial t^2} = c^2 \Delta U, \ \Delta U = \frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} + \frac{\partial^2 U}{\partial z^2} \tag{6}$$

which is the three-dimensional form of the vibrating-string and the vibrating-membrane equations (1) and (2); here c is the velocity of sound in the medium.

7. The so-called wave functions of quantum mechanics satisfy the Schrödinger wave equation

$$\Delta U + [\lambda + q(x,y,z)]U = 0 \tag{7}$$

in the simplest case. Here ΔU is defined in (6), λ is a constant and $q(x,y,z)$ is a given function; the values of λ for which there are "proper" solutions are called eigenvalues and their totality, together with certain other values of λ, form the spectrum of the system being considered. In the case of the hydrogen atom, the negative values of λ are discrete and determine the frequencies of the emitted light.

Systems of partial differential equations, which must be solved simultaneously, arise in the theories of hydrodynamics, aerodynamics, elasticity and electromagnetism. Under special conditions, a problem in elasticity may be reduced to determining plane stresses σ_{xx}, σ_{xy} and σ_{yy} that are proportional to the second derivatives of the Airy stress function $u(x,y)$, which satisfies the fourth-order equation

$$\Delta^2 u = 0; \ i.e., \ \frac{\partial^4 u}{\partial x^4} + 2\frac{\partial^4 u}{\partial x^2 \partial y^2} + \frac{\partial^4 u}{\partial y^4} = 0 \tag{8}$$

The list of applications mentioned above is certainly not exhaustive, but it may serve to suggest the importance to physics and engineering of the study of such equations. But besides the many applications to science of partial differential equations, there are also many applications to other branches of mathematics. First of all, if $u(x,y)$ and $v(x,y)$ are the real and imaginary parts of an analytic function of the complex variable z, then u and v satisfy the Cauchy-Riemann system

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \ \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x} \tag{9}$$

A great variety of systems of partial differential equations arise in the study of differential geometry (*q.v.*). In many of these, there are more equations than unknown functions, so that certain "integrability conditions" must be satisfied in order for there to be a solution. A great deal of progress has been made since 1930 in the theory of differential equations by use of the theory of operators in Hilbert and Banach spaces and some theories in the calculus of variations which were developed during the first half of this century. The many connections of the theory of partial differential equations with other mathematical theories and the solution of several long-standing problems in differential geometry by methods involving differential equations have aroused a renewed interest in this field on the part of mathematicians.

Methods of Solution.—In view of the importance of partial differential equations in science, the technique of finding solutions to such equations has been and still is being studied intensively. It is possible to obtain reasonably simple formulas for the solutions only in a very few cases. The principal techniques are those of separation of variables, combined with the use of Laplace and Fourier transforms.

One of the first equations to be solved was equation (1). First of all, by a change of scale along the x-axis ($x = cx'$), there is obtained a new equation with $c = 1$. By rotating axes through 45°, setting

$$\xi = \frac{x' - t}{\sqrt{2}}, \ \eta = \frac{x' + t}{\sqrt{2}}, \tag{10}$$

the new equation is seen to be equivalent to the equation

$$\frac{\partial^2 u}{\partial \xi \partial \eta} = 0 \tag{11}$$

which is seen to have only the solutions

$$u = f_1(\xi) + g_1(\eta), \tag{12}$$

where f_1 and g_1 are arbitrary differentiable functions. By retracing the steps, it is seen that all solutions of (1) are of the form

$$u(x,t) = f(x - ct) + g(x + ct) \tag{13}$$

The use of the method of separation of variables in the solution of (1) will now be illustrated. In the case of the vibrating-string problem a solution $u(x,t)$ of (1) is desired such that $u(0,t) = u(l,t) = 0$ for all t, l being the length of the string; this corresponds to the fact that the string is held fixed at both ends. The method involves looking for a solution of (1) of the form

$$u(x,t) = T(t) \cdot X(x) \tag{14}$$

In order for a function u given by (14) to be a solution of (1), the relation

$$T''(t)X(x) = c^2 T(t)X''(x), \text{ or}$$

$$\frac{T''(t)}{T(t)} = c^2 \frac{X''(x)}{X(x)} \tag{15}$$

must hold. Since the left side of (15) is a function of t alone and the right side is a function of x alone, both must be constants. Thus the relations

$$X''(x) = \lambda X(x) \text{ and } T''(t) = c^2 \lambda T(t) \tag{16}$$

must hold for some constant λ. Since the ordinary differential equations in (16) have exponential solutions if $\lambda > 0$, it follows that $\lambda < 0$ if $X(0) = X(l) = 0$. The only solutions of the first equation in (16) for $\lambda = -\mu^2 < 0$ are seen from the theory of ordinary differential equations (*see* DIFFERENTIAL EQUATIONS, ORDINARY) to be of the form

$$X(x) = A \cos \mu x + B \sin \mu x$$

If $X(0) = 0$, then $A = 0$; if $X(l) = 0$, then $\mu l = n\pi$ for some integer n. Hence any solution u of the desired type must be of the form

$$\sin\left(\frac{n\pi x}{l}\right) \cdot \left(C_n \cos \frac{cn\pi t}{l} + D_n \sin \frac{cn\pi t}{l}\right) \tag{17}$$

Since equation (1) is linear, any finite or convergent infinite sum of such solutions (if the derivatives also converge uniformly) is also a solution. Since any sufficiently regular function which vanishes at $x = 0$ and $x = l$ can be expanded into a Fourier sine series, it is clear that the values of $u(x,0)$ and $u_t(x,0)$, *i.e.*, the initial displacement and velocity at points along the string, may be assigned; the coefficients C_n are just the Fourier coefficients for $u(x,0)$ and the D_n are proportional to those for $u_t(x,0)$ (u_t means $\partial u/\partial t$).

It should be noted that the values of λ for which there is a solution of (16) of the desired type (in this case $X(0) = X(l) = 0$) are discrete and are all negative; in fact

$$\lambda = -\mu^2, \text{ where } \mu = \frac{n\pi}{l}$$

for some integer n (which may be assumed positive since $\sin(-n\pi x/l) = -\sin(n\pi x/l)$). It is of some interest that the value $n = 1$ corresponds to the fundamental tone emitted by the string and the larger values of n correspond to the harmonics.

In case solutions of (1) for all values of x and t or for all $t \geqq 0$ are desired, the form (13) is more general and more useful than that just obtained; it is easy to see that $u(x,0)$ and $u_t(x,0)$ may be assigned.

The use of the Laplace transform in the solution of (1) with different initial and boundary data will now be illustrated. Let

$$U(x,s) = \int_0^\infty e^{-st}u(x,t)dt, \tag{18}$$

assuming that u does not increase too rapidly with t to prevent the convergence of the integral, at least for sufficiently large s; U is called the Laplace transform (in t) of $u(x,t)$. Integration by parts gives

$$\begin{aligned}\int_0^\infty e^{-st}\frac{\partial u}{\partial t}dt &= -u(x,0) + s\int_0^\infty e^{-st}u(x,t)dt \\ \int_0^\infty e^{-st}\frac{\partial^2 u}{\partial t^2}dt &= -u_t(x,0) - su(x,0) + s^2U(x,s)\end{aligned} \tag{19}$$

Equation (1) then becomes

$$U_{xx}(x,s) - s^2U(x,s) = -u_t(x,0) - su(x,0), \tag{20}$$

which is an ordinary differential equation in x for each value of s. If $u(x,t)$ is given along two lines $x = a$ and $x = b$, for example, then $U(x,s)$ would be given along those lines for corresponding values of s; the desired solution could then be found by finding the solution of (20) for each s which had the given values (depending on s) for $x = a$ and $x = b$, and then using some "Laplace inversion formula" to solve (18) for $u(x,t)$, this last often being done with the aid of tables of Laplace transforms. In case $u(x,t)$ and $u_x(x,t)$ were given on $x = 0$ and $u(x,t)$ were desired for $x \geqq 0$ and $t \geqq 0$, then U and U_x would be given along $x = 0$ and it would be possible to solve (20) by introducing the Laplace transform of U with respect to x:

$$V(y,s) = \int_0^\infty e^{-xy}\,U(x,s)dx \tag{21}$$

The methods of separation of variables and the Laplace transform are useful for many other equations with constant coefficients in cases where the region in which the solution is desired is the whole plane, half plane, quadrant, infinite or semi-infinite strip (bounded laterally by a pair of parallel lines). They may also be useful in corresponding three-dimensional problems. Although the Laplace-transform method has many advantages, the method of separation of variables probably applies in more general situations.

For example, if polar co-ordinates are introduced in the plane, Laplace's equation ($u_{xx} + u_{yy} = 0$) in the plane becomes

$$\frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} + \frac{1}{r^2}\frac{\partial^2 u}{\partial \theta^2} = 0 \tag{22}$$

Writing

$$u(r,\theta) = R(r)\cdot\Theta(\theta)$$

and using the argument in the paragraph containing equations (15) and (16), it is seen that R and Θ must satisfy

$$\frac{r^2R'' + rR'}{R} = \frac{-\Theta''}{\Theta} = \lambda, \tag{23}$$

where λ is a constant. If solutions which are regular and single-valued inside the unit circle are desired, Θ must be periodic and of period 2π. The only values of λ which yield such solutions for Θ in (23) are

$$\lambda = n^2,\ \Theta = a_n\cos n\theta + b_n\sin n\theta$$

for some n. The corresponding solutions for R in (23) are

$$R = r^n,$$

where n is a positive integer. Of course $u =$ constant is a solution. Thus any convergent series of the form

$$u(r,\theta) = \frac{a_0}{2} + \sum_{n=1}^{\infty} r^n(a_n\cos n\theta + b_n\sin n\theta) \tag{24}$$

(in which the a_n and b_n are constants) is a solution of Laplace's equation; it can also be shown that any solution of Laplace's equation which is regular in the unit circle can be expanded into a series of the type (24), which converges absolutely and uniformly for $r < 1$. If the series (24) also converges absolutely and uniformly for $r = 1$, the series reduces to the Fourier series for $u(1,\theta)$; if such a convergent Fourier series is given and the factors r^n are introduced as in (24), a solution of Laplace's equation having the function given by the Fourier series as its boundary values is obtained. It can be proved that this is the only solution of Laplace's equation having that property. A similar result holds for solutions of Laplace's equation in a sphere in three-space, but the functions $\cos n\theta$ and $\sin n\theta$ have to be replaced by the so-called spherical harmonics (*q.v.*).

A number of techniques involving the theory of functions of a complex variable are also useful in the solution of partial differential equations. However, all the techniques taken together have only a very limited application. In the many cases where no technique leads to a solution, numerical methods must be resorted to. With the development of high-speed, large-capacity computing machines, the numerical computation of the solution of such equations has become feasible; in fact, a great proportion of the use time of these machines is spent doing just such numerical computations.

Existence Theory.—In many cases where no reasonably simple formula can be found for a solution and a great effort must be made to compute one numerically, it is clearly desirable to know that the equation has one and only one solution which satisfies the given boundary or initial conditions. This is pointed up further by the following example, presented by H. Lewy in 1957, of a pair of linear differential equations of the first order in three independent variables which has no solution defined throughout the interior of any sphere however small; the equations are

$$\begin{aligned}&\frac{\partial u}{\partial x} - 2y\frac{\partial u}{\partial t} - \frac{\partial v}{\partial y} - 2x\frac{\partial v}{\partial t} = \psi'(t) \\ &\frac{\partial u}{\partial y} + 2x\frac{\partial u}{\partial t} + \frac{\partial y}{\partial x} - 2y\frac{\partial v}{\partial t} = 0\end{aligned} \qquad (\psi = u + iv) \tag{25}$$

where $\psi(t)$ is continuous together with all of its derivatives for all t but is not analytic for any t.

The importance of knowing that a given equation has one and only one solution was recognized early during the 19th century, and a first general theorem of this sort was proved by A. L. Cauchy and generalized by Madame Sonya Kovalevski. The simplest form of this theorem states that any equation of the form

$$\frac{\partial z}{\partial x} = f\left(x,y,z,\frac{\partial z}{\partial y}\right), \tag{26}$$

where the function $f(x,y,z,q)$ is analytic in its arguments for values near x_0, y_0, z_0, and q_0, say, possesses one and only one solution $z(x,y)$ which is analytic near (x_0,y_0) and for which

$$z(x_0,y) = \phi(y), \tag{27}$$

where $\phi(y)$ is analytic at y_0 with

$$\phi(y_0) = z_0 \text{ and } \phi'(y_0) = q_0$$

(A function of two variables is said to be analytic at (x_0,y_0) if it is representable for all points (x,y) near enough to (x_0,y_0) as the sum of a convergent Taylor's series in powers of $(x - x_0)$ and $(y - y_0)$; a similar definition holds for functions of more than two variables [*see* FUNCTIONS, ANALYTIC]).

This theorem has immediate generalizations to functions of

more than two independent variables and to systems of such equations. In the case of an equation of the form

$$\frac{\partial^2 z}{\partial x^2} = f\left(x,y,z,\frac{\partial z}{\partial x},\frac{\partial z}{\partial y},\frac{\partial^2 z}{\partial x \partial y},\frac{\partial^2 z}{\partial y^2}\right), \tag{28}$$

where f is analytic in its seven arguments, there is a unique analytic solution z (near (x_0,y_0)) such that

$$z(x_0,y) = \phi(y) \text{ and } z_x(x_0,y) = \psi(y) \quad \left(z_x = \frac{\partial z}{\partial x}\right), \tag{29}$$

where $\phi(y)$ and $\psi(y)$ are given functions analytic at y_0 and having proper values there. The conditions (27) and (29) are often called Cauchy initial data or just Cauchy data, and correspond to the initial data which can be prescribed at a point x_0 in the case of ordinary differential equations. Of course equation (28) could be replaced by a system of equations (with left members $\partial^2 z_i/\partial x_1^2$) in any number of dependent and independent variables.

Equation (26) is a special form of the most general equation of the first order, and the determination of the solution with Cauchy data assigned along a segment of the line $x = x_0$ is a special problem. Consider the most general equation of the first order,

$$f\left(x,y,z,\frac{\partial z}{\partial x},\frac{\partial z}{\partial y}\right) = 0, \tag{30}$$

where $f(x,y,z,p,q)$ is required to be analytic wherever defined and where it is desired to assign Cauchy data $z = Z(t)$ along the arc

$$x = X(t),\ y = Y(t) \qquad [(X')^2 + (Y')^2 > 0], \tag{31}$$

where $X(t)$, $Y(t)$ and $Z(t)$ are analytic at t_0 with

$$X(t_0) = x_0,\ Y(t_0) = y_0,\ Z(t_0) = z_0,$$

for example. If there is a solution of (30) with the given Cauchy data and if p_0 and q_0 are the values of $\partial z/\partial x$ and $\partial z/\partial y$ at (x_0,y_0), then p_0 and q_0 must satisfy the equations

$$f(x_0,y_0,z_0,p_0,q_0) = 0,\ Z'(t_0) = p_0X'(t_0) + q_0Y'(t_0), \tag{32}$$

since in this example it is required that

$$z[X(t),\ Y(t)] = Z(t) \tag{33}$$

If equations (32) have a solution, it is natural to try to reduce the problem to the one described in (26) and (27) by introducing new co-ordinates (s,t). This may be done in many ways; for example, by setting

$$x(s,t) = X(t) + sY'(t_0),\ y(s,t) = Y(t) - sX'(t_0) \tag{34}$$

It can be shown by using implicit function theorems that the transformation of co-ordinates

$$x = x(s,t),\ y = y(s,t)$$

is one-to-one and analytic from some neighbourhood of (s_0,t_0) to a neighbourhood of (x_0,y_0) and that s and t are analytic functions of x and y near (x_0,y_0) with

$$\begin{gathered} s_x(x_0,y_0) = J^{-1}Y'(t_0),\ s_y(x_0,y_0) = -J^{-1}\cdot X'(t_0), \\ J = [X'(t_0)]^2 + [Y'(t_0)]^2 \neq 0 \quad \left(s_x = \frac{\partial s}{\partial x}, \text{ etc.}\right) \end{gathered} \tag{35}$$

In the new co-ordinates, z satisfies the equation

$$g\left(s,t,z,\frac{\partial z}{\partial s},\frac{\partial z}{\partial t}\right) = 0 \tag{36}$$

where

$$g(s,t,z,\pi,\kappa) = f(x,y,z,\pi s_x + \kappa t_x,\ \pi s_y + \kappa t_y) \tag{37}$$

where, of course, x, y, s_x, t_x, s_y, t_y are to be expressed in terms of s and t; formula (37) follows, since p, q, π and κ stand for $\partial z/\partial x$, $\partial z/\partial y$, $\partial z/\partial s$ and $\partial z/\partial t$, respectively, and

$$\frac{\partial z}{\partial x} = \frac{\partial z}{\partial s}\frac{\partial s}{\partial x} + \frac{\partial z}{\partial t}\frac{\partial t}{\partial x},\ \frac{\partial z}{\partial y} = \frac{\partial z}{\partial s}\frac{\partial s}{\partial y} + \frac{\partial z}{\partial t}\frac{\partial t}{\partial y} \tag{38}$$

Now if π_0 and κ_0 are the values corresponding to p_0 and q_0, using equations (35) and (38), and if

$$g_\pi(s_0,t_0,z_0,\pi_0,\kappa_0) \neq 0,$$

then equation (36) is equivalent to an equation of the form (26) in the new variables and the problem is solved. But

$$g_\pi = f_p \cdot Y'(t_0) - f_qX'(t_0), \tag{39}$$

as is seen from equations (35) and (37); here g_π, f_p and f_q are to be evaluated at $(s_0,t_0,z_0,\pi_0,\kappa_0)$ and (x_0,y_0,z_0,p_0,q_0), respectively. But, from (39), $g_\pi = 0$ if and only if the pair (X',Y') is proportional to the pair (f_p,f_q); that is, if the direction of the tangent to the arc (31) is the same as that determined by the pair (f_p,f_q). This latter direction is called the characteristic direction corresponding to (x_0,y_0,z_0,p_0,q_0) unless $f_p = f_q = 0$, in which case all directions are characteristic.

An entirely similar process for the general equation

$$f(x,y,z,z_x,z_y,z_{xx},z_{xy},z_{zz}) = 0 \tag{40}$$

(f analytic, etc.) shows that analytic values for z and its normal derivative can be prescribed along an analytic arc (34) unless the pair (X',Y') (evaluated at t_0) is proportional to one of the two characteristic directions (λ,μ) defined by

$$f_\lambda\lambda^2 - f_s\lambda\mu + f_t\mu^2 = 0, \tag{41}$$

where r, s and t stand for z_{xx}, z_{xy} and z_{yy}, respectively. The definition of characteristic directions and the Cauchy-Kovalevski theorem can be extended to very general systems of analytic equations in any number of independent and dependent variables.

In general, the characteristic directions depend on the values of z and its derivatives at (x_0,y_0) as well as on (x_0,y_0). However, this is not the case for linear equations. For example, for the general linear first-order equation

$$a\frac{\partial z}{\partial x} + b\frac{\partial z}{\partial y} + cz = d \tag{42}$$

(a,b,c,d are functions of x and y), the function f is

$$f(x,y,z,p,q) = a(x,y)p + b(x,y)q + c(x,y)z - d(x,y)$$

and the characteristic direction is just (a,b) at each point (x,y). In this case, $x(s,t)$ and $y(s,t)$ may be chosen as the solutions of the characteristic equations

$$\frac{\partial x}{\partial s} = a(x,y),\ \frac{\partial y}{\partial s} = b(x,y),\ x(s_0,t) = X(t),\ y(s_0,t) = Y(t)$$

and (42) takes the form

$$\frac{\partial z}{\partial s} + C(s,t)z = D(s,t) \tag{43}$$

In the case of the general linear second-order equation

$$az_{xx} + bz_{xy} + cz_{yy} + dz_x + ez_y + fz - g = 0, \tag{44}$$

the characteristic directions are defined by

$$c\lambda^2 - b\lambda\mu + a\mu^2 = 0 \tag{45}$$

for each (x,y). In case the coefficients are differentiable and the characteristic directions are real and distinct, it turns out to be possible to introduce "characteristic co-ordinates" (s,t) so that equation (44) takes the form

$$\frac{\partial^2 z}{\partial s \partial t} + A\frac{\partial z}{\partial s} + B\frac{\partial z}{\partial t} + Cz = D, \tag{46}$$

which can often be solved by successive approximations starting with the solutions in equations (11) and (12).

Although the Cauchy-Kovalevski theorem was and still is important, the restriction that the equation and Cauchy data have to be analytic is one which is often not met in applications; moreover it is often desired to know the solution in some given domain. However, the example of Lewy cited above shows that difficulties may be encountered if the equation is not analytic. But the fact that any solution of Laplace's equation is analytic in the interior of its domain of definition shows that the values of such a function

along any analytic arc in its domain are necessarily analytic.

However, for first-order equations (30), it turns out that the conclusion of the Cauchy-Kovalevski theorem (without analyticity) carries over if the function f, the arc and the data have continuous second derivatives. Moreover, if the characteristic directions of an equation (44) are real and distinct, the reduction to the form (46) can be carried out, and an equation of form (46) can be solved without requiring analytic coefficients and data. Obviously this reduction cannot be carried out if the characteristic directions defined by (45) are imaginary. This leads to the classification of second-order equations as hyperbolic, parabolic, or elliptic (at a point or set of values) depending on whether their characteristic directions are real and distinct, real and equal, or imaginary. From (45), it follows that equation (1) is hyperbolic with characteristic directions along lines $x + ct = \text{const.}$, Laplace's equation is elliptic and the one-dimensional form of the diffusion equation,

$$\frac{\partial u}{\partial t} = a^2 \frac{\partial^2 u}{\partial x^2}, \tag{47}$$

is parabolic (everywhere).

It turns out that the conclusion of the Cauchy-Kovalevski theorem carries over for hyperbolic equations, even nonlinear ones. A typical problem for equation (47) is the assignment of (possibly nonanalytic) values for $u(x,0)$; this determines $u(x,t)$ for $t > 0$. The situation for elliptic equations is illustrated by the result (24) for Laplace's equation in a circle. This result may be generalized to more inclusive equations (44) which are elliptic over a whole region and on its boundary, which is assumed to consist of several nonintersecting differentiable curves. For such a region, which may be large, the following result is obtained if the coefficient f is replaced by $f + \lambda$, where λ is a constant. If λ does not belong to a discrete set of eigenvalues, the equation has a unique solution which takes on given continuous boundary values; if λ is an eigenvalue, there are finitely many linearly independent solutions of the homogeneous equation ($g \equiv 0$) which vanish on the boundary. The parameter λ is inserted to show the exceptional nature of the case where the equation does not have a unique solution with given boundary values. Similar results hold for other types of boundary-value problems.

It is clear that the variety of types of differential equations increases greatly when systems or equations of higher order are considered, or when more independent variables are involved. Since 1930, great advances have been made in the development of the theories of elliptic, hyperbolic and parabolic equations and systems, and these types have been generalized to cover many additional types of equations. However, even the generalized types do not exhaust all equations of the second order in four variables: the wave equation (6) is hyperbolic, the four-dimensional Laplace's equation is elliptic, the diffusion equation (3) is parabolic but the equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} - \frac{\partial^2 u}{\partial z^2} - \frac{\partial^2 u}{\partial t^2} = 0$$

is not any of these three types. If more than four independent variables are allowed, it is clear that the variety of unclassified equations of the second order will increase. Very little is known (beyond the Cauchy-Kovalevski theorem) about the existence theory for the unclassified types. Moreover, there remain many challenging unsolved problems concerning the solutions of the elliptic, hyperbolic and parabolic types, especially when unbounded domains or nonlinear equations are involved.

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(C. B. M.)

DIFFERENTIAL GEOMETRY, a branch of mathematics concerned with the study of spaces in which differentiation has meaning, so that the tool of differential calculus can be employed. In such space the points must be determined by real numbers as co-ordinates. If the number of co-ordinates is to be equal to the dimension of the space, it is generally not sufficient to use one co-ordinate system throughout the space. For example, this is the case for the $(n-1)$-dimensional unit hypersphere, which is defined as the set of points at a unit distance from the origin in the Euclidean space of n dimensions. In order to have sufficient generality the space is supposed to be covered by co-ordinate neighbourhoods (at most countably many) in which a point has the real co-ordinates $x^1, \ldots, x^n$ (called local co-ordinates), such that when a point belongs to two co-ordinate neighbourhoods its two sets of local co-ordinates x^i and x'^i, $i = 1, \ldots, n$, are related by a transformation $x'^i + f^i(x^1, \ldots, x^n)$, $i = 1, \ldots, n$, where the functions have continuous first partial derivatives with the Jacobian determinant

$$\frac{\partial(f^1, \cdots, f^n)}{\partial(x^1, \cdots, x^n)} = \det\left(\frac{\partial f^i}{\partial x^j}\right) \neq 0$$

A space with such a covering is said to have a differentiable structure and is called a differentiable manifold or simply a manifold (*see* MANIFOLDS). The manifold is said to be of class k ($= 1, 2, \ldots, \infty$) if all the functions $f^i(x^1, \ldots, x^n)$ have continuous partial derivatives of orders $\leqq k$ (or of all orders, if $k = \infty$). It is called analytic if the functions $f^i(x^1, \ldots, x^n)$ are analytic. Since a point may belong to several co-ordinate neighbourhoods, the significant geometrical properties of a manifold are those which remain unchanged under changes of the local co-ordinates.

Tangent Vectors and Tensors.—Consider a differentiable manifold M of dimension n and a point P of M. Let $x^1, \ldots, x^n$ be a local co-ordinate system in a neighbourhood of P such that the co-ordinates of P itself are zero. The equations $x^i = \phi^i(t)$, $i = 1, \ldots, n$, where $\phi^i(t)$ are differentiable functions in t and $\phi^i(0) = 0$, define a parametrized curve through P. Two parametrized curves $x^i = \phi^i(t)$ and $x^i = \psi^i(t)$ are called equivalent if the derivatives $d\phi^i/dt$ and $d\psi^i/dt$, $i = 1, \ldots, n$, have the same values at $t = 0$. Intuitively, equivalent parametrized curves are curves through P having the same tangent vector at P. This geometrical observation makes it possible to define a tangent vector at P to be an equivalence class of parametrized curves through P. If x'^i is another local co-ordinate system in a neighbourhood of P and $x^i = \phi^i(t)$ and $x'^i = \phi'^i(t)$ are the equations of the same parametrized curve relative to the two co-ordinate systems, then

$$A'^i = \sum_j \frac{\partial x'^i}{\partial x^j} A^j, \; i, j = 1, \cdots, n, \tag{1}$$

where

$$A^i = \left(\frac{d\phi^i}{dt}\right)_{t=0}, \; A'^i = \left(\frac{d\phi'^i}{dt}\right)_{t=0}$$

Generally a tangent vector at P is an entity which has n components A^i relative to each co-ordinate system at P such that the components are related by equations (1) under co-ordinate transformations. Two tangent vectors A^i and B^i can be added, the components of their sum being $A^i + B^i$. A tangent vector A^i can be multiplied by a real number α, the components of their product being αA^i. Both operations are invariant under co-ordinate transformations. Thus all the tangent vectors at P form a real vector space of n dimensions, called the tangent space at P (*see* VECTOR SPACES). The existence of the tangent space at every point of a differentiable manifold is a major consequence of its differentiable structure. Roughly speaking, a differentiable manifold can be approximated locally by a linear space.

A tangent vector is called a contravariant vector in contrast to a covariant vector. The latter is defined as having the components

C_i in each co-ordinate system such that under co-ordinate transformations the components are transformed according to the equations

$$C'_i = \sum_j \frac{\partial x^j}{\partial x'^i} C_i, \; i, j = 1, \cdots, n \tag{2}$$

To a contravariant vector A^i and a covariant vector C_i is associated a real number $\sum_i A^i C_i$, which, by equations (1) and (2), is independent of the choice of the local co-ordinates. Thus the tangent space and the cotangent space (the latter being the vector space of all covariant vectors at P) are dual vector spaces; one can be considered as the space of all real-valued linear functions of the other. A mixed tensor of contravariant order r and covariant order s has the components $A^{i_1 \cdots i_r}_{i_1 \cdots i_s}$ in each co-ordinate system (*see* TENSOR ANALYSIS). These components follow the transformation rule

$$A'^{i_1 \cdots i_r}_{i_1 \cdots i_s} = \sum_{k,l} \frac{\partial x'^{i_1}}{\partial x^{k_1}} \cdots \frac{\partial x'^{i_r}}{\partial x^{k_r}} \frac{\partial x^{l_1}}{\partial x'^{i_1}} \cdots \frac{\partial x^{l_s}}{\partial x'^{i_s}} A^{k_1 \cdots k_r}_{l_1 \cdots l_s} \tag{3}$$

The tensor is called contravariant if $s = 0$ and covariant if $r = 0$. If $r, s \geqq 1$, the components $B^{i_1 \cdots i_{r-1}}_{j_1 \cdots j_{s-1}} = \sum_l A^{i_1 \cdots i_{r-1} l}_{j_1 \cdots j_{s-1} l}$ are those of a tensor of contravariant order $r - 1$ and covariant order $s - 1$. This process is called contraction. The contraction can be applied to any upper index and any lower index of $A^{i_1 \cdots i_r}_{j_1 \cdots j_s}$, and not necessarily to the last ones. If $C^{k_1 \cdots k_{r'}}_{l_1 \cdots l_{s'}}$ are the components of a tensor of contravariant order r' and covariant order s', then $D^{i_1 \cdots i_{r+r'}}_{j_1 \cdots j_{s+s'}} = A^{i_1 \cdots i_r}_{j_1 \cdots j_s} C^{i_{r+1} \cdots i_{r+r'}}_{j_{s+1} \cdots j_{s+s'}}$ are the components of a tensor of contravariant order $r + r'$ and covariant order $s + s'$. This process is called the multiplication of tensors.

A tensor is symmetric (respectively antisymmetric) in two indices if the components remain unchanged (respectively change sign) on a permutation of the indices. Thus A_{ijk} is symmetric in i,j if $A_{ijk} = A_{jik}$ and antisymmetric in i,j if $A_{ijk} = -A_{jik}$. A covariant tensor is symmetric (respectively antisymmetric) if it is symmetric (respectively antisymmetric) in every pair of two indices. An arbitrary covariant tensor A of order r has a symmetrized tensor SA whose components are

$$(SA)_{i_1 \cdots i_r} = \frac{1}{r!} \sum A_{i_1 \cdots i_r} \tag{4}$$

where the summation is over all the $r!$ permutations $j_1, \ldots, j_r$ of $i_1, \ldots, i_r$. Similarly, its antisymmetrized tensor has the components

$$(KA)_{i_1 \cdots i_r} = \frac{1}{r!} \sum \operatorname{sgn} \begin{pmatrix} i_1 \cdots i_r \\ j_1 \cdots j_r \end{pmatrix} A_{i_1 \cdots i_r} \tag{5}$$

where the summation is again over all the permutations $j_1, \ldots, j_r$ of $i_1, \ldots, i_r$, and the coefficient is $+1$ or -1 depending on whether the permutation is even or odd. The symmetrized (respectively antisymmetrized) tensor of a symmetric (respectively antisymmetric) tensor is itself. An antisymmetric tensor of order greater than n is zero.

As in the case of contravariant vectors, all tensors of a given type form a real vector space, in which addition and scalar multiplication (*i.e.*, multiplication by a real number) are defined. The tensor multiplication introduced above multiplies a covariant (or contravariant) tensor of order r and a covariant (or contravariant) tensor of order s, giving as product a covariant (or contravariant) tensor of order $r + s$. In the direct sum T of the spaces of covariant tensors of different orders, which is an infinite-dimensional real vector space, this gives rise to an associative multiplication so that T becomes an associative algebra, called the tensor algebra (*q.v.*). Similarly, the product $C_{i_1} \cdots {}_{i_{r+s}} = A_{i_1} \cdots {}_{i_r} B_{i_{r+1}} \cdots {}_{i_{r+s}}$ of two antisymmetric covariant tensors is not antisymmetric, but its antisymmetrized tensor is. The latter is called the exterior product of $A_{i_1} \cdots {}_{i_2}$ and $B_{i_{r+1}} \cdots {}_{i_{r+s}}$. By means of the exterior product the direct sum of the spaces of antisymmetric covariant tensors of orders $0, 1, \ldots, n$ has an associative multiplication and is called the exterior algebra or the Grassmann algebra. The exterior algebra is of dimension 2^n, and plays an important role in the theory of linear subspaces of a vector space. By the use of the symmetrized tensor an associative multiplication can be introduced in the direct sum of the spaces of symmetric covariant tensors of orders $0, 1, \ldots$, which is then called the symmetric algebra.

Tensor Bundles.—A tangent space has been defined at each point of a manifold M. The collection of all of them forms the tangent bundle of the manifold. The tangent bundle is a space E related to M in a special way: each point of E (*i.e.*, a tangent vector) is attached to a point of M, and all the points of E attached to the same point of M form a vector space. Moreover, the points of E over a co-ordinate neighbourhood of M can be described by the co-ordinates (x^i, A^k). Such a structure is called a fibre space, a fibre bundle or a tensor bundle. The space E itself is called the fibre space, the association of the point of M to every point of E is called the projection and the vector space attached to a point of M is called a fibre. The fibre space E is of dimension $2n$ if M is of dimension n and is a differentiable manifold of class $k - 1$ if M is of class k. Analogous "fibre bundles" can be formed from the other tensor spaces introduced above. The fibre need not even be a vector space. For instance, it could be the space of all frames (*i.e.*, ordered sets of n linearly independent tangent vectors) at a point P of M. The resulting fibre space, the space of all frames at all points of M, is called the principal fibre space; its dimension is $n^2 + n$. If M is the three-dimensional Euclidean space and the vectors of the frames are supposed to form an orthonormal system, then a frame is an oriented rectangular trihedral, and the corresponding fibre space plays a basic role in the method of moving trihedrals in the theory of curves and surfaces in Euclidean space and in kinematics. The method of moving frames, used extensively by Élie Cartan in differential geometry, is a forerunner of the notion of principal fibre space.

Operations on Tensor Fields.—Let E be a tensor bundle with a definite type of fibre. A tensor field is a differentiable mapping $f: M \to E$, such that the mapping obtained by the successive application of f and ψ is the identity. Geometrically, this means the association of a tensor to each point of M. Analytically, a tensor field is defined by expressing the components $A^{i_1 \cdots i_r}_{j_1 \cdots j_s}$ of the tensor as differentiable functions of the local co-ordinates.

An important problem is to derive new tensor fields from given tensor fields. If f is a real-valued function (*i.e.*, a tensor field of order zero), its partial derivatives are the components of a covariant vector field called the gradient of f. If X is a contravariant vector field with components A^k in the local co-ordinate system x^i, $i = 1, \ldots, n$, then $Xf = \sum A^k \frac{\partial f}{\partial x^k}$ is a real-valued function. It is called the directional derivative of f relative to the vector field X. In this way X can be regarded as a linear operator on functions. If Y is a vector field, it can be shown that $[X,Y] = XY - YX$ is also a linear combination of $\partial f / \partial x^k$ and defines a vector field. This is called the bracket operation of two vector fields. More generally, a vector field X defines an infinitesimal transformation $\delta x^i = A^i \delta t$, $i = 1, \ldots, n$, and the study of the variation of a tensor field under this infinitesimal transformation leads to a new tensor field of the same type. The latter is called the Lie derivative relative to X. The Lie derivative relative to X of the tensor field B^{ij}_k has the components

$$[L(X)B]^{ij}_k = \sum_l \left\{ A^l \frac{\partial B^{ij}_k}{\partial x^l} - B^{il}_k \frac{\partial A^j}{\partial x^l} - B^{lj}_k \frac{\partial A^i}{\partial x^l} + B^{ij}_l \frac{\partial A^l}{\partial x^k} \right\} \tag{6}$$

If A_i is a covariant vector field, then

$$\frac{\partial A_{i'}}{\partial x'^k} = \sum_{j,l} \frac{\partial x^j}{\partial x'^i} \frac{\partial x^l}{\partial x'^k} \frac{\partial A_j}{\partial x^l} + \sum_j \frac{\delta^2 x^j}{\delta x'^i \delta x'^k} A_j,$$

so that $\partial A_i'/\partial x'^k$ is not a tensor field. But

$$A_{ij} = \frac{1}{2}\left(\frac{\partial A_i}{\partial x^j} - \frac{\partial A_j}{\partial x^i}\right)$$

are the components of an antisymmetric covariant tensor field of order two. This process has a generalization: if $A_{i_1 \cdots i_r}$ is an antisymmetric covariant tensor field of order r, then

$$A_{i_1 \cdots i_{r+1}} = \frac{1}{(r+1)!} \sum \operatorname{sgn} \begin{pmatrix} j_1 \cdots j_{r+1} \\ i_1 \cdots i_{r+1} \end{pmatrix} \frac{\partial A_{j_1 \cdots i_r}}{\partial x^{j_{r+1}}} \tag{7}$$

is an antisymmetric covariant tensor field of order $r+1$. The latter is called the exterior derivative. It will be more instructive to write these results in terms of differential forms. Under change of local co-ordinates, the differentials are transformed according to the equation

$$dx'^i = \sum_j \frac{\partial x'^i}{\partial x^j}\, dx^j$$

Define a multiplication of differentials which is antisymmetric: $dx^i \wedge dx^j = -dx^j \wedge dx^i$, so that $dx^i \wedge dx^i = 0$. Then the differential form

$$\omega = \frac{1}{r!} \sum_{i_1, \cdots, i_r} A_{i_1 \cdots i_r}\, dx^{i_1} \wedge \cdots \wedge dx^{i_r},$$

called an exterior differential form of degree r, is independent of the choice of local co-ordinates. Conversely, such a differential form, together with the condition that the coefficients $A_{i_1 \cdots i_r}$ are antisymmetric, define the $A_{i_1 \cdots i_r}$ as the components of an antisymmetric covariant tensor field of order r. Thus the latter notion is equivalent to that of exterior differential forms of degree r. The exterior derivative of ω is then the differential form

$$d\omega = \frac{1}{r!} \sum_{i_1, \cdots, i_r} dA_{i_1 \cdots i_r} \wedge dx^{i_1} \wedge \cdots \wedge dx^{i_r} \tag{8}$$

Stokes' Formula; De Rham's Theorem.—Exterior differential forms are the integrands of multiple integrals in manifolds. The integral $\int_D \omega$ over an r-dimensional domain D includes as special cases, for $r = 1$, $n = 2$ and $r = 2$, $n = 3$ respectively, the line integral $\int A\,dx + B\,dy$ in the plane and the surface integral $\iint P\,dy\,dz + Q\,dz\,dx + R\,dx\,dy$ in space. If D is the boundary of an $(r+1)$-dimensional domain F, then there is the so-called Stokes' formula

$$\int_D \omega = \int_F d\omega \tag{9}$$

This formula includes as special cases the formula for integration by parts and classical formulas of C. F. Gauss, G. Green, G. Stokes and others. In the special cases mentioned above, it gives

$$\int A\,dx + B\,dy = \iint \left(\frac{\partial B}{\partial x} - \frac{\partial A}{\partial y}\right) dx\,dy,$$

$$\iint P\,dy\,dz + Q\,dz\,dx + R\,dx\,dy =$$

$$\iiint \left(\frac{\partial P}{\partial x} + \frac{\partial Q}{\partial y} + \frac{\partial R}{\partial z}\right) dx\,dy\,dz$$

The importance of exterior differential forms and their exterior derivatives lies in the fact that they help in solving problems on manifolds in which local and global properties come into interplay. The link is furnished by De Rham's theorem. An exterior differential form is called closed if its exterior derivative is zero; it is called a derived form if it is the exterior derivative of another. It follows from definition that a derived form is closed. The closed forms can be divided into classes such that two forms belong to the same class if and only if their difference is a derived form. All the classes of closed forms of degree r form a real vector space $\mathcal{H}^r$. This space is manageable, in contrast to the space of all forms of degree r or even that of all closed forms, both of which are "large" and generally infinite-dimensional. If the manifold is compact, *i.e.*, if it can be covered by a finite number of co-ordinate neighbourhoods, De Rham's theorem says that the dimension of the space $\mathcal{H}^r$ is the rth Betti number of the manifold. The latter is an integer and is a topological invariant of the manifold which describes the connectivity properties of the manifold.

Global Problems on Differentiable Manifolds.—The question of tensor fields takes a crucial turn if it is required that the tensors of the field satisfy certain algebraic conditions. The simplest situation of this kind is a differentiable vector field such that the vectors never vanish. Such a field may not exist. In fact, it is not possible to have a differentiable field of tangent vectors on the ordinary sphere without the vectors vanishing at some point. The general problem is so complicated and difficult that it has been found advisable to study only certain special cases. The most important case is when the manifold is the n-dimensional sphere (or the n-sphere); namely, the set of all points in the Euclidean space of $n+1$ dimensions at a unit distance from a fixed point. The behaviour of the tangent-vector fields of an n-sphere depends very much on the integer n. While, as mentioned above, the 2-sphere does not have a continuous tangent-vector field which is never zero, the 3-sphere has three such vector fields which are everywhere linearly independent. In general, a manifold of dimension n is called parallelizable if it has n continuous tangent-vector fields which are linearly independent at every point. In 1958 R. Bott, M. A. Kervaire and J. W. Milnor proved that the only parallelizable spheres are of dimensions 1, 3, 7. The study of this and related problems employs methods developed in algebraic topology on fibre spaces, homotopy theory, etc.

Another basic question is whether the same space can be given different differentiable structures; *i.e.*, whether there exist manifolds with the same topological space that are not differentiably homeomorphic. That this is possible was shown by Milnor in 1956, when he proved that the 7-sphere has at least seven distinct differentiable structures. It is not known whether the Euclidean space of n dimensions has, for a given value of n, more than one differentiable structure.

Very little is known about the existence or nonexistence of tensor fields that satisfy a system of partial differential equations (over the whole manifold). A problem of this kind is the complex structure on a manifold of even dimension $2m$. The existence of a complex structure is equivalent to that of a tensor field A_i^k such that $\sum_j A_j^i A_j^k = -\delta_i^k$, $i,j,k = 1, \ldots, 2m$, and such that A_i^k satisfies a system of partial differential equations called the integrability conditions. The latter is a generalization of the Cauchy-Riemann differential equations in the theory of functions of one complex variable. A manifold with a complex structure, or a complex manifold, can be described as one that can be covered by co-ordinate neighbourhoods in which complex local co-ordinates are valid such that when a point belongs to two co-ordinate neighbourhoods the local co-ordinates are related by a holomorphic transformation with a non-vanishing Jacobian determinant. Complex manifolds are natural generalizations of nonsingular algebraic varieties in algebraic geometry and of the domains in the theory of functions of several complex variables. It is not known whether the six-dimensional sphere has a complex structure. Another problem is the leaved structure (*structure feuilletée*), a global slicing of the manifold by leaves which, in terms of the local co-ordinates $x^1, \ldots, x^n$, can be defined by $x^{k+1} = \text{const.}, \ldots, x^n = \text{const.}$; k is called the dimension of the leaves. A. Haefliger proved that if a compact, real, analytic manifold of dimension n has an analytic leaved structure whose leaves are of dimension $n-1$, its fundamental group is not finite.

Among the manifolds, the most important one is the Euclidean space. This is so not only because of its historical significance but mainly because of the fact that it is closest to our geometrical intuition. The question of whether a given structure is equivalent to the induced structure of a submanifold in Euclidean space is called an imbedding problem. H. Whitney proved in 1936 that

every differentiable manifold of dimension n can be imbedded in a Euclidean space of dimension $2n + 1$. That the same is true for compact, real, analytic manifolds was proved by C. B. Morrey in 1958. J. Nash proved isometric imbedding theorems for Riemannian manifolds. If sufficient differentiability requirements are made, the dimension of the Euclidean space needed for the isometric imbedding is higher.

Further Structures.—In the historical development of differential geometry the differentiable structure was studied together with additional structures. The most important of these is the Riemannian metric, which is the geometry based on a positive-definite covariant tensor field of order two (*see* RIEMANNIAN GEOMETRY). It is a natural generalization of Euclidean geometry, because this fundamental tensor field allows the definition of arc lengths of curves and other metrical nations. Its importance is based on the fact that every manifold can be given a Riemannian metric, whereas very few manifolds have a Euclidean metric. Much study has been made on generalizations of Riemannian geometry, and these generalizations were done in several different directions.

An affine connection is a set of components Γ^i_{jk} in every coordinate neighbourhood such that under change of local coordinates the components follow the transformation rule

$$\Gamma'^{i}_{jk} = \sum_{l,m,r} \Gamma^{r}_{lm} \frac{\partial x^i}{\partial x'^l} \frac{\partial x^m}{\partial x'^j} \frac{\partial x'^j}{\partial x^r} + \sum_{l} \frac{\partial x'^j}{\partial x^l} \frac{\partial^2 x^l}{\partial x'^i \partial x'^k} \tag{10}$$

These components do not, therefore, define tensor fields. But they can be used to derive from a tensor field $A^{i_1 \cdots i_r}_{j_1 \cdots j_s}$ of contravariant order r and covariant order s a new tensor field of contravariant order r and covariant order $s + 1$. The latter is called the covariant derivative of $A^{i_1 \cdots i_r}_{j_1 \cdots j_s}$ and has the components

$$A^{i_1 \cdots i_r}_{j_1 \cdots j_{s+1}} = \frac{\partial A^{i_1 \cdots i_r}_{j_1 \cdots j_s}}{\partial x^{j_{s+1}}} + \sum_{1 \leq k \leq r} \sum_{m} \Gamma^{i_k}_{m j_{s+1}} A^{i_1 \cdots i_{k-1}\, m\, i_{k+1} \cdots i_r}_{j_1 \cdots j_s} - \sum_{1 \leq l \leq s} \sum_{r} \Gamma^{p}_{j_l j_{s+1}} A^{i_1 \cdots i_r}_{j_1 \cdots j_{l-1}\, p\, j_{l+1} \cdots j_s} \tag{11}$$

Geometrically, an affine connection is a generalization of affine geometry. There is no metric in the manifold, but the notion of parallelism of tangent vectors is defined along curves. As a consequence there are curves on the manifold, called the paths, along which their own tangent vectors are parallel. These generalize the straight lines of affine geometry.

Different affine connections may define the same paths. The theory of all affine connections with the same paths is called the projective geometry of paths. Instead of the paths, it is possible to study the geometry arising from a family of submanifolds defined by a system of partial differential equations, which generalize the linear subspaces of a given dimension in projective space. More generally, further extensions include the geometry of systems of ordinary or partial differential equations.

Another direction of generalization of Riemannian geometry lays weight on the metric. Finsler geometry is the theory of an integral of the form

$$\int F\left(x^i, \frac{dx^i}{dt}\right) dt \tag{12}$$

It reduces to Riemannian geometry if the integrand is of the form

$$\left(\sum_{i,k} g_{ik}(x) \frac{dx^i}{dt} \frac{dx^k}{dt}\right)^{\frac{1}{2}}$$

The value of the integral along a curve will be called its arc length. If, instead of a simple integral, a multiple integral of order $n - 1$ is given:

$$\int \cdots \int L\left(x^i, \frac{\partial x^n}{\partial x^1}, \cdots, \frac{\partial x^n}{\partial x^{n-1}}\right) dx^1 \wedge \cdots \wedge dx^{n-1}, \tag{13}$$

the geometry is called Cartan geometry. In Cartan geometry it is possible to measure the area of $(n - 1)$-dimensional domains, but not the lengths of arcs (if $n > 2$).

All these structures in differential geometry can be included in the general notion of a geometric object or a geometric being. The latter is defined by a set of components in every local co-ordinate system, which follow very general transformation laws. More fruitful, however, is the generalization of the affine connection to a connection with an arbitrary Lie group, such as the group of Euclidean motions, the projective group, the conformal group, etc. Such a connection can be defined in an arbitrary fibre space; the connection means geometrically a rule for the parallel transport of the fibre along curves. The problem of associating in an invariant way a connection to a given geometric object leads generally to complicated computations. However, the general theory of a connection in a fibre space can be developed in a simple and satisfactory way.

Homogeneous Spaces and Their Submanifolds.—Another important type of structure on a manifold is a group of transformations. The group is said to act transitively if, to any two points of the manifold, there is a transformation of the group carrying one point to the other. A manifold with a transitive group of transformations is called a homogeneous space. Homogeneous spaces form an important class of manifolds, because they possess in a sense a high degree of symmetry. All the spaces which are involved in the development of geometry—the Euclidean space, the non-Euclidean spaces, the affine space, the projective space, etc.—are homogeneous spaces. Much of the early work in differential geometry was concerned with the geometry of manifolds lying in a homogeneous space. This is the case with the classical theory of curves and surfaces in Euclidean space when the group is the group of motions. The study of submanifolds in affine space and projective space leads respectively to affine differential geometry and projective differential geometry.

Local and Global Problems.—Problems in differential geometry can generally be divided into two types: local problems and global problems. The tangent space at a point and different concepts of curvature are local properties. But the validity of a certain local property throughout the manifold could impose strong restrictions on the manifold as a whole; the determination of such restrictions is a global problem. Thus there are pieces of surfaces in Euclidean space with constant Gaussian curvature, but the spheres are the only surfaces which have constant Gaussian curvature and which are closed. Also, among the orientable, closed, two-dimensional manifolds only the torus can be given a flat affine connection. The latter property can be described by saying that linearity has a sense in the manifold or, more precisely, that the manifold can be covered by co-ordinate neighbourhoods such that if a point belongs to two neighbourhoods its two sets of local co-ordinates are related by a linear transformation. Results of this nature belong to global differential geometry (differential geometry in the large). *See* also ANALYSIS, COMPLEX.

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(S. S. CH.)

DIFFERENTIAL PSYCHOLOGY is the branch of psychology that deals with individual and group differences in behaviour. Such differences are quantitative rather than qualitative. Persons do not fall into sharply separated types, such as bright and dull, maladjusted and normal, introvert and extravert. On the contrary, in all psychological characteristics, individuals vary by

degree along a continuous scale. In most traits, the distribution approximates the bell-shaped normal probability curve, with the greatest clustering of cases near the centre of the range and a gradual decrease in numbers as the extremes are approached. Individual differences in behavioural characteristics are not limited to the human species; they occur throughout the animal scale. Investigations of animal behaviour, from unicellular organisms to anthropoid apes, reveal wide individual differences in learning, motivation, emotionality and other measurable traits. So large are these differences that the distributions overlap even when widely separated species are compared. When tested with the same learning problem, for example, the brightest rat in a given sample may excel the dullest monkey.

Heredity and Environment.—The origins of each individual's behavioural characteristics are to be found in the innumerable and complex interactions between his heredity and his environment. Heredity is represented by the genes, minute particles transmitted in the ovum and spermatozoon which unite at conception to form the new organism. To say that a certain factor is hereditary thus means that it can ultimately be traced to the presence of a particular gene or combination of genes. Environment may be defined as the sum total of the stimuli to which the individual responds from conception to death. Environment thus comprises a vast multiplicity of variables, ranging from food and physical habitat to the beliefs and attitudes of associates and the social climate of home and community. It should also be noted that environmental factors begin to operate before birth. Nutritional deficiencies, toxins and other chemical or physical conditions of the prenatal environment may exert a profound and lasting influence upon both physical and mental development. Several varieties of mental deficiency, for example, have been traced to abnormalities of prenatal environment. Such terms as innate, inborn, native and congenital may be misleading since they suggest that all characteristics present at birth must be hereditary, which is not the case. Another common confusion is that between organic and hereditary causation. For instance, mental deficiency resulting from early brain injury may be properly said to have an organic but not a hereditary origin.

The many techniques employed to study the relative contribution and *modus operandi* of heredity and environment in behaviour development may be subsumed under five major approaches.

1. Selective breeding for psychological characteristics has been successfully applied to several species. It has proved possible, for example, from a single initial group to breed two strains of rats comprising good and poor maze learners, respectively.

2. Normative developmental studies, charting the course of behaviour development with age, have been conducted both prenatally and postnatally with animals and human beings. Such studies show the relative influence of learning and maturation, the latter referring to the sudden emergence of a function as soon as the prerequisite stage of physical development is attained. For example, do birds fly and do children walk when they reach certain ages, regardless of prior experience?

3. A closely related approach concerns correspondences between organic and behavioural characteristics. Is there any relation between specific psychological traits and neural, glandular, biochemical and other organic conditions, either from individual to individual or from one developmental stage to another within the individual? To demonstrate an organic basis for a given behavioural difference does not, of course, prove its hereditary origin. Nevertheless, such investigation is a necessary step in tracing possible hereditary factors, since heredity can affect behaviour only through the medium of organic conditions.

4. A fourth approach to the analysis of hereditary and environmental contributions is concerned with the effects of training upon behaviour development. Experimental investigations of this question either provide special training or prevent the normal exercise of a given function. The large majority of such studies have been made with animals, a few having been conducted with young children. A less rigidly controlled application of the same general procedure pertains to the effects of schooling upon I.Q. Although many of the results of the latter investigations are difficult to interpret, follow-up studies suggest that education tends to improve intellectual level appreciably.

5. A fifth approach is based on the analysis of family resemblances and differences. Similarity of performance on both ability and personality tests has been investigated in the case of parents and children, siblings, and twins (including fraternal and identical pairs). In general, the closer the hereditary relation, the more similar will be test scores. It should be noted, however, that a family is a cultural as well as a biological unit and that a hierarchy of environmental similarity and mutual influence parallels the hierarchy of hereditary relationships. Special studies of foster children and of identical twins reared apart permit some isolation of hereditary and environmental influences, but various uncontrolled factors preclude definitive conclusions. Pedigree analysis, concerned with the genetic mechanisms whereby traits are transmitted from parents to offspring, is an effective technique for analyzing the operation of hereditary factors but is limited in its application to traits having a relatively simple genetic basis, such as colour blindness, deficiency for certain tastes, and a few rare forms of mental deficiency.

Identification of Psychological Traits.—Two persons with the same I.Q. may present very different aptitude profiles. The individual's relative standing often varies significantly from trait to trait, and for such purposes as educational and vocational guidance, as well as personnel selection and classification, it is important to know the individual's scores in separate traits, as well as his over-all I.Q. Through specially developed statistical techniques known as factor analysis, psychologists have identified a number of intellectual traits, such as verbal comprehension, numerical skills, arithmetic reasoning, spatial visualization, perceptual speed, associative memory, originality, ideational fluency and logical evaluation, as well as such personality traits as dominance, emotional stability and sociability. Factor analysis utilizes the scores obtained by the same group of persons on a large number of tests. These scores are first intercorrelated and the resulting correlation table is submitted to further mathematical analysis to identify common factors among the different tests.

Age Changes in Psychological Traits.—Longitudinal studies of age changes in performance on traditional intelligence tests reveal a slow rise in early infancy, followed by more rapid progress and eventual slowing down as maturity is approached. It should be noted, however, that intelligence tests measure a combination of several traits and that the nature of this composite varies with age. Thus in infancy the I.Q. is based largely on sensorimotor development, while in childhood it depends increasingly on verbal and other abstract functions.

Contrary to earlier findings, it has been established that intelligence-test performance continues to improve at least into the 20s. Among intellectually superior persons, especially college graduates and those engaged in relatively intellectual occupations, such improvement may continue throughout life. In more nearly average samples, tested abilities tend to decline beyond the 30s, the drop being greatest in tasks involving speed, visual perception and abstract spatial relations. Loss in motor skills is slight, especially when the subject is free to introduce compensatory changes in method. Older persons can learn nearly as well as younger but are more seriously handicapped when the task conflicts with well-established habits. Cross-sectional studies, based on different samples at each age level, may give spurious results because of lack of comparability of groups in education, cultural milieu and other factors.

Research on age differences has been extended to include a wealth of data on emotional, motivational and attitudinal changes from infancy to old age. Some popular stereotypes regarding age and personality have been called into question by such findings. For example, the "conservatism" of older persons may reflect cultural change between generations rather than age differences.

Extremes of Distribution of Intelligence.—Intellectual deviates, comprising the opposite extremes of mental deficiency and genius, have been singled out for special study. Psychological research on mental deficiency centres around problems of identification, classification, causation, training and rehabilitation. Al-

though a few rare forms of mental deficiency result from defective genes, many clinical varieties can be traced to environmental factors operating before or after birth and including both physical and psychological conditions. Investigations on the nature of genius have been concerned with gifted children, living scientists and records of eminent men of the past. Although originally focusing on high I.Q., such research has been broadened to cover creativity and leadership.

Sex Differences.—Sex differences in abilities and personality traits depend upon both biological and cultural factors. The influence of biological conditions may be comparatively direct, as in the effect of male sex hormones upon aggressive behaviour; or it may be indirect, as in the social and educational effects of the more rapid development of girls as compared with that of boys. The contribution of culture is shown by the wide variations in sex roles found in different cultures and epochs. Psychological test surveys in contemporary western cultures indicate that males as a group excel in speed and co-ordination of gross bodily movements, spatial orientation, mechanical comprehension and arithmetic reasoning, but are surpassed by females in manual dexterity, perceptual speed and accuracy, memory, numerical computation, verbal fluency and other tasks involving the mechanics of language. Examples of personality differences include the greater aggressiveness, achievement drive and emotional stability of the male, and the stronger social orientation of the female.

Racial and Cultural Differences.—Other major group differences covered by differential psychology include those associated with social class, occupational level, urban and rural areas, nationality and race. Within the closely related categories of social class, occupation and urban-rural residence, differences have been found in child-rearing practices, sexual behaviour, emotional adjustment, interests and attitudes, as well as in I.Q. and various intellectual traits. In the case of relatively isolated and underprivileged groups, intellectual retardation tends to increase with age. In all groups, differences are specific to the functions tested. Because each of these subcultures fosters the development of its own characteristic pattern of aptitudes and personality traits, comparisons in terms of global or composite ability and personality measures may be fallacious.

Races are populations that differ in the relative frequency of certain genes. They are formed whenever a group becomes relatively isolated, for either geographical or social reasons, so that marriage among its members is commoner than marriage with outsiders. Since isolation fosters cultural as well as racial differentiation, the relative contributions of biological and cultural factors to race differences in behaviour are difficult to separate. A nation is primarily a political unit, not necessarily characterized by either racial or cultural homogeneity. Usually, however, national boundaries tend to encourage race formation, since marriages are more likely to occur within than across such boundaries.

Cultural differences may affect the test performance of diverse races in many ways. The emphasis placed by different cultures on speed, on competitive achievement or on success in abstract tasks, as well as the bilingualism that may handicap children of immigrants, are familiar illustrations. In the case of such minority groups as the American Negro, intellectual development may be retarded by inferior socioeconomic level, inadequate educational facilities and the adverse motivational effects of social stereotypes. That races differ significantly in mean test performance has been repeatedly demonstrated, but rarely do the results throw any light on the causes of such differences. Some suggestive data are provided by special experimental designs utilizing hybrid (racially mixed) groups, regional differences, infants and young children, or detailed analyses of the operation of cultural factors in personality development. Although the interpretation of race differences in psychological traits is still controversial, what evidence is available points more strongly to cultural than to biological causation. *See* also PSYCHOLOGICAL TESTS AND MEASUREMENTS.

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DIFFRACTION: *see* LIGHT; ELECTROMAGNETIC WAVES; ELECTRON DIFFRACTION.

DIFFRACTION GRATING, a series of parallel straight lines spaced at equal intervals in one plane or on a concave surface. A beam of radiation after falling on such a grating is resolved into a spectrum. *See* SPECTROSCOPY; LIGHT.

DIFFUSION. In physical science, this term is applied to the random molecular motion by which matter is transported. This definition refers to true or ordinary diffusion, which is sometimes identified as molecular diffusion to distinguish it from thermal diffusion, eddy diffusion, etc. Unless otherwise specified, the term diffusion as used by physicists refers to molecular diffusion.

Diffusion occurs in all forms of matter. In solids the process is as a rule much slower than in liquids and gases. Everyone is familiar with the diffusion of ammonia if a bottle of it is opened in a room. However, if smooth disks of lead and gold are placed in juxtaposition so that their edges meet, the migration of lead into the gold and of gold into the lead will eventually reach the point where it can be readily demonstrated.

The first part of this article is devoted to a general survey of the phenomenon, including some discussion of related effects, and the practical applications of diffusion, particularly in atomic energy. The second part affords a more theoretical treatment, and some diffusion coefficients are given.

General Description of Molecular Diffusion.—Atomic science has demonstrated that the concept of matter in a static condition is merely a relative one. At any temperature above absolute zero, the individual molecules of a substance move incessantly and at random, independently of each other. Frequent collisions occur between particles, so that the path of a single particle is a zigzag one. However, an aggregation of diffusing particles has an observable drift, from places of higher to places of lower concentration. For this reason, diffusion is known as a transport phenomenon.

In liquids, the phenomenon is illustrated by the following experiment: the lower part of a tall cylinder is filled with iodine solution; pure water is added on top of this solution in a manner that carefully avoids convection and stirring. At first only the lower part of the vessel, containing the iodine, is coloured, but then the colour is observed to spread slowly. Thus the upper part becomes coloured too, the intensity of the colour decreasing from bottom to top. After a long time, the entire interior of the cylinder will be uniformly coloured.

Diffusion in gases can be demonstrated by placing a few drops of bromine at the bottom of a closed flask. Bromine, visible by its brown colour, will be distributed through the air in the flask, as the iodine was through the liquid in the previous experiment. In gases the process is much more rapid than in liquids.

While diffusion in solids is in general the slowest type, there are notable exceptions. For example, when cuprous ions are diffusing from solid cuprous iodide into solid silver iodide, diffusion proceeds with a speed comparable to, and even equal to, that exhibited in solutions.

The zigzag path taken by large particles of a diffusing substance was first described by Robert Brown in 1827, and is therefore known as Brownian movement (*q.v.*). The path traveled by a particle in the interval between two collisions is called the free path. Since this differs from collision to collision, an average value, known as the mean free path, is used as the basis of calculations. The mean free path decreases with increasing concentration.

The other quantities characterizing the diffusing substance are the mean velocity and the displacement. By displacement is meant the distance between the original position of a particle and its position after a certain period of time. The mean displacement is zero since, in the absence of a difference in concentration, positive and negative displacement are equally probable. For this reason the mean square displacement is introduced.

Consider a hypothetical horizontal plane passing through the iodine water system described above. Iodine molecules move in both directions through the plane. If one considers all the particles in a layer of a certain thickness on either side of the plane it will be observed that there are more iodine molecules in the same thick-

ness below the plane than above it. Since the same percentage of iodine molecules will cross the hypothetical boundary per second this will result in more iodine molecules moving upward than downward until there is no longer a concentration difference across the plane. There will result an over-all flow from positions of higher to positions of lower concentration. In this way the concentration is equalized. This equalization is macroscopically observable and is called diffusion. It is obvious that the mean square displacement will be a measure for the rate of diffusion. It depends, however, on time and it was found more convenient to introduce another characteristic quantity, independent of time. This is the *diffusion coefficient D*, which is related to the mean square displacement $\overline{x^2}$ as follows: $D = \frac{\overline{x^2}}{2t}$, t being the time. This equation is generally written in the form: $\overline{x^2} = 2Dt$. The mathematical description of the process of diffusion is accomplished with this quantity D, as will be shown below. For the present it is sufficient to note that the process is faster the greater D is and that D for a certain system will increase with temperature since the mean square displacement increases with the mean velocity and the mean velocity increases with temperature.

Diffusion as a Transport Phenomenon.—As has been pointed out, diffusion is due to random molecular motion, resulting in a transport of matter from places of higher to places of lower concentrations. Other transport phenomena are heat conduction and viscosity. At least in fluids and gases, these processes are also due to random molecular motion. In heat conduction, heat is transported from places of higher temperature to places of lower temperature, and viscosity is equivalent to a transport of momentum from places of higher velocity to places of lower velocity. Reference here is to the macroscopic velocity of the fluid. Thus the three transport phenomena depend on the same characteristic quantities: mean velocity, mean free path and mean square displacement. Accordingly, the theoretical treatments of all three processes will have much in common. The phenomenological theories of diffusion and heat conduction are similar, and so are the theoretical treatments of diffusion and viscosity in fluids making use of the transition-state theory.

Related Types of Diffusion.—*Eddy Diffusion.*—In fluid media, mixing by thermal convection and by eddy diffusion may become of importance equal to that of molecular diffusion, or may even predominate. Eddy diffusion, which occurs during the turbulent flow of liquids, is in many ways quite similar to molecular diffusion in still fluids. Unlike molecular diffusion, which is caused by thermal agitation resulting in a random motion of the single molecule, eddy diffusion is the random motion of small quantities of fluid (eddies). Considered in relation to the motion of the fluid as a whole, however, both are random movements.

The change from molecular diffusion to eddy diffusion corresponds to the change from laminar to turbulent flow. A quantitative theoretical treatment of eddy diffusion, comparable to that of molecular diffusion processes, is generally not possible, but considerations of similarity may lead to results of great practical value. Generally speaking, turbulence of a fluid increases with its macroscopic velocity, and so eddy diffusion increases.

Thermal Diffusion.—As has been described, ordinary (molecular) diffusion for a homogeneous phase results in an over-all migration of particles from positions of higher to positions of lower concentrations. Thus the concentration gradient may be regarded as the driving force for the diffusion. If a phase, in which there is no concentration gradient, is subjected to a temperature gradient, there may also result a particle flux, which in the case of fluid mixtures leads to a partial demixing (*see* fig. 1). The separation is much faster in gases than in liquids. Solids exhibit an analogous, though usually very small, effect. In liquids the effect is called the *Soret effect*. The demixing is greatly increased by an appropriate combination of convection and thermal diffusion as obtained in the Clusius *separation tube*. Such tubes proved most successful in the separation of isotopes. The apparatus consists of a vertical tube, the outer side of which is cooled, and an axis which is heated from within. The temperature gradient usually causes the heavier molecules to move toward the outer wall. Because of thermal convection there is an upward flow of the heated gas as a whole near the centre, while near the outer wall there is a flow downward. The lighter gas may be withdrawn at the top centre and the heavier gas at the bottom periphery. The separation efficiency of such a separation tube is much larger than that of plain thermodiffusion.

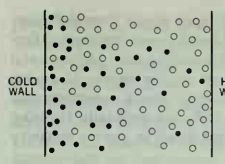

FIG. 1.—SCHEMATIC REPRESENTATION OF THERMODIFFUSION (*see* TEXT)

Knudsen Diffusion.—Under ordinary conditions the dimensions of a container in which diffusion of gases takes place are such that the mean free path is determined for a certain medium by the number of collisions with neighbouring molecules, the number of collisions with the wall being negligibly small.

For gaseous diffusion at low pressures and in a capillary, however, this is not so.

In this case the number of collisions of one molecule with other molecules is small compared with the number of collisions of the molecule with the wall. Thus the mean free path, in this case to a first approximation, is given by the diameter of the capillary, and is the same for different gases. From the law of equipartition of energy it follows that mv^2 is proportional to the temperature (m being the mass of the molecule and v its velocity). So for one gas v increases with $\sqrt{T}$, and for two gases at the same temperature the mean velocities are inversely proportional to the square root of their molecular weights. So the lighter gas will traverse the capillary sooner, in accordance with its higher mean velocity. The same effect occurs in the passage of gases through porous solids and may play its part in separation of gaseous mixtures. The gas mixture is made to penetrate a solid diaphragm with sufficiently small pores, by applying vacuum to one side and having the mixture at the other side of the diaphragm. After a certain time a large amount of the lighter gas has penetrated the solid, whereas only a small amount of the heavier gas was able to pass through. So on the low-pressure side of the diaphragm the lighter, and on the high-pressure side the heavier gas is enriched. With both fractions the same process may be repeated. The separation effect for the single process is more pronounced the bigger the difference in molecular weights. This method of separating gases was employed by Lord Rayleigh and Sir William Ramsay in their classical work on the composition of the gases in the atmosphere. It was, however, little more than a laboratory curiosity until 1945, when the giant gas diffusion plant of the atomic bomb project for separating $U^{235}F_6$ from $U^{238}F_6$ went into production. The ratio m_2/m_1 in this case is only 1.0043. It is evident that the separation must be repeated thousands of times to achieve anything like complete purification of the desired isotope, and an elaborate cascading is necessary. In the plant, located at Oak Ridge, Tenn., the largest continuous chemicophysical separation process in the world is performed.

Diffusion in Zeolites.—Zeolites (*q.v.*) are silicate compounds containing water on interstitial sites. Some of them may be dehydrated without their lattice structures being destroyed and they are then capable of taking up other compounds besides water, mainly gases and vapours. These compounds are rather mobile in the zeolite and their rate of diffusion is very high and depends on direction, whereas there is no marked mobility of the constituent particles of the crystal. For details on these rather complex phenomena the reader is referred to the literature on the subject. The properties of zeolites are quite remarkable. They act as molecular sieves and may be used as semipermeable membranes for gases. Such semipermeable membranes are not only of practical importance for the separation of gases but also of theoretical interest. In thermodynamics semipermeable membranes are often postulated. They serve as an auxiliary concept to develop the theory of thermodynamics in its entirety. However, there are very few substances which act, even approximately, as semipermeable membranes. This is especially true for gases: apart from zeolites, the

only well-known semipermeable membrane is palladium metal, which when heated allows for an easy passage of hydrogen but not of other gases.

Diffusion of Neutrons.—The diffusion of neutrons is important for the operation of nuclear reactors, as will be discussed in more detail below. For this reason the diffusion of thermal neutrons through matter has been very intensely studied in recent years. Neutron diffusion differs in some important respects from ordinary gas diffusion. Neutrons, because of their nonelectrical nature, do not interact with the electronic shell of an atom or molecule but pass through it without hindrance. Thus they find matter largely empty. To be deflected they must collide with a nucleus, which is only a minute fraction of the volume of an atom. Consequently, the mean free path of neutrons diffusing through solid matter is about 1,000,000 times greater than the mean free path in gases at ordinary pressures (1 cm. as opposed to 10^{-6} cm.). For this reason boundary effects, which are negligible a few mean free paths away from the boundary, become significant for neutron diffusion, while they usually do not play a part in the diffusion of gases. An even more fundamental complication arises from the fact that neutrons are captured on collision as well as scattered. It will be shown below how this fact may be treated theoretically.

Self-Diffusion.—In diffusion at least two substances are involved. Self-diffusion, as the name implies, refers to the diffusion taking place as result of random motion in a single pure substance. Self-diffusion in the strict sense of the word is not directly observable. There are, however, indirect methods. For only when the substances differ in some respect can flow and concentration changes be detected and measured. When the difference does not exist in any other chemical respect, but only insofar as two different isotopes of the same chemical element are involved, their interdiffusion will, to a good approximation, be equal to self-diffusion. The approximation will be better for a small relative mass difference, *i.e.*, heavy elements, and not so good for isotopes of light elements. Radioactive isotopes are usually used for measurements because of their ease of detection. Radioactive tracers are important in the measurement of other diffusional processes.

Importance and Application of Diffusion.—Diffusion determines the rate of transfer of material across stationary layers of air or liquid. The rate of evaporation of water from a free surface (one with no blanket of gas molecules) at 20° C. is about ¼ g. per square centimetre per second, while the diffusion controlled rate of transfer across only 0.1 mm. of stagnant air is 1,000 times less. Consequently, diffusion through the adhering boundary layer of air determines the evaporation of surface waters.

Diffusion is also rate-determining for many chemical reactions, both for natural processes and for technical ones, and is especially important for solid-state reactions, where there is no convection and no stirring. When iron is decarbonized, diffusion of carbon in iron is rate-determining, provided that the iron particles are not too small.

During oxidation of metals the oxide often covers the metal and forms a protective layer. Such reactions are also observed in a halogen or sulfur atmosphere and are known as *tarnishing reactions*. Once the layer has attained a certain thickness, diffusion of the components through the layer may be rate-determining for the continuation of the reaction.

Importance of Diffusion of Neutrons for the Operation of Nuclear Reactors.—The operation of nuclear reactors depends on the interaction of neutrons with the atomic nuclei of the nuclear fuels. A nucleus of these fuels, after capturing a neutron, splits in two (or more) smaller nuclei. This process is associated with the liberation of large amounts of energies and with the liberation of neutrons. It is called a *fission process*. Thus in the case of uranium-235 an average of 2.5 neutrons are emitted for each neutron captured, causing a fission process. The number is not an integer because various types of neutron interaction with the atomic nuclei take place. Since more neutrons are created than consumed, a branching chain reaction is possible. In a stationary nuclear reaction just one of the neutrons created by the fission process will cause another fission process, the others being absorbed somewhere or escaping through the boundaries of the pile. The reactor core must have a certain minimum size, called the *critical mass*, otherwise the fraction of neutrons escaping through the boundaries is too large, and the chain reaction discontinues.

It is evident that diffusion of neutrons is of fundamental importance for any mechanism of liberation of nuclear power, and especially for the operation of nuclear reactors. The neutrons have to migrate from the spot where they were created to the point at which they are utilized. This process of penetrating matter, however, is not merely diffusion, since at first the neutrons possess by their liberation a certain velocity, larger than the velocity caused by thermal agitation. And only the random movement due to thermal agitation is defined as diffusion. But once the neutrons have been slowed down, by means of the moderators in the pile, the migration of these *thermal neutrons* from positions of higher concentration to positions of lower concentration is governed by the laws of diffusion.

The pile may be surrounded by material which acts as a reflector for neutrons. It must have similar properties to that of the moderators; *i.e.*, the rate of absorption of neutrons must be as small as possible, because the neutrons absorbed would no longer be available for the fission process. In pure graphite, for instance, neutrons are mainly scattered and not absorbed.

A neutron which has already left the reactor core and is moving through the material of the reflector may be scattered back into the core because the microscopic process in diffusion is a random movement. So it is possible to define a *reflection coefficient*, or *albedo*, as the fraction of neutrons entering the reflector which are reflected back to the source medium. By surrounding the core with reflecting material the critical mass of the reactor can be reduced because neutrons, which otherwise would be lost for the chain reaction, are now scattered back into the reacting core.

Separation of Isotopes.—In most cases the separation of isotopes is not possible by chemical means because isotopes have similar chemical properties. Their difference in mass, however, involves a difference in diffusion coefficient. Thus H_2 (hydrogen) and D_2 (deuterium or heavy hydrogen) may be separated by the electrolytic decomposition of water. By this process hydrogen is enriched in the gas and deuterium in the water. This is at least partly due to the fact that the light hydrogen ions move faster; in addition complicated processes at the electrodes are involved.

A separation may also be achieved by diffusion. But even for Knudsen diffusion the separating factor is so small that the process must be applied repeatedly in order to achieve anything approaching complete separation. As early as 1932, G. Hertz described a method involving diffusion through sets of from 10 to 50 clay pipes. By this procedure the isotopes of the light elements neon, oxygen, argon, nitrogen and carbon could be separated. For the separation of heavier elements even more steps are necessary, as already described above for the separation of uranium.

In thermodiffusion, which also proved very useful for the separation of isotopes, increased separating efficiency is achieved through the use of the Clusius and Dickel separation tube as has been described in the preceding material.

THEORY OF DIFFUSION

General Theory.—With regard to the theoretical treatment of diffusion it is necessary to distinguish between two kinds of diffusion theory. The phenomenological theory of diffusion is based upon A. Fick's first law and the equation of continuity. The theory consists mainly in the mathematical solution of the differential equations for various boundary and initial conditions. Thus it is possible to obtain values for diffusion coefficients from measurements of diffusion processes and, once the coefficient is known, to calculate in advance the diffusion in systems with varying boundary and initial conditions. This in no way involves the atomic structure of matter and so the mathematics of diffusion is applicable not only to the diffusion of particles but also to the diffusion (that is, transfer) of heat. The phenomenological theory does not yield any information about the magnitude of the diffusion coefficient. This is the object of the kinetic and atomic theory of diffusion. Starting from the structure of matter it is possible to determine under which conditions and for which properties of the substances

the equations of diffusion in their special forms are valid, and from a sufficiently detailed knowledge of the structure of matter it is possible to calculate the magnitude of diffusion coefficients and discover their connection with other properties of matter.

The Phenomenological Theory (Mathematics of Diffusion).—The laws of diffusion show the relationship between the rate of flow of a diffusing substance and the concentration gradient responsible for this flow. Empirically the following relation is known to exist, which was first postulated by Fick:

$$j = -D\frac{dc}{dx}$$

It is named Fick's first law. The diffusion flow or current per unit cross section of a substance in a mixture is represented by j. It is the amount of this substance passing perpendicularly through a reference surface of unit area during unit time. Then x is the co-ordinate chosen perpendicular to the surface of reference, and c is the concentration of the diffusing substance. Thus $\frac{dc}{dx}$ is the rate of change of concentration in direction of the co-ordinate x. D is the coefficient of diffusion for the substance under consideration and is defined by the above relation. Fick's first law may be interpreted as follows. For a given substance, with nonuniform concentration, there is a flow of substance from positions of higher to places of lower concentrations, which finally results in a uniform distribution of the substance throughout the system. The amount of flow is proportional to the concentration difference between two points of unit distance. D is the constant of proportionality. If, for a certain substance, D is greater than for another one, this means, provided that the concentration change per unit length is the same for both substances, the flow of the first substance will be greater than that of the second. However, only in limiting cases D is strictly to be considered as a constant for a given medium, temperature and pressure; such limiting cases are diffusion in high dilutions and self-diffusion. In all other real systems D depends more or less markedly on concentration, and the assumption that D is a constant is to be considered as an approximation.

Fick's first law is only valid for homogeneous phases (neglecting the difference in concentration of the diffusing substance). If the medium is not homogeneous there may be a flow in the opposite direction; *i.e.*, from lower concentration to higher concentration. This paradox is called *uphill diffusion* and seems to contradict Fick's first law. The contradiction, however, is not real. To meet such conditions the law is to be generalized. The driving force in terms of chemical thermodynamics is $-\frac{d\mu}{dx}$ when μ is the Gibbs function per mole and is called the chemical potential. μ_0 is a constant, the chemical potential of the standard state. The mean velocity is:

$$\bar{v} = -u\frac{d\mu}{dx} = -\frac{D}{RT}\frac{d\mu}{dx}$$

and the flow is:

$$j = c\bar{v} = -\frac{D}{RT}\,c\,\frac{d\mu}{dx}$$

where u is the mobility and c the concentration. This is the generalized form of Fick's first law, and $u = \frac{D}{RT}$ is known as the Nernst-Einstein relation. For a homogeneous phase with:

$$\mu = \mu_0 + RT \ln c$$

the quantity:

$$j = -\frac{D}{RT}\,c\,\frac{d\mu}{dx}$$

reduces to

$$j = -D\frac{dc}{dx}$$

the original equation ($\frac{d\mu}{dx}$ being $\frac{(d \ln c)}{dx}$; T, temperature; R, gas constant; and ln c the natural logarithm of c). Fick's first law may be formulated independently of a special system of co-ordinates, using vector notation:

$$j = -D \text{ grad } c$$

This states that the vector j of the diffusion current is in the opposite direction of the concentration gradient and is proportional to its absolute value. This holds for gases and liquids, but solid crystals, with the exception of those of the regular system, are generally anisotropic and the diffusion coefficient may differ for different directions. Then D is a tensor and the vectors j and grad c may have different directions. In zeolites, for example, there is a marked anisotropy. D in the direction of the planes of the laminated structure is about 20 times greater than D normal to these planes.

The conservation of mass may be expressed mathematically as follows:

$$\frac{\partial j}{\partial x} = -\frac{\partial c}{\partial t}$$

The equation is called the law of continuity; it means that the difference between the flow that enters a volume element and the flow that leaves it is equal to the change of concentration in this element. This equation may also be formulated independently of a system of co-ordinates, by means of vector notation, and is of the form:

$$\frac{\partial c}{\partial t} = -\text{ div } j$$

From Fick's first law and the law of continuity Fick's second law follows:

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial x} D\frac{\partial c}{\partial x}$$

which is called the diffusion equation, or in vector notation:

$$\frac{\partial c}{\partial t} = \text{div } (D \text{ grad } c)$$

and for constant D:

$$\frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial x^2} \text{ or } \frac{\partial c}{\partial t} = D \text{ div grad } c$$

respectively.

Solution of the Diffusion Equation for Different Cases.—Under steady-state conditions there is no change of concentration with time; *i.e.*,

$$\frac{\partial c}{\partial t} = 0$$

For linear flow and constant D:

$$D\frac{\partial^2 c}{\partial x^2} = 0 \qquad \frac{\partial c}{\partial x} = \text{(constant)} \qquad c = c_0 + c_1 x$$

So the concentration gradient is constant, and a linear distribution exists in the whole sample under consideration. From the fact that $\frac{\partial c}{\partial x}$ is a constant, it follows that j is a constant. So Fick's first law may be integrated and gives:

$$j = D\frac{c_2 - c_1}{l}$$

with l as the length of the system (diffusion length) and c_1 and c_2 as the concentrations at both ends. This relation is very useful for the determination of diffusion coefficients, because a steady state may easily be realized.

If some volatile substance; *e.g.*, ether, is placed in the lower part of a vertical cylinder, which is open at the upper end, a steady state of diffusion will result after a certain time. The concentration at the liquid-gas interface may be determined by measuring the vapour pressure of the substance at the temperature of experiment. Therefore, j, corresponding to the amount of ether evaporating during unit time, can easily be found by weighing or measuring the height of liquid in the cylinder. The concentration at the open end is zero. So from:

$$D = \frac{jl}{c_s}$$

D of the diffusing vapour in the air may be determined. (The above relation, however, is only an approximation since the diffusion length l is not exactly a constant but increases with time, and since the opposing flow of air is zero. The approximation is valid for small concentrations c_s.)

A steady state can also be obtained in the case of diffusion through colloidal membranes or through solids. The passage of gases or vapours through membranes by diffusion is called permeation. If corresponding concentrations within the membrane are not available, one defines a permeability constant, which is the value of the diffusion current under certain conditions.

General Solutions of the Diffusion Equation.—In many cases the co-ordinates x and t enter into the resulting expression in the combination x^2/t only. As may be verified by substituting into the diffusion equation:

$$c(x,t) = \frac{s}{2\sqrt{\pi DT}} \exp\left(-\frac{x^2}{4DT}\right)$$

is a possible solution with:

$$s = \int_{-\infty}^{+\infty} c\,dx$$

This solution refers to the following physical problem. At $t=0$ the quantity s of the diffusing substance is concentrated in the immediate vicinity of the plane $x=0$, and for $t>0$ the resulting distribution of concentration is given by the above expression. The exponential is Gauss's error curve (*see* fig. 2). By integrating over $\exp\left(-\frac{x^2}{4DT}\right)$ with respect to x, a solution of the following form is obtained:

$$c(x,t) = \frac{c_0}{2}\left[1 - \operatorname{erf}\left(\frac{x}{2\sqrt{DT}}\right)\right]$$

The function erf is called error function and is defined as follows:

$$\operatorname{erf} z \equiv \frac{2}{\pi^{\frac{1}{2}}} \int_0^z \exp(-\xi^2)\,d\xi$$

The corresponding problem is the following. At $t=0$ the concentration profile is such that for $x<0$, c has the constant value c_0 and for $x>0$, c is zero. This uneven profile is gradually smoothed out as diffusion proceeds (*see* fig. 3).

A class of solutions for finite systems of length l is supplied by the Fourier series. Actually this series was introduced as early as 1822 in Fourier's work, *Théorie analytique de la chaleur*, as solution for problems of heat conduction. The solution thus obtained is:

$$c(x,t) = \sum_{n=1}^{\infty} \left[A_n \sin\frac{n\pi}{l}x + B_n \cos\frac{n\pi}{l}x\right] \exp\left(\frac{-n^2\pi^2 DT}{l^2}\right)$$

The arbitrary constants A_n and B_n must be determined in such a way as to conform with the initial conditions. In this manner diffusion out of a plate may be treated, when the concentration is constant (*see* fig. 4).

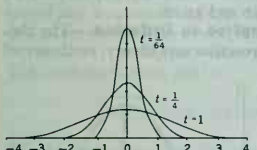

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FIG. 2.—FUNCTION REPRESENTING SMEARING OUT, BY DIFFUSION, OF SUBSTANCE ORIGINALLY CONCENTRATED AT $X = 0$

Treatment of the Diffusion Equation for D Depending on Concentration.—The solutions of the diffusion equation considered so far are only valid as long as D is constant or at least approximately constant. The measurement of D as a function of concentration is, of course, possible by choosing such initial conditions that there is only a small difference in concentration throughout the whole system. So a value of D for a mean concentration is obtained, and proceeding in the same manner by choosing other initial concentrations which also are not much apart, it is possible to determine D as a function of c. This procedure is naturally very laborious.

The differential equation for diffusion in the x direction with the diffusion coefficient depending on concentration was:

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial x} D(c) \frac{\partial c}{\partial x} \quad \text{or} \quad \frac{\partial c}{\partial t} = D(c)\frac{\partial c^2}{\partial x^2} + \frac{dD(c)}{dx}\left(\frac{\partial c}{\partial x}\right)$$

L. Boltzmann has treated this equation for the following initial conditions: $c=c_0$ for $x<0$ and $t=0$; $c=c_0$ for $x>0$ and $t=0$. The system is supposed to be infinite in the x direction. Upon the substitution of $y = \frac{x^2}{\sqrt{t}}$ Boltzmann obtained the ordinary differential equation:

$$\frac{d^2c}{dy^2} + \frac{y}{2D}\frac{dc}{dy} + \frac{dD}{dc}\frac{1}{D}\left(\frac{dc}{dy}\right)^2 = 0$$

This equation, which expresses c as a function of y, defines D arbitrarily as a function of c; however this does not make it possible to integrate D. But for practical purposes one may proceed as follows. Usually the task consists in the determination of $D(c)$ (by this is meant D as a function of c) if c has been obtained from direct experiments as a function of y. The last equation may then be rewritten:

$$\frac{d}{dy}\left(D\frac{dc}{dy}\right) = -\frac{y}{2}\frac{dc}{dy}$$

and upon a first integration:

$$D(c) = -\frac{1}{2}\frac{dy}{dc}\int_{c_0}^{c} y\,dc$$

Since the right-hand side is supposed to be given experimentally, it is always possible to carry through the integration by means of numerical or graphical methods, and thus to evaluate $D(c)$.

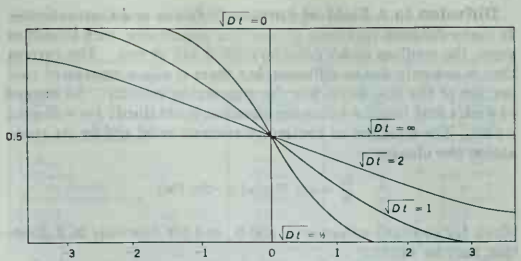

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FIG. 3.—FUNCTION REPRESENTING DIFFUSION OF SUBSTANCE ORIGINALLY CONTAINED IN ONLY ONE-HALF OF SYSTEM

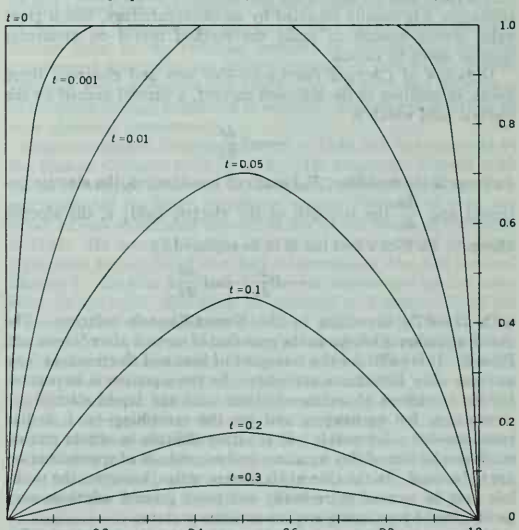

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FIG. 4.—SOLUTION, BY USE OF A FOURIER SERIES, FOR DIFFUSION OUT OF A PLATE, CONCENTRATION AT BOUNDARIES BEING KEPT AT ZERO

Diffusion in a Field of Force.—*Diffusion and Convection.*—In many diffusion problems of practical importance, with liquids or gases, the medium under consideration is not at rest. The current then is not only due to diffusion, but there is also a current of convection of the size $\mathfrak{v}c$, if $\mathfrak{v}$ is the convection velocity. So instead of Fick's first law the following equation is obtained: $j=-D \operatorname{grad} c+\mathfrak{v}c$. The equation of continuity remains valid and by its application one obtains:

$$\frac{\partial c}{\partial t}=\operatorname{div} D \operatorname{grad} c-\operatorname{div}(\mathfrak{v}c)$$

which for constant values of D and $\mathfrak{v}$, and for flow only in x direction, may be written:

$$\frac{\partial c}{\partial t}=D\frac{\partial^2 c}{\partial x^2}-\mathfrak{v}\frac{\partial c}{\partial x}$$

So in addition to the concentration change, caused by diffusion, there is a concentration change due to convection.

With this equation *sedimentation* may be treated. Under the influence of gravity, g, $\mathfrak{v}=umg$ (m is the mass of the particle and u is called its mobility: it is the constant of proportionality between a force acting on a particle and the resulting velocity). D and u are connected by Einstein's relation $D=RTu$. So,

$$j=-D\frac{dc}{dx}+cumg$$

At equilibrium, where $j=0$, the equation becomes:

$$RTu\frac{dc}{dx}=cumg$$

This equation may be integrated to give

$$c=c_0 \exp\left(\frac{mgx}{RT}\right)$$

the barometric formula. If c as a function of x is measured, this formula may serve to determine molecular weights. For measurements of practical importance it is usually very tiresome to wait until equilibrium is obtained. So it is more convenient to measure j and determine D or u from measurements at which the external force has been eliminated. This method of determining molecular weights is widely used in organic chemistry and biochemistry, and serves there also for measuring the masses of viruses, etc. The acceleration g is usually supplied by an ultracentrifuge, which gives fields strong enough to make the method useful on molecular weights down to 10,000.

Diffusion of Charged Particles.—For ions and electrons there exists, in addition to the diffusion current, a current caused by the electric field which is

$$-cuzF\frac{d\phi}{dx}$$

(u is again the mobility; F, Faraday's constant; ϕ, the electric potential and $\frac{d\phi}{dx}$ the strength of the electric field; z, the electric charge). So Fick's first law is to be replaced by

$$j=-D\frac{dc}{dx}-cuzF\frac{d\phi}{dx}$$

with $D=RTu$ according to the Nernst-Einstein relation. The above equation is known as the equation of motion after Nernst and Planck. It is valid for the transport of ions and electrons, as long as these obey Boltzmann statistics. So the equation is important for the treatment of semiconductors, solid and liquid electrolytic conductors, ion exchangers and for the tarnishing—and similar reactions—of solid metals. It is rather difficult to obtain mathematical solutions of this equation, and so methods of approximation are to be used. In the case of stationary states, however, the problem may be treated more easily and more general solutions may be obtained by assuming a quasi-stationary state.

Diffusion and Chemical Reaction.—For the treatment of diffusion in an external field of force it was necessary to extend Fick's first law. In other cases the law of continuity no longer holds, and is to be extended. For example, particles may vanish or new particles may be created by a chemical reaction. If the number of particles created by the reaction per second, $f(c)$, is a function of the concentration, the following equation is obtained:

$$\frac{\partial c}{\partial t}-f(c)=\frac{\partial j}{\partial x}$$

or in vector notation,

$$\frac{\partial c}{\partial t}-f(c)=\operatorname{div} j$$

Thus for the one-dimensional case and with D a constant the following equation holds:

$$D\frac{\partial^2 c}{\partial x^2}+f(c)=\frac{\partial c}{\partial t}$$

Apart from c, the concentration of the diffusing substance, $f(c)$ may depend on the concentration of other components and on external influences, for instance, illumination as in the case of a photochemical reaction.

The problem thus stated is closely connected with that of heat conduction, coupled with heat production. In the special case where all other influences are independent of the space co-ordinates and of time, and where $f(c)$ is proportional to c; *i.e.*, a reaction of the first order, the equation is as follows:

$$D\frac{\partial^2 c}{\partial x^2}+(\text{constant})\,c=\frac{\partial c}{\partial t}$$

This equation may be integrated by separating the variables.

Particles may also vanish or be created because of nuclear reactions. In the case of neutron diffusion, as has been pointed out, neutrons may be captured by the nuclei of the absorbing medium. The rate of capture is obviously proportional to the concentration of neutrons and inversely proportional to the mean lifetime of a neutron. The mean lifetime is $\frac{\lambda w}{\bar{v}}$; λ is the mean free path between two collisions; $\bar{v}$ is the mean velocity; and w is the probability that a capture will result from a collision. The quotient $\frac{\bar{v}}{w}$ is denoted by λ_a, the mean free path for absorption.

The following equation is obtained for the diffusion of thermal neutrons in an absorbing medium:

$$\frac{\partial c}{\partial t}=D\frac{\partial^2 c}{\partial x^2}-c\frac{\bar{v}}{\lambda_a}$$

Solutions of this equation, as given by Enrico Fermi, are necessary for calculating the process of the interaction of matter with neutrons, and to obtain diffusion lengths. Diffusion lengths in paraffin, graphite, water and other common materials for slowing down fast neutrons run between 10 and 50 cm.

Transition-State Theory Applied to Diffusion.—The theory, which is also called absolute reaction rate theory, or theory of the activated state, is applicable to any kind of chemical change, which may be a chemical reaction in the usual sense or a simple displacement of particles, as in diffusion or viscous flow. It is possible to calculate the diffusion constant from other properties of the material involved. The process of diffusion is then regarded as the passage of a particle over a potential barrier when it is moving from one position of low potential energy to an adjacent one. Such an energy barrier is represented schematically in fig. 5. Writing $\dot{n}_{12}$ instead of $\frac{dn_{12}}{dt}$ for the number of particles which cross the potential barrier per unit time, the following equation holds:

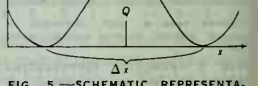

FIG. 5.—SCHEMATIC REPRESENTATION OF A POTENTIAL BARRIER

$$\dot{n}_{12}=\bar{\nu}n^{\ddagger}$$

(The $\bar{\nu}$ denotes the average frequency with which the particles cross the barrier in the right direction, $n^{\ddagger}$ is the number of particles in the transition or activated state; *i.e.*, on top of the barrier.) From statistical mechanics one gets for the number

of particles in the transition state $n^{\ddagger}$ divided by the number of particles in the ground state n_1: $\frac{n^{\ddagger}}{n_1}=\frac{f'}{f}$ where f and f' are the partition functions for the corresponding states. A partition function is defined by:

$$f=\sum g_i \exp\left(-\frac{E_i}{kT}\right)$$

where g_i is the energy and E_i the weight of a state i. From the partition function the translation states in the direction under consideration may be split off. In doing this, one obtains:

$$f'=f^*\sqrt{(2\pi\, m\, kT)}\,\frac{\delta}{h}$$

where f^* is the partition function of the activated state without the contribution of the translational energy in the direction of the x co-ordinate, δ is a certain range on top of the barrier, and h is Planck's constant. The mean velocity in the $+x$ direction is:

$$\bar{v}=\left(\frac{kT}{2\pi m}\right)^{\frac{1}{2}}$$

and consequently the frequency, ν, is $\frac{\bar{v}}{\delta}$. As only half of the total number of particles move in the $+x$ and the others in the $-x$ direction, one obtains for the number of transitions per unit time:

$$\dot{n}_{12}=n_1\frac{f^*}{f}\frac{kT}{h}$$

The factor kT/h has the dimensions of a frequency and is of the order of magnitude of 6×10^{12} per second. Transforming the energies in such a way as to get a summation over energies from $0\longrightarrow\infty$ in both partition functions and denoting the partition functions thus obtained by Z one gets:

$$\dot{n}_{12}=n_1\frac{Z^*}{Z}\frac{kT}{h}\exp\left(-\frac{Q}{RT}\right)$$

Q is the height of the potential barrier (*see* fig. 5). It is often referred to as the activation energy of the process. Then j, the current caused by the n particles, expressed in c_1 instead of n_1, is:

$$\overrightarrow{j}=c_1\frac{kT}{h}\exp\left(-\frac{Q}{RT}\right)$$

and in the opposite direction:

$$\overleftarrow{j}=c_2\frac{kT}{h}\exp\left(-\frac{Q}{RT}\right)$$

As long as the concentrations c_1 and c_2 are equal, both currents cancel and, macroscopically, no resulting current exists. For a concentration gradient, however, this is not so. Then c_1 (the concentration at x) is different from c_2 (the concentration at $x+dx$). The resulting current will be:

$$j=\overrightarrow{j}-\overleftarrow{j}=[c(x)-c(x+dx)]\frac{Z^*}{Z}\frac{kT}{h}\exp\left(-\frac{Q}{RT}\right)$$

As a first approximation this equation may be written as:

$$j=\triangle x\frac{Z^*}{Z}\frac{kT}{h}\exp\left(-\frac{Q}{RT}\right)\frac{dc}{dx}$$

(Δx is a characteristic length, which in case of diffusion in crystals may be expressed by the lattice constant); denoting the factors in front of exp by $-D_0$:

$$j=-D_0\exp\left(-\frac{Q}{RT}\right)\frac{dc}{dx}$$

Comparing this with Fick's first law,

$$D=D_0\exp\left(-\frac{Q}{RT}\right)$$

is obtained. The effect of temperature upon D_0 should be small in comparison with the effect upon exp $(-Q/RT)$. Thus the temperature dependence of D is given by exp $(-Q/RT)$. This relation may be verified experimentally. As stated already, the diffusion increases with increasing temperature.

Some Diffusion Coefficients (D)

Diffusing substance	Solvent	Temp.°C.	D(cm.²/sec.)
Gold	Copper	400	5×10^{-13}
Copper	Silver	650	2.0×10^{-10}
Copper (self-diffusion)		650	3.2×10^{-12}
		850	2.6×10^{-10}
		1,030	2.8×10^{-9}
Carbon	Iron	950	10^{-7}
Methanol	Water	18	1.4×10^{-5}
Carbon dioxide	Water	18	1.5×10^{-5}
Tobacco mosaic virus	Water	20	5.3×10^{-8}
Oxygen	Air	0	0.178
Hydrogen	Air	0	0.611
Phosgene	Air	0	0.095

See ISOTOPE: *Separation of Isotopes;* KINETIC THEORY OF MATTER; SOLUTIONS; *see* also references under "Diffusion" in the Index volume.

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DIGBY, SIR KENELM (1603–1665), English courtier, diplomat, naval commander, philosopher, scientist and author; a man of extraordinary and renowned versatility and energy in almost all fields of action and thought. He combined devoted adherence to the old religion with devoted pursuit of the new science. He claimed, justly, that it had ever been a maxim with him "that one can have no happiness either in this world or the next, but by extreme and vehement love."

He was born on July 11, 1603, the son of Sir Everard Digby, who was executed in 1606 for his part in the Gunpowder plot. After his father's death, Digby was brought up by his mother at Gayhurst, Buckinghamshire, as a Roman Catholic. In 1617 he accompanied his cousin Sir John Digby, later 1st earl of Bristol, to Spain. In 1618 Digby entered Gloucester hall (afterward Worcester college), Oxford, where he studied under the famous mathematician Thomas Allen. He left the university in 1620, traveled to France and Italy and in March 1623 was again with his cousin in Madrid shortly before the arrival of Prince Charles and the duke of Buckingham on their ill-fated mission to obtain a marriage treaty. Digby became a member of the prince's household and returned with him to England in October, when James I knighted him. In 1625 Digby married Venetia Stanley, whom he had known since childhood. To win political favour, in 1627–29 he led a privateering expedition and successfully attacked French ships in the Venetian harbour of Scanderoon, but the government disavowed his actions because of complaints by the Venetian ambassador. Lady Digby died in 1633 and he retired to Gresham college, remaining in seclusion for two years, occupied with chemical experiments.

Digby professed Protestantism after 1630 but had returned to the Roman Catholic faith by 1635. He associated himself with Queen Henrietta Maria and her Roman Catholic friends at court, and supported the king's expedition against Scotland in 1640, for which he was summoned before the bar of the house of commons in 1641. He went to France, where he was pardoned by Louis XIII after he had killed in a duel a French lord who had insulted Charles I. Back in England, Digby was imprisoned by the commons in 1642–43. Released, he returned to France. After his arrival in Paris he published his chief philosophical works, *Two Treatises, in the One of Which the Nature of Bodies; in the Other, the Nature of Mans Soule; Is Looked Into: in Way of Discovery of the Immortality of Reasonable Soules* (1644). He was appointed Henrietta Maria's chancellor and went to Rome in 1645 to solicit aid for the royalist cause from the pope. A second mission in 1647 was as fruitless as the first. He returned to England in 1649 but was banished by the council. Allowed to return in 1654, he negotiated with and for Oliver Cromwell, hoping to win toleration for Roman Catholics. At the Restoration he returned to England and he was on the council of the Royal society when it was formed in 1660. In Jan. 1664 he was banished from court, and spent the rest of his life in literary and scientific pursuits. He died in London on June 11, 1665.

Among his works were *Observations Upon Religio Medici* (1643) and *Observations on the 22. Stanza in the 9th Canto of the 2d. Book of Spencers Faery Queen* (1643). He also wrote on "the powder of sympathy," which he claimed would cure wounds without touching them. His memoirs were circulated in manuscript in his lifetime and were published, with expurgations, as *Private Memoirs*, ed. by Sir Nicholas H. Nicolas (1827).

See E. W. Bligh, *Sir Kenelm Digby and His Venetia* (1932); R. T. Petersson, *Sir Kenelm Digby, the Ornament of England* (1956).
(B. H. G. W.)

DIGBY, KENELM HENRY (1797–1880), English writer, author of *The Broadstone of Honour: or, Rules for the Gentlemen of England* (1822), a code of conduct for the upper classes based on an ideal of chivalry as "that general spirit . . . which disposes men to heroic and generous actions." It was later enlarged and issued (1826–27) in four volumes. Digby was born in Dublin, educated at Cambridge and lived as a man of letters in London, where he died, March 22, 1880.

DIGENES AKRITAS, BASILIUS, hero of a Byzantine epic composed probably in the 10th century. His parentage, exploits and death are described in the epic by direct narrative and his own tale of his adventures. He is called Digenes ("of double descent"), his father being Arabian emir, a convert to Christianity, and his mother the daughter of a Greek general, and Akritas as a warrior of the *akrai* ("borders") of the empire. His heroic nature already reveals itself in boyhood. Later, he carries off and marries the daughter of a Greek general, and, with his bride and a small band of followers, wanders in the desolate parts of the border waging war on all kinds of raiders who infest it, all of whom he exterminates single-handed. He builds a palace on the Euphrates, there to die of illness soon afterwards. The scene of action is the eastern frontier of the Byzantine empire, namely Cappadocia and the Euphrates area.

The archetypal version of the epic is lost, but six versions (one being prose) are extant, put together by different redactors and varying in length, date of composition and treatment of the original episodes. There are fragments of a Russian prose version (ed. by M. N. Speranksy, 1922). The earliest version seems to be that in a Grottaferrata 14th-century manuscript. The epic has attracted detailed study, and divergent opinions are held regarding the circumstances of its original composition and the problems, literary and historical, arising from the extant versions and from the relation of the written epic to certain Greek folk songs, the so-called ballads of the Akritic cycle. The background of the poem strongly suggests the rebellions of the Paulician heretics in the 9th century and the campaigns against them of the emperor Basil I (who, it can be plausibly argued, might have been the model for the hero of the epic). The author of the original version drew on Arabic epic material of the 10th century for part of his background, and the poem also contains borrowings from Hellenistic romances, chiefly Achilles Tatius and Heliodorus.

Though lacking in dramatic interest, the *Digenes* is characterized by an "epic comprehensiveness," and its narrative is relieved by descriptions of idyllic scenery of considerable literary merit.

Bibliography.—Edition with Greek introduction by P. P. Kalonaros, 2 vol. (1941); edition of E. Legrand (1892) reprinted with English verse translation and introduction by J. Mavrogordato (1956). *See* also H. Grégoire, *O Digenes Akritas* (1942). (S. J. Pa.)

DIGESTION, in physiology and medicine, comprises all the operations to which food is subjected from the time it is eaten until it is absorbed. The materials required for the life of the body tissues are supplied by the circulating fluids, blood, lymph and tissue fluid. This requires that the nutrients be soluble in water or be so finely divided that they can be transported in a liquid medium. Since the food as it is taken into the body is not in this condition, considerable changes must take place before it can be transported in the blood. The food, in addition to undergoing mechanical and chemical digestion, also must be transported along the alimentary tract, and the products of digestion must be transferred through membranes from the lumen of the intestine into the intestinal capillaries and lymphatics.

ORGANS OF DIGESTION

The organs of digestion, known collectively as the digestive or alimentary tract, comprise the mouth (*q.v.*), esophagus, stomach, small and large intestine and various accessory structures associated with these organs.

Esophagus.—The esophagus is a muscular tube connecting the oral pharynx with the stomach. It is lined with a tough mucous membrane similar to that lining the mouth and oral pharynx. The muscle of the upper portion of the esophagus is of the striated variety, similar to voluntary muscle, whereas that of the lower portion is of the unstriped or smooth variety.

Stomach.—The stomach is an expanded portion of the tube designed to serve as a reservoir for food and to initiate chemical digestion. It is connected with the esophagus at its cardiac or upper end, at which point a strong sphincter muscle serves to narrow the tube and to prevent easy passage of gastric contents back into the esophagus. At its lower end the stomach connects with the duodenum, and this junction is guarded by the powerful pyloric sphincter.

Intestines.—The small intestine consists of the duodenum, jejunum and ileum, which together comprise a continuous tube without any clear line of demarcation between the divisions. It is here that the greater part of chemical digestion goes on and absorption takes place. The large intestine in man serves mainly for recovery of the water secreted by the digestive glands and for elimination of undigested residues.

General Structure of the Digestive Tube.—The walls of the digestive tube contain varying amounts of smooth muscle, the activity of which serves the mechanical functions of digestion and transports the digesting mass through the alimentary tract. It is probable that muscular action also aids absorption. The digestive tract is lined with mucous membrane, the cells of which secrete either mucus or enzymes that aid in chemical digestion; in addition it serves as the medium of transport in absorption. Various glands have developed as diverticula from the digestive tract; these likewise secrete fluid containing digestive enzymes. The principal digestive glands are the salivary glands, gastric glands, liver and pancreas.

The entire tract, glands and muscle, is supplied with nerves belonging to the involuntary or autonomic division of the nervous system. It is also influenced by hormones, some developed within the tract itself and some secreted by glands situated elsewhere in the body.

For details of structure of the digestive tract *see* Gastrointestinal Tract.

MOTOR FUNCTIONS

Chewing (Mastication).—Ignoring cooking, which serves a function in chemical digestion, the digestive process begins when food enters the mouth. Here the food is subjected to the mechanical action of the teeth while being masticated, or chewed. This serves to reduce the size of the food particles and to mix the food with saliva. Saliva serves mainly to moisten and lubricate the food, but it has also some digestive action on starches. The presence of food in the mouth also serves to initiate reflexes that are important in regulation of secretion of gastric juice and, perhaps, other digestive functions.

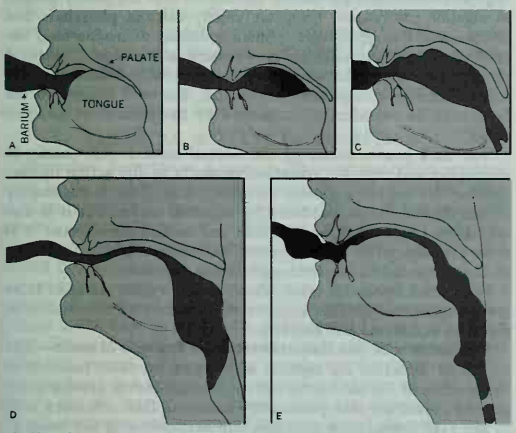
Chewing is accomplished by movements of the lower jaw, which in man can be moved anteroposteriorly, laterally or vertically; any one of these movements may be utilized in chewing. The act may be initiated and controlled voluntarily, but for the most part it is a self-regulating reflex. There is a wide divergence of opinion as to the importance of chewing in the process of digestion; nevertheless it appears evident that food should be chewed enough so that it can be easily swallowed. It is also generally believed that food must be retained in the mouth long enough for its flavour to be enjoyed thoroughly if the succeeding processes of digestion are to proceed optimally.

Swallowing (Deglutition).—Swallowing has been described as taking place in three stages: oral, pharyngeal and esophageal. In the oral stage the food is manipulated by the tongue and cheeks into position for swallowing; in the second, or pharyngeal, stage

it is passed rapidly through the pharynx into the esophagus; in the esophageal stage it is carried through the esophagus into the stomach. The mechanics of the oral and pharyngeal stages are so complicated that they are not yet thoroughly understood (fig. 1). The food is manipulated into a bolus and put under pressure by movements of the tongue and contraction of the pharyngeal muscles; consequently it moves toward the esophagus, where the pressure is lower. The combined oral and pharyngeal stages occupy only a fraction of a second, and the solid mass is often caused to move so rapidly that it may be projected halfway through the esophagus without further muscular effort. Liquids are usually projected all the way to the cardia and frequently pass directly into the stomach. Solid food usually has to be propelled, part of the way at least, by the action of the esophageal muscle. This consists of a contraction that develops in the circular muscle at the upper end of the tube and progresses slowly toward the lower end. The longitudinal muscle is also involved, but the mechanism of its action is not fully understood. The effect of the contraction is to narrow the lumen so that whatever may be ahead of the contraction is carried downward and ultimately delivered into the stomach. As the contraction wave approaches the stomach there is reflex relaxation of the cardiac sphincter accompanied by relaxation of the stomach itself, known as receptive relaxation of the stomach. This is an important factor in preventing an increase in intragastric pressure as the stomach is filled at mealtime.

Movements of the Stomach.—The muscle of the stomach is seldom completely at rest even when the organ is empty. The contractions of the empty stomach can be recorded with appropriate instruments or observed by means of X-rays. They have come to be called hunger contractions because, when they are very powerful, they give rise to a sensation that, in some people, is interpreted as hunger pain; in others they produce merely a sensation of emptiness or a desire for food. It is probable that the hunger contractions stimulate the search for food in those animals that are governed by instinct. In man they serve as a reminder that mealtime is approaching.

Gastric Peristalsis.—As soon as food is taken, contractions cease and after a variable time are replaced by rhythmic movements called digestive peristalsis. Gastric peristalsis begins as a ring of constriction about the middle of the stomach; this progresses toward the lower or pyloric end, growing deeper as it moves. In man contractions of this sort occur at a rate of about three per minute, and each takes approximately one minute to travel from its origin to the pylorus; consequently, it usually is possible to see with the fluoroscope three waves of contraction simultaneously on the human stomach. If they happen to begin at a higher level, four or more waves may be seen at one time. Contractions of the stomach serve two main purposes. The first is to aid digestion by completing the mechanical disintegration of the food; by far the greatest part of energy expended by the stomach is used for this purpose. The second is to propel the digested material into the duodenum.



ADAPTED FROM MOSHER, "LARYNGOSCOPE," 37:237 (ST. LOUIS, MO., 1927)

FIG. 1.—MOVEMENTS OF THE TONGUE IN THE ACT OF SWALLOWING. (DRAWINGS MADE FROM RETOUCHED TRACINGS OF AN X-RAY FILM)

(A) The tip of the tongue is depressed as the substance ingested (barium meal in this case) accumulates above and in front of the tip and behind the teeth; (B) the tip of the tongue rises and the dorsum sinks; (C) the tip remains up and the dorsum and base sink, forming an inclined plane; (D) the anterior half of the tongue rises as a mass to the roof of the mouth, and the base of the tongue is depressed still further. The mouth is now full. (E) The anterior half of the tongue remains at the roof of the mouth; the posterior half and the base of the tongue rise and shoot suddenly backward, driving the barium meal down the pharynx

Gastric Emptying.—When liquids are swallowed, passage into the duodenum begins at once. Solid food remains in the stomach until some portion of it is liquefied. In consequence, the chyme, as the evacuated material is called, is fluid or semifluid in consistency, although it may contain small solid particles in suspension. Once emptying begins, it proceeds rhythmically, a small portion of the chyme being projected into the duodenum with each peristaltic wave. The emptying of the stomach is regulated by means of reflexes and hormones. Regulatory reflexes arise in the upper intestine and are caused by stimuli that result from contact of the chyme with the intestinal mucous membrane.

Certain substances in the chyme cause nerve impulses to be initiated that diminish the peristaltic activity of the stomach and thus delay emptying. Substances that act in this manner are products of protein digestion, fat, fatty acids, products of starch digestion and the hydrochloric acid secreted by the gastric glands. Some foreign substances such as alcohol, strong salt solution and other irritants act similarly. Fats and carbohydrates also release from the mucous membrane of the intestine a hormone called enterogastrone, which circulates in the blood and, when it reaches the stomach, tends to slow down its activities. Fats are particularly potent in this regard, and for this reason fats remain in the stomach much longer than do other foods.

Movements of the Small Intestine.—In the small intestine digestion is completed and absorption takes place; the activity of the smooth muscle is appropriate to these functions.

Segmenting Contractions.—The commonest type of muscular action is rhythmic, or segmenting, contractions. These are ring-like contractions of the circular muscle, which occur at variously spaced intervals along the intestine, dividing it into segments. The contractions are followed by relaxation and then by contraction of the muscle in the middle of the previously relaxed segment; thus the segments appear under the fluoroscope to be constantly shifting to and fro. These contractions range in frequency from 9 to 18 or 20 per minute. The higher rates occur in small animals and in the upper end of the intestine. The effect of the segmenting contractions is to keep the intestinal contents in motion, so that the portions in contact with the mucous membrane are constantly changing; the contractions also serve a stirring and mixing function and greatly facilitate digestion and absorption.

Intestinal Peristalsis.—The progress of the digesting mass through the intestine depends on the occurrence of intestinal peristalsis. A typical peristaltic movement begins with contraction of a ring of circular muscle, narrowing the lumen of the tube. The contraction is transmitted to adjacent muscle, so that it travels as a wave that progresses in the direction of the lower end of the intestine. Intestinal peristalsis is not rhythmic and occurs only at irregular intervals. The waves appear and disappear without any apparent cause and progress for varying distances, sometimes a few inches, sometimes a few feet, and occasionally over the entire length of the small intestine. The strength of the constriction also varies, at times almost obliterating the lumen so that everything is swept before the wave, at other times causing only a slight indentation of the wall. Usually about six hours are required for an ordinary meal to pass through the small intestine. During this time practically all the usable material in the digesting mass is absorbed into the blood stream or lymph, leaving only water and indigestible residue to be emptied into the large intestine.

ADAPTED FROM STARLING, "PRINCIPLES OF HUMAN PHYSIOLOGY"

FIG. 2.—POSITION OF STOMACH AND LARGE INTESTINE IN MAN

The figures indicate the time in hours of arrival of barium meal at various levels

Movements of the Large Intestine.—In the large intestine, the water that has been used in digestion is recovered and returned to the blood. The undigested food residues, along with a great number of bacteria that inhabit this part of the intestine, are dried out, so to speak, and reduced to the consistency of the feces and propelled toward the anus.

Mixing Movements.—In the large intestine occur stirring and mixing movements that appear to be somewhat different in different species and that are not well understood even in human beings. In general they appear to accomplish a to-and-fro movement of the contents between the caecum, which is the large first portion of the large intestine, and the transverse colon. Associated with these are the contractions of the recesses of the colon (haustral contractions), which resemble to some extent the segmenting contractions of the small intestine.

Propulsive Movements.—Propulsive movements occur at infrequent intervals and are usually initiated by the taking of a meal. In some manner the process of filling the stomach stimulates intestinal motility, affecting not only the small intestine but the large intestine as well; this effect is known as the gastrocolic reflex. Since the large intestine is generally quiet between meals, this reflex assumes considerable importance.

In the human subject, following a meal, it is usual to find in the large intestine a type of movement that has been described either as mass peristalsis or mass contraction of the colon. Typical mass contractions start at the caecum, progress over the ascending and transverse colon and terminate in the descending colon. The effect of such a movement is to carry forward the contents of the large intestine and deliver them into the most distal segment, which is known as the sigmoid or pelvic colon. If the contraction wave is strong enough to carry the fecal mass into the rectum, it produces a characteristic sensation that the individual recognizes as a desire to defecate.

Defecation.—In the adult, the act of defecation is preceded by a voluntary effort consisting of relaxation of the external anal sphincter and, usually, compression of the abdominal contents by means of straining efforts. These movements in turn probably give rise to stimuli that augment the visceral reflexes originating primarily in the distended rectum. As a result of these reflexes peristaltic waves appear in the colon while the internal anal sphincter relaxes. The peristalsis of the descending colon carries its contents into the pelvic colon, which in turn transfers them to the rectum, eventually to be evacuated by way of the anus. Hence, the entire distal colon, from the splenic flexure to the anus, may be emptied at one time.

A prominent mechanical feature of the final act of evacuation is contraction of the longitudinal muscle of the distal colon; this muscle is most highly developed in the rectum itself. The shortening of the distal colon tends to elevate the pelvic colon and obliterate the angle it normally makes with the upper end of the rectum; straightening of the passage in this way doubtless facilitates evacuation. Shortening of the rectum itself, assuming that it has a firm grip on its contents at the upper end, may be an important factor in expelling the feces through the anal orifice.

The act of defecation provides another instance of a reflex that is under some degree of voluntary control. Voluntary regulation consists of the ability to inhibit the reflex under normal circumstances and to initiate it voluntarily, provided the necessary visceral stimulus (recent distention of the rectum) is present. Reflex centres for defecation have been located in the brain, namely, the hypothalamus, in the lower lumbar and the upper segments of the spinal cord and in the ganglionic plexus of the intestine.

Formation and Composition of Feces.—*Formation.*—As food material progresses through the small intestine, practically all the digestible material is absorbed and carried away by the blood or lymph. The residue consists of water, small amounts of undigested and unabsorbed food, the remains of desquamated mucosal cells and the undigestible and unabsorbable fractions of the digestive secretion; in addition, there may be present various species of bacteria and the products of their metabolism. This material is emptied from the terminal ileum into the colon, where it is subjected to further alteration through absorption of water and the action of the bacteria that inhabit the colon. Practically nothing is added in the colon except, possibly, some mucosal secretion.

Composition.—Food residues provide an excellent culture medium for bacteria, and the interior of the colon is a nearly ideal environment for their growth; in consequence they multiply enormously, so that from 30% to 50% of the weight of the feces may be made up of bacterial bodies. The colonic contents are further modified by absorption of water and inorganic salts, so that of the 75 to 180 g. of feces daily excreted only about 70% to 75% is normally water; this proportion varies a great deal, however, according to the consistency of the feces.

Feces normally contain from 5% to 25% of fatty material, including such substances as neutral fats, free fatty acids, soaps and sterols. Fats are present in appreciable amounts even on a fat-free diet, proving that some fat is excreted through the intestine. About one-third of the fecal lipid consists of sterols, chiefly cholesterol. The daily output of feces contains from 0.5 to 1.5 g. of nitrogen as nitrogen compounds. About half the nitrogen represents nitrogenous constituents of the fecal bacteria; the rest represents unabsorbed intestinal secretions and digestive fluids, mucus, desquamated mucosal epithelial cells and a small amount of food residue; some digestive enzymes also may be present. Usually, absorption and digestion of protein are so nearly complete that only small amounts of food protein nitrogen escape into the feces; likewise only small quantities of digestive enzymes are normally present, since they are usually destroyed by other enzymes or by the action of bacteria. Digestive enzymes may be increased in the stool in diarrhea and may then be responsible for severe skin irritations.

Since the pH of the feces is usually between 7 and 7.5, the inorganic constituents are mainly substances that are poorly soluble in alkaline pH ranges; these are chiefly calcium phosphate and oxalate and iron phosphate. Small amounts of magnesium, potassium and sodium salts are also present in the stool. Since, in the human being, cellulose is not digested, it may be found in the feces whenever it is present in the diet; the total volume of the feces may be considerably influenced by the amount of cellulose eaten.

The dark brown colour of the normal stool is due chiefly to stercobilin and urobilin, reduction products of the action of bacteria on the red bile pigment, bilirubin. The odour is due mainly to skatole and indole, produced by bacterial action, but it is also contributed to by hydrogen sulfide and methyl mercaptan; it is more pronounced on a high protein diet because of the formation of larger quantities of these odoriferous substances.

Even when no food is taken, about seven to eight grams of feces are excreted daily. This consists of desquamated mucosal cells, digestive secretions and bacteria.

Regulation of the Gastrointestinal Smooth Muscle.—The organs of digestion are capable of carrying on their function in the absence of the autonomic nerves, but the nerves provide a degree of regulation that presumably increases their efficiency and, in any case, brings their activities into harmony with the needs of the entire body. The muscle is supplied by two sets of nerves called respectively the sympathetic and parasympathetic nerves. The parasympathetic nerves are mainly responsible for regulating the functions of the organs of digestion, and, generally speaking, their effect on the smooth muscle is to increase its activity. The sympathetic nerves, on the other hand, are mainly responsible for diminishing or stopping the activity of the digestive organs when all available energy is needed elsewhere in the body. Thus they diminish or inhibit the activity of the gastrointestinal muscle.

Under normal circumstances a reasonable balance is maintained between these two antagonistic influences, but in conditions of stress or emotional excitement one or another set of nerves may be so stimulated as to seriously impair digestive function; for example, in case of fright or sudden anger, pain, severe exercise or even intense interest, gastric emptying may be slowed and digestion retarded. In some instances the retardation may be so severe as to cause stasis and symptoms of indigestion. Other types of emotional reactions may stimulate the parasympathetic nerves excessively and produce hypermotility, intestinal cramps or diarrhea. When such abnormal situations exist over long periods of time, or reoccur frequently, the disturbance may be so severe that organic changes occur in the digestive organs and chronic disease supervenes. Peptic ulcer and ulcerative colitis are commonly believed to be the result of certain types of stress acting directly through this mechanism or through an associated hormonal mechanism.

Vomiting.—Vomiting is a reflex that relieves the upper gastrointestinal tract of its contents; this may occur either because the contents are irritating or because the organs themselves are not in a normal state. Abnormal stimuli, arising in the irritated stomach or intestine, are conveyed to receptive areas in the brain, where they give rise to the sensation of nausea. They also go to the vomiting centre in the medulla, from which are transmitted to the smooth muscle of the stomach and intestine, and the voluntary muscles of the thorax, abdomen, neck and mouth, nerve impulses that result in a characteristic series of muscular actions.

The first movement to occur is a strong sustained contraction of the upper intestine; next the pyloric sphincter contracts and then the pyloric portion of the stomach. These changes take place during the period of nausea and result in emptying the contents of the jejunum, duodenum and pyloric portion of the stomach into the fundus and body of the stomach, which are relaxed and dilated. Then, following an inspiratory movement, the glottis is closed and the abdominal muscles contract violently, compressing the stomach between the contracted diaphragm and the abdominal organs. The pressure on the gastric contents causes their evacuation through the relaxed esophagus, oral pharynx and mouth.

Vomiting may also be induced by disease or stimulation of the uterus, kidneys, heart, semicircular canals, eyes, nose and mouth, or as a result of direct stimulation of the vomiting centre. Certain of the emetic drugs act on the centre, but most important clinically is the "central" vomiting caused by traumatic stimulation of the centre due to head injuries, increased intracranial pressure, brain tumours or meningeal irritation. This type of vomiting is characterized by the great force with which the contents are ejected (projectile vomiting) and by a minimum of nausea and very little activity of the voluntary muscles.

CHEMICAL ASPECTS OF DIGESTION

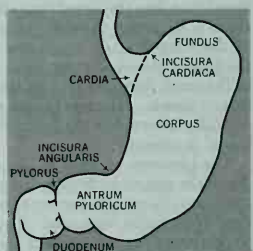
Digestive Secretions.—*Saliva.*—The first secretion encountered by the food in its progress through the gastrointestinal tract is saliva, which is secreted by three pairs of glands known as the parotid, submaxillary and sublingual glands (*see* SALIVARY GLANDS). The parotid glands are situated below the ears and behind the ramus of the mandible. They are easily located in a person having mumps, in which disease they become swollen as a result of an acute viral parotitis. The submaxillary glands are located in the floor of the mouth, just internal to the angle of the jaw. The sublingual glands, as the name suggests, are situated under the tongue. The salivary glands empty their secretions through ducts that lead into various parts of the mouth. In addition to the six large salivary glands, there are numerous smaller ones in the mucous membrane of the mouth and pharynx.

Saliva consists of water, inorganic salts and organic solids. The inorganic salts are the salts found in most body fluids, of which sodium, potassium and calcium salts are the most important. The principal organic solids are mucin and the starch-splitting enzyme ptyalin (one of the amylases). The latter is relatively abundant in human saliva but is said to be absent from the saliva of dogs. This fact may have some relation to the normal diet of the species, but since dogs are provided with abundant amylase in other parts of the digestive tract, this interpretation is open to question.

Enough saliva is secreted continuously to keep the mucous membranes of the mouth and throat moist. Changes in the rate of secretion are brought about through secretory nerves that supply the salivary glands; these belong to both the sympathetic and parasympathetic divisions of the autonomic system. The nerves are normally excited through reflexes, which may be inborn or conditioned. Inborn reflexes comprise responses to stimuli associated with the presence of food in the mouth; these include taste, smell and the sense of touch. The act of chewing also probably facilitates the flow of saliva. Conditioned reflexes are acquired; they result from associations experienced during the act of eating. For example, the sight of a lemon will induce salivary secretion in most persons because they have at some time experienced the sour taste of lemon juice. In the absence of such an experience, the sight of a lemon would have no effect whatever on the salivary glands. The salivary glands are unique in that their secretion is not influenced by any specific secretory hormone.

The composition of saliva is influenced to some extent by the type of stimulus causing secretion. For example, acids induce secretion of an abundant watery saliva, whereas alkalies stimulate mainly secretion of mucus. Mucus is also secreted in abundance when the food is dry or hard and also when the food consists entirely of milk. In fact, more saliva and more mucus are secreted in response to milk than to dry solid food. The Russian physiologist I. P. Pavlov, who made these and many similar observations, thought he saw a certain utility in the various modifications of the salivary secretion evoked by different foodstuffs. Acids, for example, require dilution in order to be tolerable. Dry foods need an abundance of secretion, particularly mucus, to enable them to be swallowed. Milk, however, is easily swallowed without saliva but nevertheless receives an abundant secretion; Pavlov was of the opinion that the large amount of saliva, especially mucus, prevented the formation of large curds in the milk when it entered the stomach. According to this interpretation there is a specific teleological relation between the quantity and type of saliva and the food eaten. There can be no doubt that the quantity of secretion and the time when it appears, as well as its composition, are adapted to the needs of the organism.

Gastric Juice.—As soon as the food is swallowed it encounters the gastric juice, a complex fluid secreted by various types of glands situated in different parts of the lining of the stomach. The gastric juice consists of water, inorganic salts, hydrochloric acid, mucin and enzymes. The presence of a strong mineral acid in one of the body fluids is a remarkable phenomenon that has aroused the interest of physiologists for many generations; the exact mechanism of its production remains unknown. The thick, tough, flaky mucus found in the gastric juice is secreted by the surface epithelial cells that constitute the major part of the lining of the stomach; while adhering to the cells that secrete it, it serves to protect them from the abrasive action of various solid substances that may be swallowed, as well as from the corrosive action of the hydrochloric acid.



ADAPTED FROM LEWIS, "AMERICAN JOURNAL OF ANATOMY," 13:491 (1912)

FIG. 3.—SUBDIVISIONS OF THE HUMAN STOMACH

Most of the fluid is formed by the gastric glands. These are small, tubular glands that dip down from the surface of the mucous membrane in the fundus and body of the stomach (*see* fig. 3). These glands are made up of two types of cells, called chief cells and parietal cells. Chief cells line the glands; it is believed that they secrete the pepsin (*q.v.*), rennin and lipase found in gastric juice. The chief cells near the orifice of the gland probably secrete a soluble type of mucus. The parietal cells appear to be applied to the external surface of the gland; they pour their secretion into the lumen through tiny canals between the chief cells. They are believed to secrete the hydrochloric acid of the gastric juice. Although these cells secrete a strong mineral acid, the protoplasm

of the cell is neutral or slightly alkaline in reaction. It is evident that the acid is in some way formed near the surface on the luminal side of the cell.

The pyloric portion of the stomach, which constitutes approximately the distal one-fourth, secretes a neutral or alkaline fluid; besides water and salts its principal constituent is mucus.

A small amount of gastric juice is secreted continuously by most human beings, but by far the greatest amount is secreted after meals. The increased volume of secretion following meals, called the digestive secretion, is the result of stimulation of the gastric glands by nervous and hormonal influence. Nervous stimulation causes what is called the initial reflex, or cephalic, phase of gastric secretion; this is due to the sight, smell and taste of food. The amount and duration of secretion during this phase depends somewhat on the intensity of stimulation, but more particularly upon the psychic response of the individual. The more pleasurable the sensations associated with eating, the more gastric juice will be secreted; thus an individual with little appetite, even though he may smell and taste the food, has little secretory response from his stomach. Gastric juice secreted during the cephalic phase has a high acidity and contains large amounts of pepsin; it is therefore a very active digestive secretion. If an experiment is arranged so that only the initial reflex phase is active—that is, so no food enters the stomach—the secretion ordinarily begins within five minutes after feeding and may last for as much as one hour.

If arrangements are made to put food into the stomach without the individual's knowledge (for example, through a gastric fistula in a sleeping subject), the initial reflex phase does not occur; nevertheless, the stomach will begin to secrete after approximately 15 minutes. Although the secretion is less abundant and less potent than that formed during the initial reflex phase, it lasts for a longer time, indeed for as long as there is food remaining in the stomach. This part of the gastric secretory cycle is known as the chemical or gastric phase and is caused by the presence of food in the distal or pyloric portion of the stomach. The mucous membrane in this region contains a hormone called gastrin, which is capable of stimulating the gastric glands to secrete. In the absence of food the hormone remains in the mucous membrane, but when food is present it is increased in amount and caused to escape from the mucous membrane into the blood that circulates in the submucosa. From there it is carried through the general circulation and, by means of the arterioles and capillaries that supply the stomach, reaches the gastric glands, causing them to secrete. The presence of food in the small intestine also causes some degree of secretion by the gastric glands. The mechanism of stimulation from this source is not fully known, but the available evidence suggests that it is hormonal in nature.

The presence of food in the stomach tends to neutralize and dilute the gastric hydrochloric acid. In consequence, after a meal, the stomach contents are never so acid as is the gastric juice at the time of its initial formation. If for any reason the secretion tends to continue after the stomach is emptied, the acidity of the gastric contents rises to abnormally high levels, and under these circumstances it is possible for the gastric juice to damage the gastric or duodenal mucosa.

One theory of peptic ulcer formation is that gastric and duodenal ulcers are the result of continued secretion of gastric juice after the stomach has emptied itself and the neutralizing effect of the food is no longer present. Some degree of protection against this is provided by a special inhibitory mechanism in the pyloric portion of the stomach. If hydrochloric acid of concentration such as is normally secreted by the fundic portion of the stomach reaches the mucous membrane in the pyloric portion, it brings about, in the normal individual, a cessation of gastric secretion. In this way the secretion of strongly acid gastric juice in the absence of food is prevented.

Pancreatic Juice.—The pancreas (*q.v.*) is a large tapering gland that stretches across the posterior abdominal wall behind the stomach. Its larger end, or head, lies in the curve of the duodenum and its smaller end, or tail, in contact with the spleen. Its secretion is conveyed into the intestine through two ducts, the larger of which, called the duct of Wirsung, enters the duodenum along with the terminal portion of the common bile duct. The other duct, called the duct of Santorini, or accessory duct, empties separately into the duodenum at a slightly higher level. The pancreatic juice contains, in addition to enzymes capable of digesting all the types of food, sodium bicarbonate in a concentration roughly equivalent to the concentration of hydrochloric acid secreted by the stomach. Thus while the stomach is secreting acid, the pancreas is secreting base, an arrangement that helps to maintain the normal acid-base balance of the blood. When the two secretions are mixed in the intestine they neutralize each other, and the products are reabsorbed and restored to the circulation. The quantity of pancreatic juice secreted in 24 hours is probably somewhat less than the amount of gastric juice secreted in the same period of time. It has been estimated that the pancreas secretes about 20 c.c. of fluid per kilogram of body weight in 24 hours. The corresponding figure for the stomach is 25 c.c. This discrepancy partly accounts for the fact that the intestinal contents are normally slightly acid in reaction.

In some species the pancreas secretes continuously, in others only intermittently. It is not known whether or not the human pancreas secretes continuously. In any case, the secretion is greatly augmented during digestion. This increase is due to stimuli associated with the presence of food in the intestine; there is no gastric phase of pancreatic secretion—that is to say, food in the stomach does not influence the pancreas. The substances that act as stimuli comprise various constituents of the chyme, including water, acid, products of protein digestion, products of starch digestion, fat and products of fat digestion. When used singly, each of these substances produces a characteristic type of pancreatic juice; for example, hydrochloric acid produces a large amount of secretion containing a relatively high concentration of sodium bicarbonate but only a small concentration of enzymes; soap and fat and the products of protein digestion cause secretion of a smaller amount of more concentrated pancreatic juice containing a relatively high concentration of enzymes.

The substances mentioned influence secretion of pancreatic juice through nervous and hormonal mechanisms. Secretory nerves are present in both the sympathetic and parasympathetic nerves that supply the gland. The nerves have a profound effect on the enzyme concentration of the pancreatic juice and moderately increase the volume output. The manner in which they are stimulated during digestion is not known, except that the vagus nerves are responsible for an initial reflex phase of secretion corresponding to, but less important than, the cephalic phase of gastric secretion. It is probable that the secretory nerves act synergistically, or cooperatively, with the hormones.

The discovery by William Bayliss and Ernest H. Starling in 1902 of a hormonal mechanism for regulation of pancreatic secretion was an epochal event in the history of physiology. They found a substance in the mucous membrane of the duodenum that, when injected into the blood stream, stimulated the pancreas to secrete. This was the first instance in which a specific chemical substance was known to act as a stimulus for an organ at a distance from its site of origin. Bayliss and Starling called their chemical stimulus secretin and coined the word hormone to characterize secretin and similar substances. Secretin is released from the mucous membrane of the intestine by various substances found in the gastric chyme, of which hydrochloric acid is the most effective. After absorption, it is carried by the blood to the pancreas, where it induces an abundant secretion of dilute pancreatic juice. Its principal effect is to stimulate the secretion of water and bicarbonate, although a small amount of enzyme is always present.

Later, two other English physiologists, A. A. Harper and H. S. Raper, demonstrated in the duodenal mucous membrane another hormone, which they called pancreozymin, which specifically increases the enzyme output from the pancreas. Normally during digestion both hormones are active; consequently, there is an abundant secretion of pancreatic juice with a relatively high concentration of enzymes.

Intestinal Secretion.—The mucous membrane lining the small intestine produces a secretion that aids in the terminal phases of digestion. This is an alkaline fluid somewhat resembling pancreatic

juice in its inorganic composition and known as succus entericus. It contains, in addition to enzymes, much cellular debris resulting from the sloughing of cells from the mucous lining of the intestine. It is not known whether the enzymes present in the juice are actually secreted by living cells or result from the disintegration of cells sloughed from the mucous membrane. In any case, they perform their function of completing carbohydrate and protein digestion within the lumen of the intestine. The intestinal mucosa also secretes enterokinase, which activates the trypsinogen of the pancreatic juice, converting it to trypsin, an enzyme that digests protein.

The secretory activity of the intestine is influenced by nervous, hormonal and mechanical stimuli. The parasympathetic nerves for the most part augment the secretion, which is also increased by mechanical distention and by the presence of food in the intestine. E. S. Nasset demonstrated the presence of a specific hormone, which he called enterocrinin and which has the function of increasing the secretion of intestinal juice. One of the functions of the intestinal mucous membrane is to act as a semipermeable membrane between the blood and the intestinal contents. In consequence, there is a constant interchange of fluid between the intestinal contents and the lymph and tissue fluid. This interchange can be considered as comprising simultaneous secretion and absorption of water.

The net movement of water is determined by the osmotic relation between the intestinal contents and the tissue fluids. Hypertonic fluid in the intestine, such as concentrated sugar solution, will cause an outpouring of fluid into the intestine, increasing the volume of the intestinal contents; but it would be a mistake to suppose that physical factors are alone responsible for absorption and secretion.

Formation of Bile by the Liver.—Bile is an important digestive secretion, but it also serves an essential excretory function having to do with hemoglobin metabolism. The red blood cells, which contain hemoglobin, are constantly being broken down and destroyed in the body, probably as a result of the wear and tear they encounter in the rapidly moving blood stream. The pigment that they contain is excreted by the liver in the form of bilirubin. Bilirubin, while circulating in the blood, is combined with a protein molecule; when it reaches the liver it is conjugated with glycuronic acid and excreted as bilirubin glycuronide. Bilirubin and its derivatives give to the bile, urine and feces their characteristic colour.

The constituents of the bile important for digestion are the bile acids. These are synthesized in the liver and comprise various modifications of cholic acid. The important bile acids in the human bile are glycocholic and taurocholic acids, which appear in the bile as their sodium salts. Bile is secreted continuously, but in those species equipped with a gall bladder (*q.v.*), including human beings, it does not enter the intestine continuously but only in response to specific stimuli. Effective normal stimuli are, in general, connected in some way with the process of digestion, so that the bile is usually delivered to the intestine during the digestion of food.

Bile secreted in the intervals between meals is diverted into the gall bladder, where it undergoes various changes, the most important of which is loss of water and inorganic salts, which are absorbed through the mucous lining of the gall bladder and returned to the blood stream. As much as 90% of the water may be absorbed, resulting in a tenfold increase in concentration of unabsorbed solids. In this way the gall bladder is able to store the typical biliary solids secreted during about ten hours, although its capacity is equal only to the volume of the bile secreted by the liver in one hour. Apparently water and salts are absorbed in approximately equal molecular proportions; at any rate, no significant change in the total salt content ratio has been reported.

Bile contains, in addition to the constituents already mentioned, quantities of cholesterol (*q.v.*). This relatively insoluble substance is concentrated along with the other bilary constituents when water and salts are absorbed from the gall bladder. In certain circumstances, the cholesterol may precipitate and form stones, which, once started, have a tendency to increase in size. It is not uncommon to find a gall bladder solidly packed with stones, the chief constituent of which is cholesterol.

Normally the gall bladder fills during the interdigestive period and empties during digestion, although some degree of spontaneous emptying may occur if the fast is prolonged. Effective stimuli for contraction, hence emptying, of the gall bladder are provided by various foods and irritant substances present in the duodenum. These include, among others, hydrochloric acid, protein in solution, proteoses, peptones, fats and concentrated salt solutions. One salt that has been widely used for inducing emptying of the gall bladder for therapeutic purposes is concentrated magnesium sulfate. Mechanical stimulation of the duodenum is also effective. Of the food substances, fat has the most pronounced effect. Probably emptying of the gall bladder is usually initiated by reflexes over the vagus nerves, with food in the intestine acting as an effective stimulus. The sustained contraction normally seen during digestion, however, is maintained by a hormone known as cholecystokinin, which is liberated from the intestinal mucous membrane by the action of hydrochloric acid and also by fat.

After entering the intestine the bile salts serve an important function in digestion and absorption of fat, as mentioned above; they are then reabsorbed into the blood and returned to the liver to be used again, with the exception of about 10% that is lost in the feces. This loss has to be replaced by the synthesis of bile acids in the liver.

The bile pigments and other constituents of the bile are normally excreted in the feces, although a small amount of the pigment is reabsorbed and has to be excreted by the kidney.

Digestion of the Various Food Substances.—Chemically, digestion consists of the breakdown of complex food molecules into simpler substances, essentially a reversal of the growth process. In the growth and development of plant and animal tissues that are used by man for food, protein molecules are synthesized from the simpler amino acids; carbohydrate molecules are built up from simple sugars; and fats are made from fatty acids and glycerol. During digestion this process is reversed, the food being reduced to amino acids, simple sugars, glycerol and fatty acids. The process is known chemically as hydrolysis, which means a breakdown by means of water.

In hydrolysis a water molecule is used to split a more complex molecule; in the process the water itself is split, part of the water molecule joining with one fragment of the complex molecule and the other part with the other fragment. In this way, by the addition of the elements of water, a protein molecule, for example, which may be made up of 50 to 100 different amino acids, is broken down into the original "building stones" from which the molecule was constructed. It is apparent, too, that a certain amount of water is used up in the process. Similarly, carbohydrates and fats are split, utilizing water in the process. By this means the organism is able to reduce its food to soluble, easily distributed forms; furthermore, since human proteins, fats and carbohydrates are not necessarily the same as those that exist in plants and in other animals, human beings are able to build their own characteristic materials from these simple building stones.

Carbohydrates.—Most carbohydrate is taken into the body as either sugar or starch, so starch digestion may serve as a model for the description of carbohydrate digestion in general. The hydrolysis of starch is accomplished by enzymes known as amylases, which are sometimes given special names depending upon the source; for example, the amylase of human saliva is called ptyalin. Ptyalin is a relatively weak enzyme, and the amount of digestion that goes on in the mouth is not quantitatively important; however, since the food becomes thoroughly mixed with saliva in the process of chewing, digestion may go on in the stomach for a period of time after the food is swallowed.

Probably most of starch digestion occurs in the intestine, where the powerful enzyme pancreatic amylase is able to attack the starch molecules. The amylases reduce starch to maltose, a disaccharide sugar, a small amount of glucose being released at the same time. Amylases are also found in the liver and in the intestinal mucous membrane. The maltose produced by starch digestion, and the other disaccharides that may be present in the

food—notably sucrose (table sugar) and lactose (milk sugar)—are broken down to simple sugars, monosaccharides, by the action of appropriate enzymes in the intestine; the monosaccharides are glucose, levulose and galactose. The monosaccharides are absorbed by the intestinal mucous membrane, whereas the disaccharides are not readily absorbed.

Proteins.—Protein digestion begins in the stomach, where the food encounters pepsin and hydrochloric acid. Since pepsin acts only in an acid medium, the presence of hydrochloric acid in the gastric juice is essential for optimal protein digestion. Pepsin has a unique capacity to digest native protein (that is, protein that has not been altered by the action of other reagents or by heat), in contrast with most of the other proteolytic enzymes of the body, which act best on denatured or partly digested protein. Peptic digestion serves to make the protein constituents of the food soluble and also to render them more readily digested by the proteolytic enzymes encountered in the intestine.

Pepsin also has the capacity to coagulate milk, though in young animals another enzyme known as rennin fills this specific function.

After passing from the stomach into the intestine the products of peptic digestion as well as any undigested protein remaining in the chyme encounter the proteolytic enzymes trypsin and chymotrypsin, secreted by the pancreas. As secreted in the pancreatic juice, neither of these enzymes has any proteolytic activity; they are then known as trypsinogen and chymo-trypsinogen, respectively. Trypsinogen is altered to trypsin by the action of enterokinase. Chymo-trypsinogen on the other hand is activated by trypsin. These enzymes are less active in the digestion of native protein than pepsin, but they carry the digestion farther; that is to say, their products are of lower molecular weight than are those of peptic digestion. Both these enzymes, like pepsin, release a certain amount of free amino acids.

The peptones and polypeptides produced by pancreatic digestion are further digested by a group of enzymes known as peptidases, of which there are several. At least one of these, carboxypeptidase, is found in pancreatic juice. Others are found in the mucous membrane and the secretion of the small intestine. The end products of protein digestion are amino acids, all of which are absorbable through the intestinal mucous membrane.

Fats.—Fats are digested by lipases, which occur in gastric, pancreatic and intestinal secretions. The only one of importance in digestion of food fat is pancreatic lipase. These enzymes split neutral fats into glycerol and fatty acids; since each glycerol molecule combines with three fatty acid molecules, products of fat digestion may be monoglycerides, diglycerides or free fatty acids and glycerol. The mono- and diglycerides are probably important in emulsification of fat in the intestine. Pancreatic lipase is active as secreted, but its activity is greatly accelerated by the presence of surface-active agents, the normal activating agent being bile.

It is probable that some fat is absorbed undigested; in order for this to take place the fat must be divided into extremely minute particles, hence emulsification by the action of the bile salts and the mono- and diglycerides is an important step in fat digestion and absorption.

Absorption of Food From the Intestine.—Absorption of the products of digestion occurs almost exclusively in the small intestine. Absorption of food from the stomach is negligible, and absorption from the large intestine is limited largely to water and inorganic salts.

The ability of the small intestine to absorb the various products of digestion depends in part on the enormous surface presented by the mucous membrane; this is many times greater than the outer surface of the intestine because of the superabundance of the mucosa, which forms many circular folds called plicae circulares. A still greater surface is provided by the intestinal villi, which are nipplelike projections of the mucous membrane about one millimetre in length that are present over the entire inner surface of the intestine; macroscopically they resemble the pile on a piece of velvet. Each villus is provided with a little strip of muscle that runs its length and that under appropriate circumstances imparts to it a characteristic movement. In a fasting animal, the villi lie flat on the mucosal surface and are inactive, but when exposed to the intestinal contents during digestion they become erected and either perform a lashing movement or exhibit rhythmical shortening and lengthening. These movements accelerate the flow of blood and lymph and aid mechanically in absorption.

The mechanisms of absorption are complex and include such physical factors as osmosis, filtration and diffusion as well as the active intervention of the epithelial cells involving expenditure of energy. Physical processes account for considerable absorption, especially when a favourable concentration gradient exists, but active intervention of the epithelial cells is indicated by the fact that some substances can be absorbed when their concentration is lower in the intestinal contents than it is in the blood; also by the fact that different sugars are absorbed at different rates, even though their physical properties are similar.

Carbohydrates.—The carbohydrates are absorbed as simple sugars, of which glucose, levulose and galactose are the most important. These sugars on entering the epithelial cells combine with phosphate to form hexosephosphates, which are broken down in the cells, releasing the original sugar molecule into the interstitial fluid. In the process, a certain amount of energy is released; it is believed that it is this energy that accelerates the absorption of these sugars as compared with sugars that are not phosphorylated.

Absorption of sugars takes place chiefly in the upper portion of the small intestine; *i.e.*, the duodenum and upper jejunum.

Proteins.—Of the products of protein digestion, only the amino acids or very simple polypeptides are absorbable. The possibility of occasional absorption of a whole protein molecule, however, cannot be excluded. This fact provides the basis for the development of certain allergies involving food protein. There is evidence that the amino acids are absorbed more readily than would be accounted for by physical diffusion, even though the concentration of amino acids in the blood is usually low.

Fats.—Absorption of fat presents special problems, since even the products of digestion are not completely soluble. Considerable neutral fat appears in the intestinal lymphatics, suggesting that it was absorbed without digestion or that it was resynthesized in transit through the cells; the available evidence indicates that some neutral fat is absorbed as such into the lymphatics, the remainder being digested and absorbed into the portal blood as fatty acids and glycerol.

Before absorption, fatty acids are made soluble by combination with bile salts. Some experimental evidence indicates that fat is absorbed more rapidly from the ileum, of the small intestine, than from the duodenum or jejunum.

Salts, Water and Other Nutrients.—Diffusion and osmosis play a large part in the absorption of water and salt. Water is constantly being transferred in and out of the intestine by osmotic forces, and such water is always accompanied by a certain amount of inorganic salt; however, there is conclusive evidence for the selective absorption of inorganic salts. For example, sodium chloride is absorbed selectively from a mixture of sodium chloride and magnesium sulfate.

Absorption of other nutrients presents special problems. The fat-soluble vitamins are not absorbed when the absorption of fat is interfered with, as in pancreatic insufficiency. Adequate absorption of iron and calcium is dependent upon the presence of hydrochloric acid in the gastric juice. Vitamin B_{12}, which is essential for the formation of red blood cells, is absorbed only when a certain unknown substance called intrinsic factor, which is normally secreted by the mucous membrane of the stomach, is present. Absorption is favourably influenced by the internal secretions of the pituitary, thyroid and sex glands. *See* NUTRITION; ENZYMES; HORMONES, VERTEBRATE; GASTROINTESTINAL TRACT; *see* also references under "Digestion" in the Index volume.

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(J. E. T.; X.)

DIGGERS, the name given to a group of agrarian communists who flourished in England in 1649–50 and were led by Gerrard Winstanley and William Everard. In April 1649 about 20 poor men assembled at St. George's hill, Surrey, and began to cultivate the common land. They held that the Civil War had been fought against the king and the great landowners; now that Charles I had been executed, land should be made available for the very poor to cultivate. (The price of food had reached record heights in the late 1640s.) The numbers of the Diggers more than doubled during 1649. Their activities alarmed the Commonwealth government and roused the hostility of local landowners—rival claimants to the common lands. The Diggers were harassed by legal actions and mob violence, and by the end of March 1650 their colony was dispersed. The Diggers themselves abjured the use of force, but hoped that their example in seizing waste lands for communal cultivation would be followed elsewhere. Winstanley's pamphlets and the dispatch of emissaries from the colony won supporters in Kent, Buckinghamshire, Northamptonshire and Essex. The Diggers also called themselves True Levellers, but their communism was denounced by the leaders of the Levellers (*q.v.*).

See L. H. Berens, *The Digger Movement* (1906).
(J. E. C. H.)

DIGGES, LEONARD (d. 1571?), English mathematician and land surveyor, who experimented with the optical effects of lenses, has been credited with anticipating the invention of the telescope. He studied at University college, Oxford, but did not take a degree.

In the first book of his *A Geometricall Practise, named Pantometria,* a work in three books published by his son Thomas Digges (d. 1595) in 1571 (2nd rev. ed., 1591), is included a discussion of "the marvellous conclusions that may be performed by glasses concave and convex, of circular and parabolical forms." He said he had dealt with "these conclusions . . . at large in a volume . . . [which] opened the miraculous effects of perspective glasses," but such a book was not published.

Leonard Digges began the work entitled *An Arithmeticall Militare Treatise, named Stratioticos: compendiously teaching the Science of Numbers.* The book was completed and reworked to some extent by Thomas, who published it in 1579. A second edition appeared in 1590.

Sir Dudley Digges (1583–1639), the son of Thomas, was a judge, diplomat and member of parliament. Sir Dudley and his father jointly wrote *Foure Paradoxes or Politique Discourses* (1604).

DIGITALIS, in pharmacy, the dried leaf of the common foxglove (*q.v.*), *Digitalis purpurea.* It was first introduced into medicine as a diuretic (stimulant of urine secretion) in dropsy in 1775 by William Withering of Birmingham, Eng., who recognized it as the active ingredient of an old woman's secret formula.

Three cardiac glucosides have been isolated in crystalline form from *Digitalis purpurea:* digitoxin, gitoxin and gitalin. All three have essentially similar pharmacological actions, although they differ in the rate in which they are absorbed and eliminated in the body and also in their solubilities in various solvents. In addition, digitalis also contains a number of saponins (*see* SAPONINS AND SAPOGENINS), which probably modify the effect of the cardiac glucosides without producing cardiac effects themselves.

The beneficial actions of the cardiac glucosides in heart disease include a tonic effect on the heart, with diminution of the volume of the organ and increased cardiac output; a slowing of the pulse; and a slowing of the conduction of nerve impulses throughout the heart. These effects are produced at near toxic doses and are frequently accompanied by gastrointestinal upsets, caused probably by a stimulation of the vomiting centre by reflexes set up by the cardiac effects. The diuretic effect of digitalis is secondary to its improvement of the circulation.

Digitalis is indicated in congestive heart failure from any cause, being most effective in cases of auricular fibrillation. Prolonged use leads to cumulation of the drug in the body because of its slow excretion and destruction. Because of this cumulation and because of the small margin between therapeutic and toxic doses, untoward effects are not uncommon and may consist of mild gastrointestinal upsets and visual disturbances or more alarming cardiac irregularities.
(F. O. K.)

DIGNE, chief town of the *département* of Basses-Alpes, southeastern France, lies on the left bank of the Bléone river, 190 km. (118 mi.) E.S.E. of Grenoble by road. Pop. (1954) 8,098. The Ville Haute stands on a mountain spur, dominated by the present cathedral of St. Jérôme (late 15th century, largely restored). The majestic old cathedral of Notre Dame du Bourg (13th century, part earlier) is disused. The Boulevard Gassendi, the chief artery of the town, separates the Ville Haute from the Ville Basse, other main thoroughfares being the boulevards Victor-Hugo and Gambetta. The hot and cold springs (3 km.) are valued for rheumatism and other illnesses. Digne is on the Nice branch of the Grenoble–Marseilles railway and has good road connections. Tourism is the chief industry. Agriculture includes sheep rearing and the cultivation of lavender and of orchards which have made Digne famous for its preserved fruits and confections, honey and yellow wax. The annual lavender fair is held in September. The Dinia of the Romans, Digne was the capital of the Bodiontii. From the early 6th century at least it has been an episcopal see, in the province of Embrun until 1790 but in Avignon after 1802. It suffered in the religious wars of the 16th–17th centuries.

DIGOEL, a large river of southwest Netherlands New Guinea. Length *c.* 326 mi. It rises in the Star mountains, part of the main east-west mountain system of central New Guinea, and flows southward across an extensive, low and forested plain, in which there are many broad swamps in the rainy season. The river is navigable for small ocean vessels as far as Tanahmerah, the chief settlement, founded in 1927 as an internment camp for political prisoners from the Netherlands Indies.
(D. W. F.)

DIJON, a city of eastern France, capital of the *département* of Côte-d'Or, lies at the foot of the Burgundian plateau where the valley of the Ouche river opens out into the Saône plain, 323 km. (208 mi.) S.E. of Paris by road. Pop. (1956) 106,267.

Despite the development of new districts, where large blocks of flats alternate with houses, the commercial centre is still in the old city. Along the narrow winding streets are wooden 15th-century houses together with bourgeois dwellings of the following century, with sculptured façades, and the magnificent town houses of members of the *parlement* dating from the 17th and 18th centuries. There are many outstanding buildings. The cathedral of St. Bénigne in the west of the old city, originally an abbey church, was rebuilt in the 14th century but preserves an 11th-century crypt. The church of St. Philibert, close by, has a Romanesque nave, an early 16th-century steeple and a doorway of the 16th and 18th centuries. Notre Dame church is famous for the grace of its interior and for the magnificent carvings on the western façade with its triple doorway. The façade of St. Michel's church is 16th and 17th century and it, too, has a finely sculptured doorway. The former Jesuit church (now the city library), the Carmelite church (now Brune's barracks) and the chapel of Ste. Anne are examples of 17th-century religious architecture.

In the centre of the old city stands the splendid group of buildings which was the palace of the dukes of Burgundy and is now the *hôtel de ville.* This former ducal palace was built in the 14th and 15th centuries and extended in the 17th and 18th centuries; two towers, the guardroom and the kitchen survive from the original building. The *hôtel de ville* contains the city archives and the Musée des Beaux-Arts (founded 1785); in a very rich collection are the magnificent tombs of Philip the Bold and John the Fearless, dukes of Burgundy, and also the Master of Flémalle's picture "The Nativity." The two tombs were transferred to the museum from the Chartreuse (Carthusian monastery) of Champmol founded by Philip the Bold so that its chapel might provide a mausoleum for his dynasty. The Chartreuse was destroyed in 1793 and a lunatic asylum built on the site in 1840; the only surviving parts of the original building are the doorway of the chapel and the *puits de Moïse,* a pedestal that once supported a great

calvary, by Claus Sluter. The Palais de Justice, to the south of the ducal palace, contains the "golden" room in which the *parlement* of Burgundy met in the 16th century. The archaeological museum is near the cathedral in the dormitory of the former Benedictine monastery.

The park was laid out in the 17th century at the end of the mile-long Cours du Parc south of the town. On the west the Jardin le l'Arquebuse adjoins the botanic garden.

Dijon university (founded 1722) has faculties of law, science and letters and a school of medicine. From being scattered in the centre of the city, it was, in the late 1950s and early 1960s, gradually being moved to great buildings outside, the new faculty of sciences having been opened in 1957. There are also a higher school of commerce, a school of fine arts and a conservatory of music. The city library and the archives of Côte-d'Or and the former province of Burgundy are particularly important. Several learned societies exist in Dijon, the best known being the Académie des Sciences-Arts et Belles-Lettres, founded in 1740.

Dijon is an important communications centre. The road from Paris to Geneva there crosses that from Nancy to Lyons and the Mediterranean. The station is one of the chief ones on the Paris–Lyons–Marseilles railway and there the line branches to Lausanne and Milan. The Burgundy canal, joining the Saône and Seine, formerly was much used. There is an airfield for tourist traffic.

Dijon possesses a large number of industries, most of them of only secondary importance: metalwork, autocycles (motor-assisted bicycles) and bicycles, electrical and optical material, shoes, tobacco and pharmaceutical products; and there are railway works. Celebrated foods produced in Dijon are gingerbread, mustard and a black currant liqueur called cassis. The city is important as a tourist and market town, an administrative and intellectual centre, and the seat of a bishop (from 1731).

The name of Dijon (Divio, Castrum Divionense) does not appear until the 6th century but the city is much older as the site has always been a great road centre. Many traces of Roman occupation have been discovered and show that the place was then important; it was fortified against the Germanic invasions. The accounts of St. Bénigne's martyrdom have no historical foundation; indeed, the very existence of the saint is doubtful. As soon as the Capetian duchy of Burgundy was founded in the 10th century (*see* CAPET) Dijon became the Burgundian capital, but it was not until the second ducal dynasty, that of Valois (*q.v.*; 1364–1477), that Dijon really took on the character of a provincial capital, which it retained after Burgundy was reunited to the French crown. (*See* BURGUNDY.) The annexation of the then Spanish Franche-Comté (*q.v.*) by France in 1678 extended the distance from Dijon to the French frontier and thus began an especially brilliant epoch in the history of the city. Many fine buildings were put up and by the 18th century it had become one of the chief intellectual centres in France. This prosperity was brought to an end by the Revolution, which suppressed all provincial institutions, and thereafter the city declined. It was occupied by the Austrians in 1814 and 1815. The coming of the railway in 1851 brought Dijon to life once more—the citizens had insisted that the line from Paris to Lyons should make a detour to pass through their city. From that day onward Dijon grew steadily—at the beginning of the 19th century it had 20,000 inhabitants, in 1939 there were 95,000. In the Franco-German War the city was occupied by the Germans on Oct. 30, 1870, but recaptured by Garibaldi a few days later and unsuccessfully attacked from Jan. 21 to 23, 1871. In World War II Dijon was in German hands from June 1940 until Sept. 11, 1944. (P. Gs.)

DIKE (DYKE), a trench dug out of the earth for defensive and other purposes (*cf.* Dutch *dijk*, Ger. *Teich*). Water naturally collects in such trenches, and hence the word is applied to natural and artificial channels filled with water, as appears in the names of many narrow waterways in East Anglia. "Dike" is also used of the bank of earth thrown up out of the ditch, and so of any embankment, dam or causeway, particularly the defensive works in the Netherlands, the Fen district of England and other low-lying districts which are liable to flooding by the sea or rivers. (*See* NETHERLANDS, THE; FENS; RIVER AND RIVER ENGINEERING.) In Scotland any wall, fence or even hedge used as a boundary is called a dike.

In geology the term is applied to wall-like masses of rock (sometimes projecting beyond the surrounding surface) which fill up vertical or highly inclined fissures in the strata. *See* GEOLOGY: *Physical Geology*.

DIKRAN: *see* TIGRANES.

DILAPIDATION, the process of falling into a state of decay or disrepair. In English law, the word is usually used in the plural to mean the disrepair of premises let under a tenancy or occupied by the incumbent of an ecclesiastical benefice.

At common law a tenant is liable for waste (*q.v.*), but in most cases the lease or tenancy agreement expressly provides for liability for repairs. The duty of repairing may be placed wholly on the landlord, wholly on the tenant or partly on each; and sometimes some or all of it is placed on neither. In short tenancies (*e.g.*, for three years or less) and in tenancies of offices and apartments, the landlord is usually made liable for external and structural repairs and the tenant for internal decorative repairs, these conditions being sometimes subject to an exception of fair wear and tear. For longer tenancies, especially of entire buildings, the tenant is usually made liable for most or all of the repairs. But since the Housing act, 1961, the landlord of any dwelling house let for less than seven years is liable, despite any contrary agreement, to repair the structure and exterior and most of the service installations. Subject to this, liability depends on the terms of the lease negotiated.

If a landlord considers that his tenant has failed in his obligations to repair, he usually instructs a surveyor to prepare a "schedule of dilapidations," which itemizes every defect alleged to constitute a breach of covenant, usually by stating the action required to remedy the defect. This schedule is then served on the tenant, accompanied by a notice requiring him to make good the breaches of covenant and to compensate the landlord. After allowing a reasonable time for compliance, and subject to any negotiations as to the propriety of any items, the landlord may proceed against the tenant for outstanding dilapidations. If the lease was granted for not less than seven years and has at least three years still to run, the Leasehold Property (Repairs) act, 1938 (as amended), protects the tenant against unreasonable pressure from the landlord. Within 28 days of the landlord's notice being served on him, the tenant must serve on the landlord a counter-notice claiming the protection of the act. Thereafter, the landlord can neither sue for damages nor proceed to forfeit the lease without the leave of the court; and leave can be given only on certain specified grounds; *e.g.*, that the cost of immediate repair would be small in comparison with the cost of repair in the future. Subject to the act, the landlord can usually sue the tenant for damages or (subject to the power of the court to grant relief) for forfeiture or for both. Damages are limited to the diminution in the value of the landlord's reversion, and no damages are recoverable if at the end of the tenancy the premises are to be demolished or to be altered structurally in such a way as to make repairs valueless. The court may also grant relief against unreasonable claims with respect to internal decorative repairs.

Under ecclesiastical law, the liability of the incumbent of a benefice for keeping in repair the rectory, vicarage or other house of residence, together with certain other property, was modified by the statutory provisions contained in the Ecclesiastical Dilapidations measure, 1923, as amended. This establishes an elaborate system, under the church commissioners, providing for inspection and report every five years by a surveyor appointed by the diocesan dilapidations board. Willful dilapidations have to be made good by the incumbent forthwith, but other dilapidations are paid for out of a repair account maintained by a repair rate charged on the revenues of the benefice; and the church commissioners may lend money for repairs. (R. E. My.)

United States.—In the United States the term dilapidation is not often used, but some statutes provide that the lessor of any building intended for the occupation of human beings must, in the absence of an agreement to the contrary, place the premises in a condition fit for occupation and repair all subsequent dilapi-

dations. Wherever used, the term refers to a state of partial ruin resulting from a failure to make necessary repairs.

See also LANDLORD AND TENANT. (H. H. LR.)

DILATATION, a term used in medicine to denote the widening or enlarging of a cavity, orifice or hollow organ beyond its normal dimensions. Dilatation may arise pathologically from obstructions in hollow organs such as those of the gastrointestinal tract and the urinary and biliary tracts. Fluid accumulates above the obstruction, leading to dilatation. This usually causes an increased muscular activity above the obstruction, which produces a sensation of pain and may ultimately lead to a thickening of the muscular wall. Following the removal of the obstruction the organ may or may not assume its original dimensions, depending on the elasticity of its muscular layers. In dilatation of the ventricles of the brain, expansion of the brain is limited by the rigidity of the skull, hence hydrocephalus (*q.v.*) results. The term is used in connection with heart disease when the muscle is weakened and one or more cavities dilated, thus causing interference with normal circulation. Digital dilatation is employed in diagnosis, and "dilatation" also refers to operative procedures when an orifice or passage is dilated with an instrument. (F. L. A.)

DILEMMA. In traditional logic, a *dilemma* is any one of several forms of inference in which there are two major premisses of hypothetical form and a disjunctive minor premiss; *see* the full list in the article LOGIC.

It is not necessary that a dilemma should have an unwelcome conclusion. But this was often the case in illustrations, the dilemma having been originally a device of rhetoric for confuting an opponent. Hence in common usage the word has come to mean a situation in which each of alternative courses of action that are open leads to some unsatisfactory or ill consequence.

Some traditional logicians have used the term *polylemma* for a generalization of the dilemma in which the minor premiss is a disjunction that is more than twofold and the number of major premisses is correspondingly increased. For example, the constructive trilemma: $A \supset D, B \supset D, C \supset D, A \vee B \vee C$, therefore **D.**

In mathematics, this form of inference is more usually known as *proof by cases.* (Ao. C.)

DILIYIANNIS (DELYANNES), **THEODOROS** (1826–1905), Greek statesman, five times prime minister and for many years the exponent of a resolute anti-Turkish policy, was born at Lankadia, Peloponnese, on Jan. 14 (new style; 2, old style), 1826, and studied law at Athens. In 1862 he became minister for foreign affairs. From Jan. 1867 to Feb. 1868 he was minister in Paris. In the ministry of 1877 he voted for war with Turkey, and on its fall entered the cabinet of Alexandros Koumoundouros as minister for foreign affairs. He was a representative of Greece at the Berlin congress in 1878. From this time forward, and particularly after 1882, when Kharilaos Trikoupis again came into power, the duel between these two statesmen dominated Greek politics. Diliyiannis first formed a cabinet in 1885, but resigned the following year when his warlike policy ended in failure. He returned to power in 1890, with a radical program, but did not tackle the financial crisis. This led to a conflict with the king, who dismissed him in 1892. In 1895, however, he again became prime minister. He was thus at the head of affairs during the Cretan crisis and the opening of war with Turkey. The humiliating defeat which ensued caused his fall in April 1897, though this time the disastrous war policy had been forced on him somewhat against his will. He kept his own seat at the election of 1899, but his following dwindled. He was again prime minister in 1902–03 and finally returned to power in Dec. 1904. On June 13, 1905, he was murdered for his measures against gambling houses.

DILKE, SIR CHARLES WENTWORTH (1843–1911), British statesman whose highly successful political career was tragically broken by involvement in a notorious divorce case, was born in London on Sept. 4, 1843, the son of the 1st baronet of the same name. He was educated privately and at Trinity hall, Cambridge, where he was senior legalist, president of the Union and a notable rower. After leaving Cambridge he made a world tour and recorded his impressions in *Greater Britain* (1868), a highly successful work in which he developed one of the dominant ideas of his life—the view that the English race, freed of the trappings of a monarchical and hierarchic society, would exercise an increasingly powerful role in the world.

Dilke was elected to parliament in 1868 as Radical member for Chelsea. In 1869 his father died and he succeeded to the baronetcy and to substantial family property. Throughout his first parliament Dilke took up an extreme left-wing position, and in the winter of 1871–72 he delivered a series of speeches strongly critical of the monarchy. He was always a theoretical republican, but except for this brief and unsuccessful foray he took no action in this direction. After 1874, with the Liberals in opposition, Dilke moved closer to his official leaders, and he was entrusted with many important speeches on foreign policy. Extensive travel and a good mind for detail had by this time given him an encyclopaedic knowledge of the minutiae of foreign policy. He also established a close partnership with Joseph Chamberlain (*q.v.*). When Gladstone formed his second government in 1880, Dilke and Chamberlain fought hard to secure two cabinet seats, but they had to compromise, and it was Dilke who got the worst of the deal, remaining outside the cabinet as undersecretary for foreign affairs under Lord Granville. After declining an offer to be chief secretary for Ireland outside the cabinet, Dilke was finally promoted to the cabinet as president of the local government board in 1882. He was responsible for the setting up in 1884 of the royal commission on the housing of the working classes, and himself presided over a membership which included the prince of Wales and Cardinal Manning. He failed to promote a government of London bill, but he was highly successful in negotiating with the Tories a redistribution bill which passed into law as an agreed measure in 1885 and which gave the basic shape to the modern electoral map.

Apart from these departmental activities Dilke was eager, with Chamberlain, to press the general Radical point of view within the cabinet. This eagerness led him to submit frequent resignations to Gladstone. It also led him to a position of great political promise. By the end of the government, in June 1885, Disraeli's prophecy of 1879 that Dilke would be prime minister looked plausible. Gladstone could not long continue, and the leadership of the party would probably then go to the Radicals. Although less well known and with smaller powers of political impact and decision than Chamberlain, Dilke would have been more acceptable to the house and to the bulk of the Liberal party.

The issue was never put to the test, for, a month later, Dilke was cited as corespondent in a sensational divorce suit. Virginia Crawford, the 22-year-old wife of a Scottish Liberal lawyer, told her husband that she had been Dilke's mistress since 1882. Dilke strenuously denied the story and when the case was heard, in Feb. 1886, there was adjudged to be no evidence against him, although Crawford got his divorce. A press campaign, in which W. T. Stead of the *Pall Mall Gazette* took the lead, made this an inadequate victory for Dilke. To try to clear his name he got the queen's proctor to reopen the case, and a second hearing took place in July 1886. This went heavily against Dilke. One of his public difficulties was that, although he rebutted Mrs. Crawford's allegations, he was forced to admit to having been her mother's lover.

Dilke never again held office. Six years later, however, he returned to the house of commons as member for the Forest of Dean and held that seat until his death. He was active in the house of commons as a military expert and as an exponent of advanced labour legislation. He did much to encourage trade unionists in politics, and in 1894 it was suggested that he should become leader of the Independent Labour party. Much of his energy, however, was devoted to gathering evidence that might clear his name. He was assisted by his second wife, formerly Mrs. Mark Pattison, who had married him immediately after the scandal broke and who retained complete faith in his innocence. The evidence they accumulated showed decisively that much of Mrs. Crawford's story was a fabrication; whether there was a substratum of truth remains uncertain. Dilke died in London on Jan. 26, 1911.

Apart from *Greater Britain*, Dilke's principal works were: *The Fall of Prince Florestan, a Satire* (1874), *The Present Position of European Politics* (1887), *The British Army* (1888), *Problems of Greater Britain,* 2 vol. (1890), *Imperial Defence* (with S. Wil-

kinson, 1892), *Army Reform* (1898) and *The British Empire* (1899). (R. J.)

See S. Gwynn and G. M. Tuckwell, *Life of Sir Charles Dilke*, 2 vol. (1917); Roy Jenkins, *Sir Charles Dilke, a Victorian Tragedy* (1958).

DILL, SIR JOHN GREER (1881–1944), British field marshal, a leading figure of World War II, was born at Lurgan, N. Ire., on Dec. 25, 1881, and was educated at Cheltenham college. After service in the South African War and World War I he became successively commandant of the British army staff college and director of military operations. Recognized as the foremost British strategist, he would have been the natural choice for chief of the imperial general staff in 1937 or 1939; but when war broke out in the latter year he remained in command of the 1st corps in France until brought home in April 1940 to become chief of the imperial general staff in the following month. As such he was the government's chief military adviser until the end of 1941, and was largely responsible for the decisions to reinforce Egypt with 150 tanks in Aug. 1940, in spite of the shortage at home, and to send the expedition to Greece in March 1941. Perhaps Dill's greatest services were rendered as the prime minister's military representative and head of the British joint staff mission in Washington, D.C. (1941–44). His clear mind, charm and integrity won the admiration and affection of soldiers of both nations, and his friendship with Gen. George C. Marshall did much to cement Anglo-U.S. solidarity. He died at Washington on Nov. 4, 1944, and his monument stands in the national cemetery at Arlington, Va. (J. R. M. B.)

DILL (*Anethum graveolens*), a fennellike annual or biennial herb of the family Umbelliferae, native to the countries bordering the Mediterranean and widely cultivated in Europe, India and North America. The entire plant is aromatic and the leaves, small stems and immature umbels are used for flavouring soups, sauces and particularly pickles. The seed is employed as a condiment and drug. Dill herb oil, distilled from the plant at early fruiting stage, has largely replaced the whole herb in commercial uses as a flavouring and seasoning agent. The United States—Oregon and Idaho—and Hungary are the principal producers of dill herb oil. The whole seeds and the seed oil have carminative properties and have been used in treating flatulent colic. (Q. J.)

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DILL (ANETHUM GRAVEOLENS)

DILLENIUS (DILLEN), **JOHANN JAKOB** (1687–1747), German botanist, author of several descriptive works on plants, was born at Darmstadt in 1687 and educated at the University of Giessen. In 1721 he moved to England. He became professor of botany at Oxford where, on April 2, 1747, he died. His most notable works are *Hortus Elthamensis*, 2 vol. (1732), containing descriptions and 324 plates of illustrations of plants in the Sherard garden at Eltham, and *Historia Muscorum* (1741), describing and illustrating over 600 species of "mosses," including true mosses, liverworts, lycopods, algae, lichens, etc. An account of the life and works of Dillenius is given in *The Dillenian Herbaria* by G. Claridge Druce (1907). (J. W. Tr.)

DILLMANN, (CHRISTIAN FRIEDRICH) AUGUST (1823–1894), German orientalist and biblical scholar, to whom in large part the 19th-century revival of interest in Ethiopic studies is attributable, was born at Illingen on April 25, 1823, and studied at Tübingen. He held chairs of theology at Tübingen (1853), of philosophy at Kiel (1854), and of theology at Giessen (1864) and Berlin (1869). He died on July 4, 1894.

Dillmann was author of an Ethiopic grammar (1857) and lexicon (1865), and he also prepared editions of Ethiopic texts of a number of books of the Old Testament, as well as of some noncanonical books. His commentary on Job (1869) stamped him as one of the foremost Old Testament exegetes. His renown as a theologian was mainly founded on a series of commentaries on other Old Testament books.

DILLON, HAROLD ARTHUR LEE, 17TH VISCOUNT (1844–1932), antiquary and authority on arms and armour, was born in London on Jan. 24, 1844. He entered the Rifle brigade, served in India and Canada, and retired from the army in 1874. Thereafter he devoted himself to antiquarian studies and produced a long and valuable series of papers. The most considerable of these was a study of Calais and the Pale under the English occupation during the Hundred Years' War (*Archaeologia*, 1893). In 1895 he was appointed as the first curator of the armouries of the Tower of London. He reorganized the armouries, swept away false traditions and conducted valuable research among the state papers. In 1904 he published in facsimile the Jacobe album, which had been acquired on his advice by the Victoria and Albert museum, and he was able to connect its drawings with many surviving armours. He served as secretary and later president of the Society of Antiquaries of London, and he was appointed to the boards of trustees of the British museum, the Wallace collection and the National Portrait gallery. He died on Dec. 18, 1932.

See an obituary notice and a bibliography of his writings in the *Proceedings of the British Academy*, vol. xviii, p. 335 (1932). (J. G. Mn.)

DILLON, JOHN (1851–1927), Irish nationalist politician, one of the leaders of the Irish parliamentary party in the struggle for Home Rule, was born near Dublin on Sept. 4, 1851, the son of John Blake Dillon, a leader of the Young Ireland movement. John Dillon was educated at University college, Dublin, and qualified as a surgeon. He became one of C. S. Parnell's most dynamic young colleagues and accompanied him to the United States in 1879; while abroad, he was elected member of parliament for Tipperary (1880).

Dillon was one of the most vehement of the leaders of the Land league, and in 1881 he was imprisoned, his health being seriously impaired by his prison treatment. He had to resign his seat in parliament in 1883, but was in 1885 elected member for East Mayo, which he represented until 1918. He was closely associated with the "plan of campaign" of William O'Brien (*q.v.*) and was several times prosecuted in 1886–87 and was imprisoned for six months in 1888. After his release he went to Australia to raise funds for Parnell. Again arrested on his return in 1890, he escaped with O'Brien to France and thence to the U.S. Both men returned when the crisis of Parnell's involvement in Capt. W. H. O'Shea's divorce case arose in 1890; after inconclusive conferences with Parnell they declared against his continuance as leader. When the Irish party then split, the anti-Parnellite majority formed the Irish National federation, of which Dillon became chairman in 1896. In 1897 he organized a convention of the Irish people from all parts of the world which about 2,000 delegates attended.

After years of confusion and bitter recrimination, the party was reunited in 1900 under the Parnellite, John Redmond. Dillon showed great magnanimity in accepting service under his former rival. Although he was a staunch upholder of Parnell's strategy of independent Irish opposition in parliament, Dillon became increasingly distrustful of conciliatory efforts by the Conservatives. He declined to enter the Land conference promoted by George Wyndham in 1902, and believed that Conservative policy under A. J. Balfour was directed to allay any discontent by constructive reform and "killing Home Rule by kindness." In 1905 Dillon advised Irishmen in Great Britain to vote Liberal and he supported all the reforms of the Liberal governments. On the outbreak of World War I he was tortured by divided loyalties. He had been keenly apprehensive when the Irish Volunteers were organized in 1913, considering them a threat to the discipline and cautious guidance of the official party, and he gave positive, though reluctant, consent to Redmond's appeal for whole-hearted resistance in Ireland to German aggression. But he vehemently opposed the extension of military conscription to Ireland, both because it would strengthen the Sinn Fein agitation, and because he never accepted the view that Irish and imperial interests must coincide. As the party became more deeply committed to the imperial war effort, the relations between Redmond and Dillon grew

increasingly strained. Dillon refused to take part in the Irish convention set up by Lloyd George in 1917 to reach a settlement. On Redmond's death in 1918 he became leader of the party, but it was widely discredited in Ireland, and Sinn Fein won an overwhelming victory in the general election of Dec. 1918, Eamon de Valera defeating Dillon in East Mayo. Dillon died Aug. 4, 1927.

See F. S. L. Lyons, *The Irish Parliamentary Party, 1890–1910* (1951); D. Gwynn, *Life of John Redmond* (1932). (D. G.)

DILTHEY, WILHELM (1833–1911), German philosopher, who devoted himself mainly to literary criticism and to the history of ideas, was born at Biebrich on Nov. 19, 1833. He was successively professor at Basle (1866), at Kiel (1868), at Breslau (1871) and at Berlin (1882; in succession to R. H. Lotze). He died at Seis, near Bolzano, on Oct. 1, 1911.

Dilthey's philosophy is of Kantian inspiration, but deeply influenced by British empiricism and by French positivism. He believes that the central place once held in philosophy by metaphysical speculation must now be given to the theory of knowledge which, however, must learn to give due recognition to the part played in cognition by the will as well as by sensation and thought. Several fundamental concepts (*e.g.*, reality, causality) can only be defined by reference to volitional experience. We must also distinguish between cognitive statements, which refer to existing things, and value judgments and imperatives, which express attitudes of feeling or will. Metaphysics, while it cannot claim to be knowledge of reality, has importance as expressing a total attitude to life (*Weltanschauung*), a function which it shares with religion and art; and the great metaphysical systems may still be profitably studied from this point of view. Dilthey holds that there are three main types of *Weltanschauung* (naturalism, the idealism of freedom and objective idealism) which constantly recur in religion, art and philosophy alike and represent three fundamentally different ways of reading experience.

His greatest philosophical project, which occupied him throughout his career, was to write a "Critique of Historical Reason" which might do for the historical and social studies (*Geisteswissenschaften*) something like what Kant had done for the natural sciences. In the course of this work he broke new philosophical ground by his study of the relations between lived experience, expression and understanding (*Erlebnis*, *Ausdruck* and *Verstehen*); the interdependence of self-knowledge and knowledge of other persons; and the logical development from these to the understanding of social groups and historical processes. The subject matter of the historical and social studies is the human mind, not as it is enjoyed in immediate experience nor as it is analyzed in psychological theory, but as it manifests or "objectifies" itself in languages and literatures, actions and institutions. Dilthey holds that the historical consciousness, the consciousness of the historical relativity of all ideas, attitudes and institutions, is the most characteristic and the most challenging fact in the intellectual life of our time. It shakes all belief in absolute principles, but it thereby sets us free to understand and appreciate all the diverse possibilities of human experience.

Dilthey's chief publications were: *Leben Schleiermachers* (1870); *Einleitung in die Geisteswissenschaften* (1883); *Die Jugendgeschichte Hegels* (1905); *Das Erlebnis und die Dichtung* (1905); *Das Wesen der Philosophie* (1907); and *Der Aufbau der geschichtlichen Welt in den Geisteswissenschaften* (1910). Much other valuable material, both philosophical and historical, previously unpublished or published piecemeal, was brought together posthumously in his *Gesammelte Schriften*, 12 vol. (1913–36).

See H. A. Hodges, *The Philosophy of Wilhelm Dilthey* (1952). (Hr. A. H.)

DIMENSION, a term used in geometry to denote a magnitude measured in a specified direction, as, for instance, along a diameter or a principal axis or an edge. A point is said to be without dimension; a line has the one dimension of length, a surface has the two dimensions of length and breadth, while a solid has the three dimensions of length, breadth and thickness. Since the lengths of lines, the areas of surfaces and the volumes of solids are represented respectively by linear, quadratic and cubic algebraic expressions, the term dimension has been carried over into algebra. Thus quadratic, cubic, biquadratic algebraic expressions (*e.g.*, x^2, x^3, x^4) or equations are said to be respectively of two, three, four dimensions (or degree or order). Similarly, the term dimension is used in mechanics with reference to the units of time, length and mass and various derived units (*see* DIMENSIONAL ANALYSIS), and it occurs in many other parts of physics, notably in the theory of electricity and magnetism (*see* PHYSICAL UNITS).

The fundamental descriptive proposition concerning space, as we are accustomed to it in experience, is that space is a continuum (a continuous or unbroken distribution of points) having three dimensions. The intuitive basis of this proposition may be elucidated as follows. If on a curve (or line) we mark certain points (elements without dimension), we separate the curve into parts bounded by the points in such a way that we cannot pass along the curve from one part to another without encountering and passing over one of these marked points. Since the curve may be separated into parts by elements without dimensions, it is itself said to be a figure having one dimension. But a surface cannot be thus separated into parts by marking isolated points on it; for, in going from one place to another on the surface, we can always avoid passing over these marked points by going around them. If we draw in the surface a suitable closed curve (a figure of one dimension), then the surface is separated into parts in such a way that we cannot move over the surface from one part to another without encountering and passing over a point on the curve. Since a surface cannot be separated into parts by points (figures without dimension) but can be separated into parts by a suitable figure of one dimension, we say that a surface itself has two dimensions. Similarly space cannot be separated into parts by isolated points or curves or both taken together, while it can be so separated into parts by means of a closed surface (a figure of two dimensions). For this reason we say that space has three dimensions. This, according to Henri Poincaré, is the fundamental qualitative ground for ascribing three dimensions to the usual space of experience.

The mathematician introduces three co-ordinates to represent the points of ordinary space and much of his analysis of its properties is carried out algebraically. Now the algebraic analysis is competent to deal with sets of any number n of co-ordinates. Thus algebraic geometry leads readily to the conception of spaces of any number n of dimensions; and these have been extensively treated, though no one has a lively mental picture of spaces having more than three dimensions. Popular interest in these higher spaces (as opposed to the interest of mathematicians in them) has been centred principally around the concept of the "fourth dimension," the designation often given to time in Einstein's theory of relativity. But the number of dimensions of these higher spaces is unlimited; and, in fact, several kinds of space with an infinite number of dimensions have been investigated.

That the higher spaces may be given a concrete representation in terms of experience is shown by the fact that the totality of straight lines in our usual space of three dimensions constitutes a veritable space of four dimensions (*see* PROJECTIVE GEOMETRY). This arises from the fact that four independent co-ordinates are necessary to define completely the position in space of a line of unlimited extent. Therefore a geometry in which the elements are the lines of ordinary space is a geometry of four dimensions. (R. D. Ca.)

DIMENSIONAL ANALYSIS. The principal use of dimensional analysis is to deduce from a study of the dimensions of the variables in any physical system certain necessary limitations on the form of any possible relationship between those variables. The method is of great generality and mathematical simplicity. The name dimensional analysis is comparatively new; Lord Rayleigh, one of the earliest and principal exponents of the method, called it the principle of similitude.

This method is not capable of completely determining the unknown functional relationship. In the simplest cases it can give everything except a numerical factor of proportionality; for example, it can show that the time of swing of a simple pendulum is independent of its mass and proportional to the square root of its length, but cannot determine the constant of proportionality.

In more complicated cases, where there are a larger number of variables, it can show that the variables must enter the function in certain definite combinations, thus reducing the number of the undetermined functional relations. Perhaps its most important use is in connection with problems so complicated that not only may an exact solution by purely mathematical methods be impossible, but also it may be impossible even to give a precise and detailed formulation of the fundamental equations from which the solution is to be found. Many problems of airplane or ship design are of this nature. In these cases a knowledge of the necessary limitations on any possible functional relationship makes it possible to cover completely the range of all possible experimental relationships with a much smaller number of experiments than would be necessary otherwise. In this capacity it now receives the widest application in engineering. Other uses of dimensional analysis are: as a simple check against error in writing out equations or their solutions; in changing units from one system to another; and in theoretical investigations in making preliminary orienting surveys to explore promising lines of attack.

The methods of dimensional analysis depend to an important extent on the properties of the systems of measurement in ordinary scientific use and presuppose the use of such systems. These systems are subject to certain definite limitations. It is a matter of extensive past experience that all the physical systems ordinarily encountered can be completely described in terms of measurements of the restricted and conventional scientific sort. It is this past experience, the mere existence of which is not always obvious to an uncritical glance, that is capitalized on in obtaining the results of dimensional analysis. For, since the system of measurement is subject to limitations and has definite properties, the fact that it can be applied to such a wide variety of situations implies the possession of certain properties by those situations; it is these properties which are brought explicitly to light by dimensional analysis. In respect to this degree of dependence on past experience dimensional analysis differs from no other scientific enterprise; for it is never possible to obtain factual information about any concrete physical situation by pure ratiocination, but any factual information which emerges in the final mathematical formula had to be explicitly inserted into the mathematics at an earlier stage.

Since it is basic to everything that follows, we begin our detailed argument with an examination of such properties of the systems of scientific measurement as are necessary for our purpose. Many different systems of measurement are in general possible, the desirability of any particular system depending on the purpose in hand and on the physical system to which the measurement is applied.

The primary purpose of a system of measurement may be taken to be precise description. In practice one method of securing precision has proved to be so overwhelmingly superior to any other that it alone survives in serious scientific usage; this is by the specification of numbers. Measurement, then, in a very broad sense means description by the assigning of numbers. Given a concrete physical system, it is possible to assign various numbers to it by performing various sorts of physical operation upon it. The number obtained by any particular kind of physical operation constitutes a particular kind of measurement. Different aspects of the system are dealt with by employing different sorts of measuring operation. If one were dealing with only a single isolated physical system a high degree of arbitrariness would be permissible in the measuring operations by which the system is described. In practice, however, a large part of this arbitrariness disappears because of the fact that we desire to deal with large numbers of physical systems. This leads to the requirement not only that the physical operations back of the measurements be easily applicable to the widest variety of systems, but also that they be such that it is possible to express in relatively simple mathematical terms correlations between the results of measurements on different systems. The discovery of measuring operations which satisfy these requirements came only after hundreds of years of experience and experimenting, and demanded a wide acquaintance with the factual content of our environment.

The requirements of convenient application to many systems and of adaptability to mathematical correlation are not sufficient, however, to determine uniquely the measuring operations; a great deal of flexibility remains. As a matter of fact, a wide variety of systems and methods of measurement are in scientific use today.

We now consider in some detail the properties of the systems of measurement in actual physical use, starting from the general point of view that a physical measurement is a number obtained by a particular kind of physical operation. The sort of measurement that it is, is determined by the sort of operation that it is.

Length, Weight and Time.—Consider, for example, length. We may define this as the number obtained by the operation of applying a metre stick to successive positions on a body, counting the number of applications, and reading the fractional part from the divisions inscribed on the metre stick. This procedure is applicable to a wide variety of physical systems. From the point of view of maximum precision, once having defined length by this single definite procedure, the name length should be applied only to numbers obtained by this one procedure. In practice, however, there prove to be whole families of operations giving numbers which are either undistinguishable from the numbers given by the defining operation or else are related to them by a constant of proportionality; so that in practice the term length is given the extended meaning of a number obtained by any one of the family of operations.

The family of operations which is at present accepted as defining length may be divided into various subfamilies. Some of these subfamilies involve drastic physical changes in the measuring operations: such, for example, as measuring lengths by optical methods of triangulation, or by counting interference fringes. It is particularly necessary to subject the equivalence of widely different types of operation to fresh experimental check whenever the field of application is extended. Other subfamilies of operations, however, may be specified with very slight verbal changes. By far the most important of these involve the use of some fundamental measuring stick other than the one of the fundamental definition. For example, instead of specifying the metre stick as basic to the operations of measuring length, we may substitute a foot rule, keeping all the other verbal instructions the same. Strictly, it requires experimental confirmation to show that the verbally specified operations are still physically performable when foot rule is substituted in the specifications for metre stick. The recognition that the operations are performable with either is so deeply ingrained in all our experience that we usually do not realize, unless we stop to think about it, that we are saying something about the structure of the world when we say that a length may be measured either with a metre stick or with a foot rule. Dimensional analysis involves some of the consequences of the world being constructed in this way.

We designate the results of operating according to the specifications for measuring length as length in metres or length in feet. An inspection of what we do now shows that there is a simple invariant relation between the two sorts of length. The metre stick itself is an object whose length in feet can be determined, and similarly the length of the foot rule may be measured in metres. We express this by saying so many feet make a metre or a certain fraction of a metre makes a foot. Due consideration of this, together with an examination of the details of any concrete measuring operation, shows that the ratio of the length of any concrete object in metres to its length in feet is a constant, independent of the object, and equal to the number of metres in a foot or the length of the foot in metres. A generalization of this consideration evidently applies to measurement of length with any other primary standard of length, parasang, verst or what not. An immediate mathematical consequence of this application is that the ratio of the lengths, that is, the ratio of the length numbers, of any two concrete objects, both measured with the same primary standards, is the same, independent of what primary standard is used. We may express this by saying that relative length has absolute significance. This is only a special case of a general requirement exacted of any method of making any sort of physical measurement which is to be accept-

able for scientific use, namely: the requirement of the absolute significance of relative magnitude.

The possibility of maintaining the requirement of the absolute significance of relative magnitude has to be determined by fresh examination of the details of the measuring process for each new kind of measurement with which we are concerned. For instance, the measurement of weight is obviously an entirely different sort of measurement from the measurement of length. The operations for weighing may be specified in terms of an equal arm balance. It is not the place here to expand the details of the weighing process. It is evident, however, that certain of the same general results hold for measuring weights as for measuring lengths. We may measure weights in terms of different standards of weight. The weights of the same object in terms of different standards bear a fixed ratio depending on the relative magnitude of the standards, and the ratio of the weights of two different concrete objects is independent of the standard of weight. The requirement of the absolute significance of relative weight is satisfied. Detailed examination shows that the fact that it is satisfied involves the physical law of the conservation of weight—the total weight of all the little weights into which we cut up a standard in order to make a new standard is the same as before it was cut up. There is no immediate, obvious connection between the physical property of conservation of weight and the geometrical properties of lengths placed end to end. We could not have predicted the possibility of the absolute significance of relative weight from the known absolute significance of relative length; but a fresh appeal to experiment is necessary.

Equally fundamental with length and weight is the measurement of time. The physical operations are again basically different: time does not recur; we pass over it only once. We cannot ask whether two intervals of time are equal by placing one interval in juxtaposition with another and comparing them, as we do two lengths or two weights. The operations are different; they are performed with clocks, according to rules which we shall not attempt to formulate in detail. However, the same results that we have found previously carry over to the new situation. In particular, we can specify operations by which the same interval may be measured in terms of different standard intervals. The ratio of the time numbers obtained for any specified time interval by operating with different standard intervals is always the same and depends only on the standards. Furthermore, the relative value of any two different concrete intervals is independent of the interval adopted as fundamental, or in other words, the requirement of absolute significance of relative magnitude is still met. A proof of this can be given by observation of the details of the measuring process with clocks, and involves the properties of the angles swept over by the hands of the clock. There is no immediate connection with the physical situation involved in the absolute significance of relative length or of relative weight.

The measurements of length, weight (or mass) and time are similar in that the operations make direct reference by one physical process or another to standards of length, mass or time. This involves the existence of different physical operations for mass, length and time analogous to the mathematical operation of addition for numbers. Furthermore, other properties of these physical operations are involved; for the resulting mass numbers, or length numbers, or time numbers are combinable according to the commutative or associative rules for mathematical addition. These requirements are obviously definitely restrictive; not every sort of simple physical operation satisfies them, for example, successive rotations through a finite angle about different axes. It required long experience to find such operations. There are still other sorts of physical operations which may be made the basis of other sorts of physical measurement which have similar properties. For example, forces may be measured by direct comparison with a standard force given by a definite deflection on a spring balance, and the physical operation for the addition of forces exists and consists in simply applying two spring balances in parallel to produce twice the force.

Secondary Measurements.—When we make a measurement in this way by direct reference to some concrete standard by means of a physical addition law, we may be said to be making a primary measurement. Most physical measurements are, however, more complicated, and are compounded of simple primary measurements. Such may be called secondary measurements. A simple example is velocity, which is ordinarily defined as the quotient of distance by time, or more exactly the quotient of a distance number by a time number. To measure the velocity of any concrete moving object, we measure the time required by it to traverse a known measured distance, and divide the distance by the time. The distinction between primary and secondary measurement is not absolute; in some cases either method may be used. An example is force. We have indicated above how to measure force as a primary quantity by reference to a spring balance. If we wish to define it as a secondary quantity we may utilize Isaac Newton's first law of motion, defining force as equal to mass times acceleration. In this case we obtain the force on any body by measuring the mass of the body and its acceleration, which in turn is obtained by measuring the change of velocity in a known time interval, the velocities themselves being obtained from measurements of distance and time. That is, when force is defined as a secondary quantity it is measured by making certain primary measurements (mass, length and time), which are then combined by mathematical rules. Other instances may be given of the possibility of either a primary or a secondary definition. Thus, velocity may be measured as a primary quantity by methods which have been described in detail. Or density, which ordinarily is treated as a secondary quantity and defined as mass divided by volume, may be treated as a primary quantity. In this latter case the difficulties of the necessary physical manipulations would obviously be prohibitively great except when dealing with gases at comparatively low pressures. Whether a given quantity is to be treated as primary or secondary is to a certain extent a matter of convenience, depending on the particular situation. In certain problems, for example, force is best treated as secondary, while in others more information is obtained by treating it as primary.

A certain aspect of the measurement of secondary quantities which is significant for our purposes is singled out and specified by giving the dimensional formulas of these quantities. Since the numerical magnitude of any primary quantity changes when the size of the corresponding primary standard is altered, the numerical magnitude of secondary quantities also changes when the size of the primary standards is changed. It is with this aspect that we are chiefly concerned in setting up dimensional formulas. Thus, the dimensional formula of velocity, defined as above, is LT^{-1}, or $[V]=[LT^{-1}]$, where the square brackets denote "dimensions of," and the equation stands for the verbal expression: the dimensions of velocity are the dimensions of length divided by time. This is merely a shorthand statement for: the number which, in the given system of measurement, measures the velocity of any concrete object, is obtained by multiplying the number which measures some distance associated with the object by the reciprocal of another number which measures some time associated with the object. In future applications the square brackets will usually be omitted as unnecessary. In the formula, T^{-1} indicates the reciprocal of a number obtained by the process for measuring T; the exponent -1 is to be associated with the number, not with the T; that is, the existence of another physical operation, the analogue of the mathematical operation of taking the reciprocal, is not involved or implied by this notation. The dimensional formula is obviously only a partial statement: it does not, for example, contain the detailed specifications for associating the measurements of length and time. The dimensional formulas apply to the primary quantities as well as secondary quantities. For instance, we denote the dimensions of length by L. The significance of this is that the number which measures a length is obtained by a definite physical procedure and the L recalls this procedure. Whenever L occurs in a dimensional formula, the connotation is that a number was obtained by the procedure specified for measuring length. By recalling this pro-

cedure we are in a position to find how the numerical magnitude changes when the size of the standard changes.

Dimensional Formulas.—Let us examine other examples of dimensional formulas. What is the dimensional formula for acceleration? By what procedure do we obtain the number which measures acceleration? This is given by definition: acceleration is change of velocity in a given time so that the first result would be, $[\text{Acceleration}] = [(V_1 - V_2)T^{-1}]$, where V_1 and V_2 apply to the final and initial velocities. In use this expanded dimensional formula is at once contracted; the first contraction is to write $[\text{Acc}] = [VT^{-1}]$. That is, our purpose does not demand that we continually remind ourselves that a certain number was obtained by taking the difference of two velocities; but it is sufficient to remember only that the procedure for obtaining velocity entered our operations. This contraction obviously implies a very important restriction, which indeed is contained in the definition; we must measure the initial and final velocity in the same system of units. The reason that the contraction of the dimensional formula is permissible is that under the conditions the difference of two concrete velocities changes by the same factor as do each of the velocities separately when the fundamental units are changed. The dimensional formula for acceleration may now be contracted further by writing $[\text{Acc}] = [LT^{-1}T^{-1}]$. Here we have expressed the fact that the number measuring a velocity is obtained by dividing a length number by a time number. A further contraction at once suggests itself: to combine the two T^{-1}'s into a single term, writing $[\text{Acc}] = [LT^{-2}]$. But this contraction obviously involves another implication that the unit of time used in measuring velocity is the same as the unit of time used in measuring change of velocity. If this is not the case, we have left out a factor which determines how the number changes when we change the fundamental units. In practice, hybrid units are not uncommon. The performance of the brakes of an automobile might be described by saying that the car is brought to rest from a velocity of 30 m.p.h. in five seconds. Acceleration measured in this way is not covered by the dimensional formula above.

In all our analysis it is expressly supposed that all measurements of secondary quantities are such that the same primary units are consistently used at all stages of the measuring process. Under these restrictions we are justified in contracting $T^{-1}T^{-1}$ to T^{-2} because the number obtained by multiplying the reciprocal of a number obtained by measuring a concrete time interval by the reciprocal of another number measuring another concrete time interval, changes by the same factor as the inverse second power of the number measuring any other concrete time interval when the fundamental unit of time is changed. It appears, in general, that addition or subtraction of simple dimensional symbols is without significance for our purpose and may be ignored (as in the formulas for acceleration), and products may be combined by the simple algebraic rules for exponents.

The dimensional formulas of the simple secondary quantities, velocity and acceleration, examined thus far are of the same simple type; that is, products of powers of the primary quantities. This is true of a number of other such quantities, now given for illustration. The dimensions of force, defined as mass times acceleration, are MLT^{-2}; the dimensions of momentum, defined as mass times velocity, are MLT^{-1}; the dimensions of work or energy, defined as the product of force and distance (parallel to the force), are ML^2T^{-2}; the dimensions of moment of force, defined as product of force and distance (perpendicular to force), are also ML^2T^{-2}; and the dimensions of viscosity, defined as force per unit area per unit velocity gradient, are $ML^{-1}T^{-1}$. All these secondary quantities are seen by inspection to have the same important property which, as we have seen, is enjoyed by the primary quantities—that is, the property of absolute significance of relative magnitude. This property follows at once from the construction of the dimensional formulas as products of powers.

The Property of Absolute Significance of Relative Magnitude.—It is easy to give a formal proof that any quantity whose dimensional formula is composed of products of powers has the property of absolute significance of relative magnitude. It will be sufficient to consider systems in which the fundamental quantities are taken as mass, length and time—the extension to other systems involving only trivial modifications.

Consider any secondary quantity of the specified type, the dimensional formula of which may be written as $M^\alpha L^\beta T^\gamma$. Consider two concrete examples measured in a certain system of concrete units, and denote by $M_1^\alpha L_1^\beta T_1^\gamma$ and $M_2^\alpha L_2^\beta T_2^\gamma$, the numbers obtained by combining the component measures of mass, length and time in the way specified by the definition of the secondary quantity. Then the ratio of the two magnitudes is $M_1^\alpha L_1^\beta T_1^\gamma / M_2^\alpha L_2^\beta T_2^\gamma$. Now consider a second system of measurement in which the unit of mass is smaller in the ratio μ than in the first system; the unit of length is smaller in the ratio λ; and the unit of time is smaller in the ratio τ. Then the number which measures any concrete mass will be larger by the factor μ in the second system than in the first, and similarly for the numbers which measure length and time. Hence, the numerical magnitude of the secondary quantity for the first concrete example will now be $(\mu M_1)^\alpha (\lambda L_1)^\beta (\tau T_1)^\gamma$, and for the second concrete example $(\mu M_2)^\alpha (\lambda L_2)^\beta (\tau T_2)^\gamma$. On taking the ratio of these, the μ, λ, and τ cancel, leaving the same result as at first. That is, the ratio of the numerical measures of any two concrete examples is independent of the size of the fundamental units for secondary quantities constructed on the scheme of products of powers of the primary quantities; this is what is meant by absolute significance of relative magnitude. The converse is also true; the dimensional formula of any quantity which satisfies the principle of the absolute significance of relative magnitude is constructed of products of powers of the primary quantities (the proof will not be given here).

The property of absolute significance of relative magnitude has proved to be of such very great convenience in application that no secondary quantities are in present scientific use which do not satisfy this principle, and whose dimensional formulas therefore are not products of powers. *It is an express presupposition of all the following discussion that the dimensional formulas of all quantities have the form of products of powers.* The formulas of primary quantities already have this form identically.

The Formula as Definition.—The dimensional formula may serve as a signpost suggesting the underlying definition. There is obviously no rigorous and exact correspondence between the dimensional formula and the definition, as shown by the example above in which energy and moment of force have the same dimensions. However, in a great many practical cases the dimensional formula permits a decision between conceivable alternatives and is therefore useful as a mnemonic device. In fact it is not uncommon for the system of measurement to be specified by listing the dimensional formulas of various quantities. This method is much used with reference to the various systems of electrical units. Such a listing of dimensional formulas is often entirely adequate; but obviously it presupposes an initial specification more formal and more precise.

Assume that we have developed a system of physical measurement, with measuring procedures and fundamental units specified, secondary quantities defined and all dimensional formulas written out. We address ourselves to apply this system of measurement to some physical system or set of systems. Our problem is to find relationships between various measureable quantities. We proceed at first on a purely empirical basis, by plotting certain quantities or combinations of quantities against others to find whether the points lie on curves or surfaces. The existence of such curves or surfaces means a relationship; having found such, we then try to find a mathematical equation which shall reproduce the curve or surface within experimental error. Having found this we believe that we have acquired the power to predict the results of any new experiment or measurement on the system, because if we substitute into the equation (or plot on the graph) an independent variable as yet not realized experimentally, the corresponding dependent variable as determined by the equation or the graph will correspond to what we will find when we make the experiment. Of course there is no

logical necessity in this. The assumption is made in virtue of our past experience that interpolation is usually smooth.

Consider a very simple example. We use for our fundamental primary units the pound, the foot and the second, and make application to all systems of weights falling freely from rest under the action of gravity near the surface of the earth. We collect data for the widest range of conditions and find that all our observations satisfy certain equations, namely:

Distance of free fall = 16 × (square of time of fall)
Velocity of fall = 32 × (time of fall).

These equations are a complete and adequate description in the sense that given the time or distance or velocity we can predict what the other two quantities will be for any new experiment in the future or recall what they were at any time in the past. But this may not satisfy us; we notice that there has been an element of arbitrariness in our procedure in that we chose the pound, foot and second as fundamental units. We might have chosen the gram, centimetre and minute as fundamental. If we had, would we have to make our physical measurements all over again? We suspect that we would not, and that there must be some relation between measurements in the two systems, because each system is constructed on the same pattern, and the principle of absolute significance of relative magnitude holds for measurements in the two systems. In fact, substitution of the concrete values for two examples shows that for any other such system satisfying the principle of absolute significance of relative magnitude we must have:

Distance of free fall is proportional to square of time of fall.
Velocity of free fall is proportional to time of fall.

The factors of proportionality obviously depend on the system of measurement. We now have the answer to our question: given a relationship between quantities in any scientific system of measurement, we can at once find corresponding relationships in any other system for which the principle of absolute significance of relative magnitude holds. The change from one system to the other is to be made by changing certain factors of proportionality. Precisely how shall we change the factor of proportionality? We have seen how to change the numerical value of a physical quantity given its dimensional formula. Can we perhaps assign dimensional formulas to our factors of proportionality in our present problem? Inspection shows at once that if we assign to the factor in the first equation the dimensions of LT^{-2} and to the factor in the second equation the dimensions of VT^{-1} our problem is solved, because through the compensatory action of the factor of proportionality the numbers which we substitute into the equation when we measure in pounds, feet and seconds combine so as to give identically the same final result as when we measure in grams, centimetres and minutes.

The Dimensional Constant.—We see then that we may pass back and forth between equations for different systems of measurement, provided the systems satisfy the principle of absolute significance of relative magnitude, by the device of assigning suitable dimensions to various factors of proportionality. A factor of proportionality which varies when the units change according to a scheme which can be specified by giving to it a dimensional formula is called a dimensional constant.

The equations for the falling body, written with the appropriate dimensional constants, obviously hold for any system of units in which mass, length and time are taken as fundamental. An equation of this sort, which holds without formal change when the size of the fundamental units changes, is called a complete equation. In the problem of the falling body there are two dimensional constants, one for the first and one for the second equation. We notice, however, that the dimensions of the second constant, VT^{-1} reduce to those of the first constant, when we substitute for V its dimensions LT^{-1}. That is, in this problem we have essentially only one dimensional constant, instead of the two which are given formally by the two equations. What is the significance of this?

The problem of the falling body is a problem over which we have adequate theoretical mastery; it is a problem in mechanics, and the motion of the body can be obtained by an integration of the equations of motion. We should, therefore, be able to obtain the relations between distance and velocity and time of fall by purely mathematical operations performed on the fundamental equations of motion. An inspection of the nature of any purely mathematical process, such as is involved in solving the equations of motion, shows that if the initial equation is complete the final equation resulting from the mathematical manipulation is also complete. Furthermore, no new dimensional constants can be introduced by any mathematical manipulation. Any dimensional constants in the final result must have been present in the original equations from which the final result was deduced. The equation of motion for a falling body is:

Acceleration of falling body = constant.

The constant acceleration is usually denoted by g, and it is obviously a dimensional constant because its numerical magnitude changes with the size of the fundamental units. In other words, the fundamental equation of motion contains only one dimensional constant, and any relationships implicit in the equation and deducible by mathematical manipulations can contain only the same constant. Of necessity the dimensional constant in the two empirical equations first written must be the same. In fact, the explicit relations are:

$$s = \tfrac{1}{2}gt^2, \text{ and } v = gt$$

It is obvious that any empirical equation whatsoever expressing a relation between various physical parameters can be written as a complete equation by the device of introducing dimensional constants as factors multiplying each parameter, the numerical values of the constants being so adjusted as to be unity in the original system of units. This device demands as many constants as parameters. However, if the relationship can be deduced theoretically, that is by mathematical manipulation of fundamental equations, which by construction are always complete equations, then the relationship will be complete and will involve only those dimensional constants which enter the fundamental equations. The number of such constants, in general, will be smaller than the number of physical parameters, so that an advantage has been gained as compared with the purely empirical method of treatment.

Scientific achievement has now reached such a state of progress that the nature of the fundamental governing equations is known for practically all situations of ordinary occurrence, so that in these situations we know that there are relationships which can be expressed in the form of complete equations between the physical parameters of the system and certain specifiable dimensional constants, that is, the constants which appear in the fundamental equations.

The Pi Theorem and Dimensional Homogeneity.—Any mathematical relationship between parameters x_1, x_2, x_3, etc., can be written by a rearrangement in the form of an equation $f(x_1, x_2, x_3, \cdots) = 0$. If the physical system to which this equation applies is one of the very large number in which the nature of the fundamental governing equations is understood, then this equation can be so rearranged as to appear to be a complete equation, because it might have been deduced by mathematical manipulation. There are important restrictions on the mathematical form of any complete equation. Dimensional analysis is essentially a study of the restrictions on the form imposed by the requirement of completeness. There is a fundamental theorem here, the so-called pi theorem, apparently first explicitly enunciated by E. Buckingham, although used implicitly ever since the time of Baron Jean Baptiste Fourier, who was the first to apply dimensional considerations. All the parameters which enter into the functional relationship are given. These will include both physical parameters and dimensional constants, and both physical parameters and dimensional constants are similar in that they have dimensional formulas expressible as products of powers of the fundamental units.

The pi theorem states that, subject to an important restriction, the functional relationship must be expressible in such a form that it contains as arguments only such products of powers of the physical parameters and dimensional constants as have zero dimensions in all the fundamental quantities. The restric-

tion is that there be not more than one independent functional relationship between the quantities. The pi theorem may be rephrased to express the principle of dimensional homogeneity, which is often taken as the fundamental theorem of dimensional analysis. Let us express the function which satisfies the pi theorem, as

$$F(\pi_1, \pi_2, \cdot \quad) = 0$$

where the π's are the dimensionless products formed from all the parameters. We may solve the equation for one of the arguments, say π_1, and express π_1 in terms of the component parameters, say as $p_1^\alpha p_2^\beta p_3^\gamma \ldots$, and then solve for the first, writing the equation as

$$p_1^\alpha = p_2^{-\beta} p_3^{-\gamma} \cdots f(\pi_2, \pi_3, \cdots)$$

The function f, having only dimensionless arguments, contributes only dimensionless terms. By construction of π_1, the dimensions of p_1^α (which stands on the left-hand side of the equation) are the same as the dimensions of $p_2^{-\beta} p_3^{-\gamma} \cdots$ which multiplies the f on the right, all the terms of which are dimensionless. Hence, every term on the right-hand side has the same dimensions as the single term on the left; or, in other words, the equation expressing the relationship is dimensionally homogeneous.

Attempts have often been made to prove the principle of dimensional homogeneity by vague intuitive arguments. The following is an example: "Every equation which expresses an 'essential' physical relation must be independent of the size of the fundamental units, and in such an equation every term must have the same dimensions because it is meaningless to add together terms with different physical dimensions, as for example a length and a time." That such an argument is not valid in general can be seen by considering such equations, for example, as the equation for a falling body $(v - gt) + (s - \frac{1}{2}gt^2)^3 = 0$. This is a true equation, since it is always satisfied whenever the simultaneous values of v, s and t for any falling body are substituted into it; furthermore, it is a complete equation, because it holds without change no matter what the size of the units of length and time. It is, however, obviously not dimensionally homogeneous.

The restriction that there is only one functional relationship is essential to the pi theorem and to the principle of dimensional homogeneity. The equation just given obviously falls apart into two equations: $v = gt$ and $s = \frac{1}{2}gt^2$. In practice the requirement of only one functional relationship is no essential restriction because we are always interested in reducing the relationships until only one remains. If there should be two relationships, one of the arguments may be eliminated between the two, leaving a single relation between a smaller number of arguments.

The functional relation as it first comes from the pen of the mathematical analyst may not obviously satisfy the pi theorem, but some rearrangement may be necessary. The pi theorem states that such rearrangement is always possible. This has particular application to the so-called logarithmic constants which often present themselves in thermodynamic analysis.

The pi theorem places no restrictions whatever on the form of the functional relationship; the restriction is only on the arguments. The importance of the restriction consists in the fact that the number of possible independent dimensionless arguments is in general less than the full number of physical parameters. The number of experiments necessary to find the form of an unknown function is obviously less if we are dealing, for example, with a function of only one argument instead of with one of three.

Consider a system of measurement in which there are m kinds of fundamental units whose magnitude may be changed and in terms of which any equation of relationship must be a complete equation. Suppose this system of measurement is being applied to a physical system in which there are n parameters, including all dimensional constants. Then in general, unless there is some special relationship, the n parameters can be combined into only $n - m$ independent dimensionless products, and any possible functional connection is a function of only $n - m$ arguments instead of the full n. If there are special relationships between the exponents in the dimensional formulas of the parameters, the number of independent dimensionless arguments may be either greater or smaller than $n - m$. It is possible to include these special exceptional cases in a general formulation, but in practice they are usually immediately obvious to inspection, so that we shall avoid here the complication of a perfectly general formulation.

Since products of powers of dimensionless products are themselves dimensionless products, there is no unique way of writing the $n - m$ dimensionless products—it is only the number which is determined. The precise form in which these products are to be written must be chosen with discretion, to suit the purposes of the application.

Making the Dimensional Analysis.—The steps in a dimensional analysis of any concrete problem are as follows. We first have to decide what sort of physical system we are dealing with in the sense that we have to decide what is the nature of the fundamental governing equations. For example, it may be a mechanical system governed by the equations of mechanics, or it may be an electromagnetic system governed by the equations of electrodynamics. We then have to decide on the system of measurement, which involves fixing the sort of quantities that are to be treated as primary and setting up the definitions of the secondary quantities. This will involve setting up the dimensional formulas; in cases of doubt it will pay to write out the definitions explicitly. We then imagine the fundamental equations written for this system of measurement, paying especial attention to any dimensional constants that may be used in writing the equations. We then make a list of all the parameters entering the particular problem, including both so-called physical quantities and dimensional constants. We write the dimensional formulas of all these parameters. We next form all the independent dimensionless products of these parameters; this is to be done by a method of solution of simple algebraic equations in the unknown exponents, as will appear from a study of the detailed examples. If necessary, the dimensionless products which first present themselves are to be rearranged so as to be more convenient for the particular problem. An arbitrary function of these dimensionless products is then to be set equal to zero, and this function is to be rearranged to suit the special exigencies. This is as far as dimensional analysis proper can go. An additional step is often taken by further restricting the form of the function by applying any special information that one may have: as, the effect of a certain parameter on the function disappears if the parameter is very small (or very large). Lord Rayleigh was especially successful in supplementing the dimensional analysis proper with other sorts of general physical information.

It is especially to be noticed that no detailed solution of the governing equations is assumed—in fact, if we were in a position to give the detailed solution we could get the complete relationship, and dimensional analysis to that extent would be superfluous. All we need to know about the fundamental equations is what goes into them—in particular, what dimensional constants. It follows that we can apply the method to situations so complicated that it would be hopeless to attempt a detailed writing out of the equations, much less to obtain a solution; and in fact the most important applications of dimensional analysis are precisely to such complicated situations.

It is important to notice that a great deal of flexibility is possible in the form in which the governing equations are written, both in the system of measurement and in the definitions for the secondary quantities. The governing equations do not have to be written in any unique canonical form, but may be specially adapted to the particular problem. This flexibility is to be utilized so as to reduce the number of independent dimensionless products to a minimum. The larger the m, other things being equal, the smaller the number of dimensionless products. Special problems often permit an increase in m. For example, a problem in mechanics or hydraulics will ordinarily be set up with conventional mechanical units, mass, length and time, as primary. But if the physical situation is of such a special character that the connection between force, mass and acceleration does not enter, as in a problem of steady motion like the Sir

George Gabriel Stokes problem of the fall of a sphere in a viscous medium where accelerations are zero, then force may be used as an independent primary unit, and the problem may be set up with four independent primary units: force, mass, length and time, instead of three. The result is a reduction in the number of dimensionless arguments, and hence more highly specialized information. If one chooses, any problem in mechanics may be set up in these four primary units; but in most problems the equation connecting force, mass and acceleration will be necessary; and this equation, written in four primary quantities, demands a new dimensional constant, the factor of proportionality between force and mass times accelcration. In general, then, the gain in increasing the number of primary quantities is nullified by an increase in the number of dimensional constants, so that the number of independent dimensionless products is unchanged.

It obviously requires experience and insight to know when the special situations arise; dimensional analysis yields an amount of information dependent on the skill and experience of the analyst. Positive errors are never introduced by failure to recognize these special situations—it is only that less than the maximum information is obtained. In the limiting case, where one has nothing whatever to contribute to a knowledge of the nature of the physical system, dimensional analysis does not give incorrect results, but only trivial results.

We have seen that any empirical connection whatever can be thrown into complete form by introducing an appropriate dimensional constant as a factor multiplying each physical parameter. If there are n' physical parameters, in this case there will be $2n'$ dimensional parameters altogether, including the dimensional constants, and hence $2n'-m$ dimensionless products. The result is some undetermined function of $2n'-m$ arguments. But in general $n'>m$, so that $2n'-m>n'$, and we know less by applying the analysis than before, because we knew in the beginning that there was some functional connection between the n' parameters. Although positive errors are not introduced by using an unnecessarily large number of independent quantities, it is obviously fatal to omit from the analysis any parameter which should actually enter the results. Experience and understanding are required of the analyst in order to ensure this. Consider now several typical applications.

(1) *The Simple Pendulum.*—This is the conventional introductory problem. The physical paramcters defining the simple pendulum may be taken to be the mass of the bob and the length of the suspending rod. The problem is obviously one in mechanics, and we may take as the fundamental units, mass, length and time. A detailed solution of the equations of motion will give the time of any complete oscillation, and this oscillation may be characterized by its angular amplitude. Our physical command of the situation is sufficient to show that the time of oscillation for any particular amplitude must be uniquely determined, since the bob starts from rest at the extreme point of the oscillation and the boundary conditions and the equation of motion determine a unique solution. The equations of motion will involve the force on the bob, and this will involve the acceleration of gravity; that is, in the equations of motion will appear the dimensional constant g. The detailed solution should therefore give a relationship between mass of bob, m, length of pendulum, l, angular amplitude of oscillation, θ, acceleration of gravity, g, and the period of oscillation, τ. This is a complete relationship, being deduced by mathematical manipulations from a complete equation, and therefore the pi theorem applies. We write the parameters which enter:

Parameter	*Dimensional formula*
m	M
l	L
θ	0
g	LT^{-2}
τ	T

The pi theorem instructs us to form all the independent dimensionless products. There will in general be 2, because n, the number of parameters, is here 5, and m, the number of primary units, is here 3. One of these products, θ, is obvious on inspection. We then must form one dimensionless product from the four remaining parameters. The exponents in the dimensionless product are unknowns which we write as $\alpha, \beta, \gamma, \delta$. We must now find these four quantities so that $m^\alpha l^\beta g^\gamma \tau^\delta$ is dimensionless. Substitute the dimensional formulas for the parameters. $M^\alpha L^\beta (LT^{-2})^\gamma T^\delta$ must be dimensionless, or the total exponents of M, L and T must vanish. This condition gives three algebraic equations:

$$\left.\begin{aligned} \alpha &= 0 \\ \beta+\gamma &= 0 \\ -2\gamma+\delta &= 0 \end{aligned}\right\}$$

There are three equations and four unknowns, which means that one unknown may be assumed arbitrarily. Take δ as the arbitrary one. Then the solution is: $\alpha=0$, $\gamma=\frac{\delta}{2}$, $\beta=-\frac{\delta}{2}$. The dimensionless product is $l^{-\frac{\delta}{2}} g^{\frac{\delta}{2}} \tau^\delta$. The pi theorem states that the solution is some functional relationship between the two independent products, or:

$$F[(l^{-\frac{1}{2}} g^{\frac{1}{2}} \tau)^\delta, \theta] = 0$$

where F is completely undetermined.

This equation may be rearranged by solving for the quantity in parenthesis, giving:

$$l^{-\frac{1}{2}} g^{\frac{1}{2}} \tau = f(\theta)$$

where f is completely undetermined. This again may be rearranged as:

$$\tau = f(\theta)\sqrt{\frac{l}{g}}$$

That is, the time of swing is independent of the mass, proportional to the square root of the length, and inversely proportional to the square root of the acceleration of gravity. As far as this analysis goes it may be any function of the amplitude. The detailed solution would show that for small amplitudes f has approximately the constant value 2π.

Even in this simplest of all problems we have had to make approximations and utilize special knowledge. For example, friction has not entered our result, yet every actual pendulum experiences friction, both from the resistance of the air and from imperfect elasticity of the supports. A precise formulation of the equations of motion would have involved the coefficient of viscosity of the air and an internal damping coefficient for the material of the supports. There would have been two more parameters, and the final result would have involved an arbitrary function of three arguments instead of one. Furthermore, we would have lost the information that we now have that time varies as the square root of the length. Suppose, for example, that we consider the effect only of the damping of the air. We would have had one more parameter, the viscosity of air, μ, of dimensions $ML^{-1}T^{-1}$, and one more argument of the function. Our result would have had the form

$$F[(l^{-1} g^{\frac{1}{2}} \tau), (m l^{-\frac{1}{2}} g^{\frac{1}{2}} \mu^{-1}), \theta] = 0$$

In this solution l cannot be isolated, and the dependence on l is tied up with that of the other parameters. Our original simplified analysis can be justified only by the additional knowledge, acquired either by experiment or by other considerations, that the effect of viscosity of the air on the period is vanishingly small. This sort of supplemental information is almost always necessary to make dimensional analysis yield useful results.

(2) *The problem of the resistance experienced by some body of definite shape moving at constant velocity through a body of fluid of dimensions indefinitely large compared with those of the moving body.* Special cases of this problem are: the resistance encountered by a projectile, by a submarine in deep water, by an airplane, or by a falling raindrop. The case of the ship is not included because for a ship, part of the resistance to motion arises from the creation of surface waves against gravity. The converse problem obviously is covered also; that is, the problem of the force exerted on a stationary obstacle by an infinite mass

of fluid streaming past it. The problem is evidently one of mechanics, involving for its formulation the equations of hydrodynamics (*see* HYDROMECHANICS). These equations involve no dimensional constants if written in terms of units of mass, length and time as primary. The parameters are therefore the physical parameters only. These will include the resistance to motion, the velocity through the fluid and the other parameters defining the physical setup. We may divide the latter into two groups: parameters defining the body and parameters defining the fluid. The fluid has density, viscosity and compressibility, the last of which may be specified by giving the velocity of sound in it. The body influences the result only through its geometry and through its surface properties, the interior being supposed rigid, so that the specific properties of the material of the body do not enter.

If we suppose that there is no surface slip between body and fluid, which corresponds to a very wide range of experimental conditions, the surface condition reduces merely to the condition that the velocity of the fluid is zero at the surface, and this condition can be stated without the help of any parameters. There remain the geometrical properties of the body. The geometry of the body may be specified by giving its shape and its absolute size; the latter may be specified by giving the numerical measure of some critical dimension and the former by giving the ratio to it of other determinative dimensions. For example, if the body is ellipsoidal in shape, its geometry may be specified by giving the major axis and the ratio to it of the minor axis. The latter are called shape factors and are obviously dimensionless.

We now formulate the problem by listing the quantities as follows:

Name of Quantity	*Symbol*	*Dimensional Formula*
Resistance	R	MLT^{-2}
Velocity	v	LT^{-1}
Density of fluid	d	ML^{-3}
Viscosity of fluid	μ	$ML^{-1}T^{-1}$
Velocity of sound in fluid	v'	LT^{-1}
Fiducial dimensions of body	l	L
Shape factors	$r_1, r_2, \cdots$	0

This list of properties of the fluid is evidently not complete. By leaving out certain properties we are drawing on our experience that these properties have no appreciable effect on the resistance. Obviously there can be little doubt of the propriety of omitting such properties as the electrical, magnetic or optical. But the omission of other properties limits the applicability of our results. Thus we have not included the boiling point or the latent heat of vaporization. This means that the solution is restricted to velocities so low that frictional resistance does not produce enough heat to vaporize the fluid.

Within the limitations imposed by our assumptions we now apply the pi theorem, and form the independent dimensionless products. The shape factors are already in this form; another one is obvious on inspection, namely v'/v. This leaves five parameters, R, v, d, μ, l. In general there should be two dimensionless products, and each of the products will involve four of the five parameters. We have therefore considerable latitude in choosing the precise form of the products. Since we are interested primarily in R, we will do well to include this in only one of the products, so that it may be isolated in the final solution. It will be convenient to omit μ from the other product. Following the procedure illustrated in detail in connection with the pendulum problem, we find that $Rv^{-2}l^{-2}d^{-1}$ and vld/μ are dimensionless. The solution is therefore:

$$F(Rv^{-2}l^{-2}d^{-1}, vld/\mu, v'/v, r_1, r_2, \cdots) = 0$$

where F is unrestricted. This may be rewritten as:

$$R = v^2l^2df(vld/\mu, v'/v, r_1, r_2, \cdots)$$

with f unrestricted.

This general solution covers a range of special conditions. At low velocities the problem is one of the steady state under the viscous resistance of the liquid; under these conditions the density of the liquid and the velocity of sound in it do not enter. If the density is to drop out, f must be linear in the reciprocal first parameter, and the solution is:

$$R = \mu vl\varphi(r_1, r_2, \cdots)$$

where φ is unrestricted. Therefore at small velocities the force of resistance is proportional to velocity, to viscosity and to the linear dimensions of the body. This is the solution for a falling raindrop.

In a higher range of velocity the motion loses its "laminar" character and becomes turbulent. In turbulent motion the microscopic momentum of the liquid enters, so that the density enters. In this range the fluid may be treated as incompressible, and the velocity of sound in it does not enter. These requirements give the specialized form of the result:

$$R = v^2l^2df'(vld/\mu, r_1, r_2, \cdots)$$

This equation is applicable to airplanes at velocities low compared with the velocity of sound.

The transition from the first solution, where the motion is laminar, to the second solution, where the motion is turbulent, occurs in the range where the deviation of the function $f(vld/\mu, v'/v_1r_1, \ldots)$ from linearity in the argument vld/μ becomes important. That is, when vld/μ reaches some critical value, the character of the motion alters. The dimensionless combination vld/μ is known as the Reynolds number, and is of great significance in discussing the flow of fluids.

The equation

$$R = v^2l^2df'(vld/\mu, r_1, r_2, \cdots)$$

is of wide applicability. The important matter is to determine the form of the function f'. If we restrict ourselves to geometrically similar bodies (constant shape factors), f' is a function of a single parameter, and may be determined by varying the parameter vld/μ over a wide enough range. This means that we do not have to study the effect of varying v, l, d and μ separately, but it is sufficient to vary any one of them. This obviously will result in an enormous saving of experimental manipulation.

The theory of model experiments is contained in dimensional equations like this. Suppose we wish to determine the behaviour of an airplane from model experiments. The model airplane must in the first place be made geometrically similar to the actual example; that is, the shape factors must be kept constant. If the experiment with the model is made in air, then in order to have the same values of f', vl for the model must have the same value as vl for the full-scale example. If the model is one-tenth size, this would mean that the model must travel at ten times the velocity of the original, an impossible requirement. At first glance this would seem to preclude the possibility of making model experiments on airplanes. The situation is saved by the special form which the function f' is found to have. Above a certain value of the argument vld/μ the function is found by experiment to be asymptotically constant. If vld/μ for both model and full-scale example can be got into this range, resistance is then proportional to v^2l^2, and this gives the information we seek. In practice, the asymptotic constant can be reached with the model, and model experiments are feasible.

At still higher velocities the velocity of sound enters. This is the case for projectiles. An analysis on the lines above would show that if we tried to make model experiments for projectiles by using water as the medium instead of air, a velocity of the model projectile in water five times as great as the velocity of the original in air would be demanded. The requirement is impossible to meet, and model experiments on projectiles cannot be made by changing the medium from air to water. Model experiments on projectiles are usually made in air; in this case the model must be geometrically similar to the original and it must travel at the same speed. That is, the model itself must be projected by some explosive mechanism. Under these conditions the formula shows that the resistance varies as the cross-sectional area.

(3) *The Problem of Heat Transfer.*—A body of given shape is surrounded by an infinite stream of liquid flowing past it at uniform velocity. The body is maintained at a given temperature higher than that of the remote parts of the stream. It is required to find the rate of heat interchange between body and stream. A complete solution of this problem would be excessively complicated; we shall make several essential simplifications. The heat convected away by the stream is known if we know the velocity distribution in the liquid and know the rate of heat transfer into each element of its volume. We assume that the velocity is so low that the flow is nonturbulent; in this region the distribution of flow velocity is independent of the viscosity of the fluid, although the forces are not. Further, the preceding problem shows that in this range the density of the fluid does not affect the velocity distribution. At the surface of separation of liquid and body there is no surface slip. The rate of heat transfer into the liquid at the surface depends on the temperature gradient in the liquid at the surface, and this will depend on the thermal conductivity of the liquid, its thermal capacity, and the rate at which new liquid is brought up by the motion, that is, on the velocity of the liquid. We suppose that the thermal conductivity of the solid body is so much higher than that of the liquid that the thermal conductivity of the solid offers no restriction on the rate of heat transfer from solid to liquid, and therefore the heat conductivity of the solid will not enter.

The conditions in this problem are sufficiently special so that it is advantageous to use a special set of primary units. We have the following table of parameters and dimensions:

Name of Quantity	*Symbol*	*Dimensional formula*
Rate of heat transfer	h	HT^{-1}
Velocity of fluid	v	LT^{-1}
Temperature difference	τ	τ
Thermal conductivity of liquid	k	$HL^{-1}T^{-1}\tau^{-1}$
Heat capacity of liquid per unit volume	c	$HL^{-3}\tau^{-1}$
Linear dimensions of body	l	L
Shape factors	$r_1, r_2, \cdots$	0

Here we use new kinds of fundamental unit, quantity of heat, H, and temperature, τ, while mass does not appear. The justification is in the details, as outlined above. This is a problem in static flow; that is, as far as the velocity of flow is concerned it is a problem in statics and masses do not enter. The equations deal directly with the flow of heat as such; and, since there is no transformation of heat into mechanical work, we are not concerned with the fact that in other kinds of systems heat and mechanical energy are mutually transformable. It is therefore sufficient to treat heat as a primary unit. Furthermore, temperature enters only through temperature differences and through those properties of the body which determine the behaviour when there are temperature gradients. Temperature may, therefore, be treated as a primary unit, in spite of the fact that there are other kinds of physical systems whose behaviour involves the fact that absolute temperature is proportional to kinetic energy per degree of freedom.

Disregarding the shape factors, we have six parameters expressed in terms of four primary units. Unless there is something exceptional in this situation the pi theorem leads us to expect two dimensionless products. Since we are interested in h, we choose one of the products without h. Detailed carrying through of the solution shows that there is nothing exceptional here, and the two independent dimensionless products are found to be $h/lk\tau$ and lvc/k. The solution is:

$$F[h/lk\tau, lvc/k, r_1, r_2, \cdots] = 0$$

where F is arbitrary. The solution may be rearranged and solved for h, giving:

$$h = lk\tau f[lvc/k, r_1, r_2, \cdots]$$

where f is arbitrary. The rate of heat transfer is therefore proportional to the temperature difference. In a model experiment, identical values of the function f can be kept only by increasing the velocity in proportion as the linear dimension of the body is decreased. In the range in which the transfer is proportional to the velocity, it is also proportional to the square of the linear dimensions; that is, to the area and independent of the thermal conductivity of the liquid. This means that under these conditions the transfer is entirely a convective phenomenon. In this range the effect of increasing the velocity of flow is the same as decreasing the heat capacity by the same factor.

The importance of a judicious choice of units adapted to the particular problem is particularly apparent here. If we had taken temperature to be a secondary quantity, and defined it as proportional to the kinetic energy of the atoms (as we might in perfect consistency with kinetic theory), the dimensional formulas and all the parameters would have been expressed in terms of three instead of four primary units, we would have had one more dimensionless product; the arbitrary function would have involved one more argument, and the relationships that we could have deduced would have been correspondingly less restricted, although not actually incorrect. The point is that the phenomena of kinetic theory do not enter this problem, and we are only handicapping ourselves unnecessarily if we try to bring them in by way of the definitions. A problem in which the connection between temperature and energy has to be brought in by way of the units is, for example, the very simple problem of the pressure-volume-temperature relation for a perfect gas.

(4) *Electromagnetic Problems.*—In dealing with problems in electrodynamics the question of the most suitable system of primary units is likely to prove more troublesome than in mechanical problems, because of the much larger number of alternative systems which have been proposed and which are in actual use. From the point of view of dimensional analysis the only requirement is that the system is consistent and adapted to the particular problem in hand. This requirement does not fix the system of measurement uniquely, and alternative definitions and corresponding alternative sets of dimensional formulas are possible in dealing with most of the problems of electrodynamics. There has been much controversy and misunderstanding in this connection; at one time an engineering society tried to determine the correct point of view by majority vote. The view has been very common that a dimensional formula expresses the essential physical nature of a quantity. From this point of view the present indeterminateness in dimensional formulas is an expression of our present incomplete knowledge of the complete physical mechanism, and the time is anticipated when we shall be able to write the correct dimensional formula for the dielectric constant and the magnetic permeability of empty space. The thesis is often defended that when this occurs all fractional exponents will disappear from all dimensional formulas. This attitude has a partial explanation as a historical survival from the time when the displacement current of Maxwell's equations was thought to indicate a movement of an electrical fluid which pervaded all space and which was everywhere elastically tethered to a second all-pervading rigid framework. This point of view has outlived any usefulness it may ever have had in suggesting experiment; it appears not to be unusual for a point of view to survive in its effect on philosophical attitude after it is dead in its original significance.

As an illustration of the application of dimensional analysis to a problem of electrodynamics, consider the classical problem of the electromagnetic mass of the electron. The electron is conventionalized by specifying its total charge, e, and its equivalent radius, a. To find the electromagnetic mass the electron may be placed in a constant electric field, and the resultant acceleration determined. If this acceleration should prove to be constant, independent of the velocity of the electron, then its behaviour is similar to that of a mechanical particle with ordinary mechanical mass, and it is proper to speak of electromagnetic mass. However, until the solution has been carried through one cannot say whether the electron has an electromagnetic mass or not. In carrying through the solution the field equations of

electrodynamics will be used, and into them will be substituted the parameters characterizing the electron. For the solution of theoretical problems of this nature the Gaussian system of units is often regarded as most convenient, and we shall suppose this to be the system used. In the field equations written in this system one dimensional constant occurs, c, of the dimensions of velocity, and numerically equal (by experiment) to the velocity of light. Our problem is then to build up a quantity of the dimensions of mass from the three quantities: electronic charge, e, electronic radius, a, and c. In the Gaussian system e^2 has the dimensions ML^3T^{-2}. Inspection shows that ae^2/c^2 is of the dimensions of mass, so that the point of view which anticipated an electromagnetic mass is to this extent justified and the mass is proportional to ae^2/c^2. The constant of proportionality can be found only by a detailed solution and will depend on the manner of distribution of the charge.

Applications to Theoretical Physics.—The general scheme of applying dimensional analysis to theoretical physics is not different from that in the applications already considered, provided the underlying mechanisms of the system are sufficiently understood. The method may, however, be applied as a tool of preliminary exploration in situations which are not yet completely understood, in order to find whether certain lines of attack are sufficiently promising to justify more detailed and elaborate development. A well-known example is the application by Albert Einstein to a discussion of the infrared characteristic frequency of solids. Before Einstein, no connection had been envisaged between the mechanism responsible for the ordinary elastic behaviour of a solid and that controlling its optical behaviour. Einstein suspected that the forces resisting the ordinary elastic deformations in a solid were the same in character as those responsible for the characteristic optical frequency in the infrared. An exact working out of the point of view would obviously have demanded detailed and laborious calculations, which one would not lightly enter upon. A preliminary dimensional analysis was therefore made. A connection is sought between characteristic frequency, ν, compressibility, K, the mass of the atom, m, and the number of atoms per cm^3, N. The dimensions of these quantities in ordinary mechanical units are respectively T^{-1}, $M^{-1}LT^2$, M, and L^{-3}.

There is in general one dimensionless product, and the result is obtained that

$$K = \text{numerical const.} \times \nu^{-2} N^{-1} m^{-1}$$

A connection of the suspected sort is therefore possible. However, in its present form very little significance can be attached to this result, because in general a dimensionless product may be formed with any four quantities chosen at random. If the exponents in the dimensional formulas of the parameters had proved to have such a special relationship that the dimensionless product was impossible, then the result would have been of immediate significance, but it would have been negative, and the line of inquiry would have been dropped as impossible. However, in the actual situation further argument is required to find whether the existence of this dimensional relation is significant, and this further argument was supplied by Einstein from an examination of the numerical value of the constant of proportionality.

Substituting actual numerical values for the physical parameters of a representative solid, copper,

$$7\times10^{-13} \text{ for } K,\ 7.5\times10^{12} \text{ for } \nu$$
$$7.5\times10^{22} \text{ for } N$$
$$1.06\times10^{-22} \text{ for } m$$

and gives the value 0.18 for the numerical constant, a value neither very large nor very small. Einstein's argument is based on the empirical observation that any very large or very small numbers which appear in equations of physics derived theoretically have their origin in physical parameters; such as the charge on the electron or the number of atoms per cm^3. On the other hand, any numbers which are the result of purely mathematical manipulations are likely to be neither very large nor very small. In the analysis above a number was found, 0.18, neither very large nor very small, so that it might have been the result of mathematical operations on certain fundamental equations containing the physical parameters. The point of view therefore appears to be worth further investigation. It is well known that detailed analysis did justify the general point of view, and the whole modern theory of specific heats at low temperatures has come out of it. The method is admittedly far from rigorous, nor can it be made rigorous; it is intended only to be suggestive, as a tool for preliminary exploration.

Use in Checking Equations.—Another use of dimensional analysis, which often saves much time, is in checking the correctness of a theoretical derivation of a formula. An equation derived from theoretical considerations should in general be a complete equation; the terms should then all have the same dimensions. Simple errors in manipulation are often discoverable by observation of a failure of dimensional homogeneity, and the place of origin of the error may be quickly traced. Consider, for example, a formula in thermodynamics for the adiabatic thermal expansion in terms of the isothermal expansion and other quantities, which might appear as:

$$\left(\frac{\partial v}{\partial \tau}\right)_s = \left(\frac{\partial v}{\partial \tau}\right)_p + C_\tau \left(\frac{\partial v}{\partial p}\right)_\tau \Big/ \left(\frac{\partial v}{\partial \tau}\right)_p$$

We ask whether this expression is dimensionally homogeneous? The dimensions of thermodynamic quantities are often expressed most conveniently in terms of pressure (p), volume (v), and temperature (τ) taken as primary. The dimensions of $\left(\frac{\partial v}{\partial \tau}\right)_s$ in the formula are $v\tau^{-1}$, as also are those of $\left(\frac{\partial v}{\partial \tau}\right)_p$. The dimensions of C_p, defined in this case as the heat required to raise the temperature one degree, are $pv\tau^{-1}$, pv having the dimensions of heat or energy. Substitution gives v for the dimensions of

$$C_p \left(\frac{\partial v}{\partial p}\right)_\tau \Big/ \left(\frac{\partial v}{\partial \tau}\right)_p$$

This differs by τ^{-1} from the dimensions of the other terms, so that there must be some error. Consideration would show that a factor τ^{-1} had been lost, and the correct formula is:

$$\left(\frac{\partial v}{\partial \tau}\right)_s = \left(\frac{\partial v}{\partial \tau}\right)_p + C_p \left(\frac{\partial v}{\partial p}\right)_\tau \Big/ \tau \left(\frac{\partial v}{\partial \tau}\right)_p$$

Use in Changing Units.—By writing out the dimensional formulas of various quantities a method is afforded of finding how the numerical magnitudes of any concrete examples change when the size of the primary units of measurement change. The method is so simple that no elaborate or formal exposition is necessary; it will be sufficient to give several illustrative examples. The method has already been applied in an earlier discussion in this article.

Suppose that a given body is moving with a velocity of 60 m.p.h. and we wish to find what its velocity would be in feet per second. Since 1 mi. contains 5,280 ft. and 1 hr. contains 60×60 sec., we may write:

$$60 \frac{\text{mi.}}{\text{hr.}} = 60 \frac{5{,}280 \text{ ft.}}{3{,}600 \text{ sec.}} = 88 \frac{\text{ft.}}{\text{sec.}}$$

Or, what is the pressure of the atmosphere, which we may take as 15 lb. per square inch, expressed in kilograms per square centimetre? One pound is equal to 0.4536 kg., and 1 in. equals 2.54 cm. Hence, $15 \frac{\text{lb.}}{\text{in.}^2} = 15 \frac{0.4536 \text{ kg.}}{(2.54 \text{ cm.})^2} = 15 \frac{0.4536 \text{ kg.}}{(2.54)^2 \text{ cm.}^2} = 1.054 \text{ kg./cm.}^2$

The method illustrated is obviously general. In fact it may be extended to much more complicated sorts of examples in which the conversion is between systems of units different in general nature, as from a system with mass, length and time as fundamental to one with force, velocity and energy as fundamental.

In applying the method the symbolic and abbreviated character of the notation is especially not to be lost sight of. We do

not, for example, divide a mile by an hour, but we divide a number obtained by the physical operation for measuring a distance in miles by a number obtained by the physical operations for measuring a time interval in hours. Our question is, what number would we have obtained if we had operated on the same physical system with the operation for measuring a length in feet and the operation for measuring a time in seconds?

Critical Comments.—While there is general agreement as to the details of the application of dimensional analysis to any concrete problem, and also with regard to the specific form of the results, there has not by any means been agreement with regard to the philosophy of the subject, and many questions are still controversial. The view presented here is one which apparently is increasingly accepted in the U.S. The crux of this point of view is that dimensional analysis is an analysis of an analysis: that is, an analysis of the implications of the fact that methods of analyzing experience have been found profitable which employ certain types of measuring process and certain methods of mathematical treatment of the results of the measurements. There is nothing absolute here, but a great deal of flexibility.

On the other hand, there has been a view, widely held by British authors and also on the continent, that the dimensions of a physical quantity have a much more esoteric significance; that dimensions refer to its essential physical nature, and that the correct dimensions are unique and sometime perhaps may be discovered. Examples of this point of view have been given in the text; this opinion leads, for example, to an intuitive proof of the necessary dimensional homogeneity of all physical equations, and also to an aversion for fractional exponents in dimensional formulas, the occurrence of which is supposed to indicate that certain essential dimensions have been suppressed. Somewhat connected with this point of view is the feeling, held by many contemporary writers, that it is necessary to distinguish two different sorts of operation in our handling of physical situations: that is, ordinary mathematical or arithmetical operations with numbers, and corresponding operations with physical quantities. Thus, according to this view, a velocity is the quotient of a physical length by a physical time.

Contrasted with these points of view, the point of view of this article may be characterized as a minimum point of view. The thesis is: whether or not it is possible to give satisfactory meaning to operations with physical quantities, or whether or not there is reason for thinking that things have an ultimate essential physical nature, for present purposes it is not necessary to settle these questions, but everything that we actually need or use in applying dimensional analysis is contained in the considerations set forth in this article. In particular, the various symbols in a dimensional formula perform the function of indicating the different sorts of physical operation that give rise to certain numbers that we use in our calculations.

See PHYSICAL UNITS.

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DIMINISHING RETURNS. If, in the production of a commodity, all inputs are increased, output is apt to rise in the same proportion. If only one input is increased, the output is likely to rise, but after a certain point is reached it is likely to rise only at a progressively diminishing rate. This relationship is known as the law of diminishing returns, or the principle of diminishing productivity.

A farmer, for example, who owns a given acreage of land will find that a certain number of labourers will yield the maximum output per worker. If he should hire more workers the combination of land and labour would be less efficient because the proportional increase in the over-all output would be less than the expansion of the labour force. The output per worker would therefore fall. In the extreme, as workers crowd the land they are meant to work, output might fall to zero. This rule will hold in any process of production unless the technique of production also changes.

Early economists, neglecting the possibility of technical progress, used the law of diminishing returns to predict that as population expanded in the world, output per head would fall, until misery kept population from increasing further. In stagnant economies, where techniques of production have not changed for long periods, this effect is clearly exemplified. In progressive economies, on the other hand, technical progress has succeeded in more than offsetting diminishing returns as population increases. In these economies, the standard of living has risen in spite of rising population density on the land.

See also ECONOMICS. (H. O. Sc.)

DIMITRI DONSKOI (1350–1389), grand prince of Moscow, succeeded his father Ivan II when only nine. His advisers' first task was to establish the supremacy of Moscow over the other independent Russian principalities. Only Tver was strong enough to offer effective opposition, and that only because of Lithuanian support. Thrice the Lithuanians under Algirdas, urged on by his brother-in-law Mikhail Aleksandrovich of Tver, invaded Muscovy (1368, 1370, 1372). Each time they were forced to withdraw. In 1375 Dimitri, supported by most of the Russian princes, marched on Tver. Receiving no help from Lithuania, Mikhail made peace, agreeing to recognize Dimitri as his "elder brother," to support him militarily and to renounce his friendship with Lithuania. Moscow's supremacy in northeastern Russia was now undisputed, and Dimitri was able to concentrate on the Tatars. Though the power of the Golden Horde was being sapped by internecine feuds, the Tatars, held together by Mamai during the 1370s, kept up their raids on Russian lands. The Russians, however, were able to hold their own; they even inflicted defeats on the enemy. In 1380 Mamai, determined to avenge a defeat by the Russians in 1378 on the Vozha river, collected a vast force and allied himself to Jogaila (Jagiello) of Lithuania and Oleg of Ryazan, who both failed him. Dimitri mustered an equally large army consisting of troops from most of the northeastern principalities. On Sept. 8, the two armies met on Kulikovo plain at the confluence of the Nepryadva and Don rivers. The Tatars were routed. Russian morale received a great fillip; the Tatars were no longer considered invincible; Dimitri Donskoi ("of the Don") was now recognized as the national leader. It was not, however, the end of the Tatar yoke, for in 1382 Khan Tokhtamysh invaded Russia and sacked Moscow; and Mongol control over Russia was once more restored. (J. L. I. F.)

DIMITRI, FALSE (PSEUDO-DIMITRI), the name given to three pretenders to the Muscovite throne who, during the "Time of the Troubles," claimed to be Dimitri, the son of the tsar Ivan IV the Terrible (*see* RUSSIA: *History*). The tsarevich Dimitri died in mysterious circumstances while still a child in 1591, in Uglich, his widowed mother's appanage. The tsarevich's sudden death has been attributed to Boris Godunov, but historians are at variance on this point (*see* GODUNOV, BORIS FEDOROVICH).

First Pretender.—The first pretender was YURI OTREPIEV, a member of the lesser nobility who had taken the name of Grigori when he became a monk. He was a habitué of various princely and boyar houses in Moscow, particularly that of the Romanovs. As a result of various treasonable utterances he was banished to the Solovetski monastery in the White sea, but forewarned, fled

to Poland, where in 1603 he announced to Prince Adam Wisniowiecki that he was the tsarevich Dimitri. This was accepted as fact, and Otrepiev's cause was taken up by the Polish magnate Jerzy Mniszek, with whose daughter, Maryna, Otrepiev had fallen in love and whom he was to make his tsaritsa. Mniszek, whose reputation was that of a lover of intrigue, presented him to the papal nuncio Claudio Rangoni, who in turn presented him to King Sigismund III. Otrepiev was converted to the Roman Catholic faith and received support from the Jesuits. Although Polish and Catholic interest lay in supporting the False Dimitri's claim, public opinion, on the whole, was against a war with Russia. The king, however, allowed him to recruit an army privately. In exchange for Polish help, Otrepiev promised to encourage the growth of Roman Catholicism in Russia, to pay a large sum of money to Poland and to cede to Poland territory along the Russian frontier including Novgorod, Pskov and Smolensk.

In Aug. 1604 Otrepiev advanced into Russia with an army of 4,000, of whom fewer than 2,000 were Poles. After a few early successes, he suffered a severe reverse and could have been completely routed had it not been for the animosity of the boyars to Tsar Boris (Godunov) and their resulting unwillingness to destroy his rival. The sudden death of the tsar supervened on Jan. 23 (new style; 13, old style), 1605, and the principal Russian army then declared its allegiance to the pretender. On June 20 (N.S.; 10, O.S.) Boris' widow and son were murdered, and on June 30 (N.S.) the pretender entered Moscow to the acclamation of the mob, who were convinced that he was Ivan's son. On July 4 (N.S.) he appointed a new patriarch, a Greek, Ignati, who crowned him on Aug. 9.

Subsequently, the pretender declined to honour his bargain with Poland, hiding his conversion, refusing to allow Catholic propaganda in Russia and offering money in place of a cession of territory. He made himself suspect to his subjects by his dislike of ceremony and by his predilection for western manners and for his Polish friends. His marriage to Maryna Mniszek, which brought a non-Orthodox bride and many foreigners to Moscow, infuriated the Muscovites. Plotters led by Prince Vasili Shuiski, whose life the False Dimitri had reprieved in June 1605, killed the pretender (and more than 2,000 foreigners in Moscow) in the Kremlin on May 27 (N.S.), 1606. Of his political actions, the most important were his efforts to secure the title of emperor for himself and his plan for an alliance between the Holy Roman emperor, the pope, Venice, Poland and Muscovy against Turkey.

Second Pretender.—The second pretender, called the "Thief of Tushino," first appeared on the scene about 1607 at Starodub. His origins are unknown. Although nobody believed his assertions, he became a focal point for malcontents and opponents of the tsar Vasili Shuiski's unpopular government. Reinforced by the Poles, he advanced on Moscow in the spring of 1608, routing the tsar's army at Bolkov on his way. He entrenched himself at the village of Tushino, a few miles from the capital, which he converted into an armed camp. In the course of the year he captured Maryna Mniszek, who acknowledged him to be her husband (subsequently quieting her conscience by privately marrying this impostor, who in no way resembled Otrepiev). This marriage brought him the support of the Lithuanian magnates, including Lew Sapieha. He raised another captive, Philaret Romanov, to the rank of patriarch. In the spring of 1610, however, when the tsar's armies received reinforcements, the pretender fled to Kaluga. Moreover, Sigismund III of Poland, making war on his own account, recalled all the Poles to the army in Smolensk. The pretender made another attack on Moscow, which failed, but the support of the Don Cossacks confirmed his hold over all southeastern Russia. He was killed on Dec. 21 (N.S.), 1610, by a servant while hunting.

Third Pretender.—The third Pseudo-Dimitri, supposed to have been a deacon called Sidorka, appeared in Ivangorod (Narva) on April 7 (N.S.; March 28, O.S.), 1611. The Cossacks, ravaging the environs of Moscow, acknowledged him as tsar on March 12, 1612.

The rebels forced the inhabitants of Pskov to swear allegiance to him; hence he is called the "Thief of Pskov." Betrayed on May 28, 1612, he was later executed in Moscow.

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DIMITRIJEVIC, DRAGUTIN (1876?–1917), Serbian army officer, was born in Belgrade in Aug. 1876 or 1877. He entered the military academy in 1892, was commissioned three years later and was appointed lecturer in strategy in 1910. From 1913 he was chief of the general staff intelligence and became colonel in 1915. From 1901 he was a member of the conspiracy which ended in the assassination (1903) of King Alexander Obrenovich. Its ringleaders then brought the army under their rule. Dimitrijevic—brave, patriotic and energetic, but inconsiderate and uncompromising—was surnamed "Apis" because of his strength. He became omnipotent in the army and began to interfere in politics. In 1911 he founded the Black Hand secret society *Ujedinjenje ili smrt* ("Union or Death"), which aimed at uniting all the Serbs, and he was one of the inspirers of the Sarajevo assassination of the archduke Francis Ferdinand.

During World War I, in Aug. 1916, two shots fired in Salonika near the regent Alexander's car were alleged to have been an attempt upon his life. Dimitrijevic and a group of his supporters were arrested in Dec. 1916 and prosecuted as promoters of the Black Hand, which was alleged to aim at overthrowing the government, and therefore plotting against the regent. Although his guilt was not fully proved, a court martial, sitting in Salonika in May 1917, sentenced him and his friends Ljubomir Vulovic and Rade Malobatic to death. The regent, carried away by desire to regain for the king the supreme authority in the army and persuaded that he was acting justly, refused the reprieve. The irregularities of the trial, however, could not have escaped the notice of the government, especially after its Independent and Progressist members had resigned. The coalition was broken up, and the Radical ministry did not oppose the execution, which took place on June 27 (new style; 14, old style), 1917. At a staged retrial of the case in Belgrade in 1953, all the condemned were found not guilty by the supreme people's court and rehabilitated.

See R. W. Seton-Watson, *Sarajevo* (1927); M. Ž. Živanović, *Pukovnik Apis* (1955). (K. ST. P.)

DIMITROV, GEORGI (1882–1949), Bulgarian Communist leader and statesman, was born at Kovachevtsi, near Radomir, on June 18, 1882. He became a militant Socialist at the age of 20 and played a major part in organizing and inspiring the left-wing ("narrow") Socialists who in 1919 became the Bulgarian Communist party. Both at home and at international conferences Dimitrov took a firm stand against any concessions to moderate Social Democracy: he wanted Bulgarian Socialism to be a revolutionary movement. Ideological rejection of war and militarism led him and his party to persistent opposition to Bulgaria's mobilization and entry into World War I. After brief imprisonment in 1918 he went abroad and in 1921 became a member of the Comintern's executive committee. Dimitrov was one of the principal leaders and organizers of the armed risings in Bulgaria after the overthrow of Aleksandr Stamboliski's Agrarian government in Sept. 1923 and narrowly avoided capture during the fighting. Sentenced to death *in absentia*, he resumed his international activities abroad. The *Reichstag* fire trial (*see* GERMANY: *History*) in 1933 brought to Dimitrov world-wide fame for his fearless and able defense against the accusation of being the instigator of the arson. Soon after his acquittal, on Dec. 23, he was granted Soviet citizenship and settled down in Moscow where, from 1935 to 1943, he was secretary-general of the Comintern's executive committee and deputy to the supreme soviet of the U.S.S.R. After the German invasion of the U.S.S.R., Dimitrov devoted all his energy to inspiring and directing the resistance movement in Bulgaria, in which the Communist party played a leading part. On Nov. 6, 1945, he returned to Bulgaria, reverted to Bulgarian nationality, became prime minister on Nov. 22 and presided over the drawing up of the constitution of the Bulgarian People's republic.

Dimitrov died on July 2, 1949, in the Barvikha sanatorium

near Moscow, where he had gone for medical treatment.
(N. I. M.)

DIMITROVGRAD, a town in southern Bulgaria, in the upper Thracian lowlands of the Maritsa river, is located 82 km. (50 mi.) E. of Plovdiv. It is a railway junction on the Belgrade-Sofia-Istanbul railway line. Pop. (1956) 34,162. A modern town, built in 1947 and uniting the neighbouring villages Rakovski and Mariino, it was named after Georgi Dimitrov, Bulgarian political leader and well-known international Communist figure. Until World War II vegetables, cotton, sesame and grain were grown there. There was a lignite colliery near the Rakovski railway station, as well as a small thermal power station, a vegetable cannery and lime kilns. After the war a plant for the production of chemical fertilizers was built, as well as the biggest cement works in Bulgaria and a factory for earthenware products. Dimitrovgrad provides electric power for the Rhodope mining district.

DIMITROVO (PERNIK), a town in southwest Bulgaria, lies in a small valley of the same name 30 km. (19 mi.) S.W. of Sofia. Pop. (1956) 59,930. Dimitrovo produces about one-half of Bulgaria's coal output; there is a 100,000 kw. thermal power station, steel, engineering, glass, cement and pectin works, the last the only one in the Balkans.

During the middle ages Pernik was strongly fortified and after repeated attempts by the emperor Basil II to seize it, it fell into Byzantine hands (1018) and in 1204 was captured by the Bulgarian king Kaloyan. Under the Turks Pernik was a small agricultural village, but after the liberation it developed as a mining centre in the 1890s, when brown coal was found and worked in the neighbourhood. It was given the status of a town in 1929. Developing rapidly after World War II, Pernik was renamed Dimitrovo in 1949 after Georgi Dimitrov, Bulgarian prime minister from 1946 to 1949.
(L. DI.)

DIMITY (from the Greek *dimitos,* "of double thread"), a fabric with two or more warp threads thrown into relief, forming fine cords. Originally it was made of silk or wool but since the 18th century it has been woven almost exclusively of cotton. The term was applied to two types of corded cottons: a heavy material used for bedcovers, drapery and the like; and a lightweight, almost sheer fabric either corded or made in check effects. Dimity now refers primarily to the latter. It may be dyed or printed and is a popular, lightweight, staple cotton goods. (G. E. L.)

DINAJPUR, a town and district in the Rajshahi division of East Pakistan. The town, the headquarters of the district, is situated on the east bank of the Punarbhaba just below its junction with the Dhepa. Pop. (1961) 37,711. Dinajpur proper is the northeastern quarter of the town where the maharaja of Dinajpur formerly had his residence; this quarter, as the original seat of government, gave its name to the town and district. Rajgarh is the central portion of the town containing shops and markets; Kanchanghat, on the west close to the river, is an upper-class residential suburb; Paharpur, the southern portion, contains the railway station, courts, circuit house (for senior government officials on tour) and other public buildings. The area south of the railway line has a fine maidan with handsome trees. There is a college (Surendra Nath) affiliated to Rajshahi university. The town is connected by rail with Kurigram in the east and Katihar (India) in the west. Roads radiate from it in all directions.

DINAJPUR DISTRICT, in the northwestern corner of the Rajshahi division, has an area of 2,609 sq.mi.; 1,418 sq.mi. were taken from it at the 1947 partition to make the Indian district of West Dinajpur. Pop. (1961) 1,709,917. It is a flat alluvial plain broken in the south by a slightly elevated tract known as the Barind and in the northwest by low hills. It is an important rice-growing district and stands first in both production and acreage of sugar cane in East Pakistan. Tradition associates Tarpan Ghat in the Nawabganj thana with Valmiki, the author of the Ramayana. In the 9th century Dinajpur came into the possession of the Pala kings who left their traces in numerous pillars and inscriptions.
(K. S. AD.)

DINAJPUR, WEST, a district of West Bengal, India, was created in 1947 at the time of the partition of Bengal. Pop. (1961) 1,330,346. Area 2,115 sq.mi. The southern part is composed of older alluvium, dissected into rolling plains. The principal rivers are the Tangan, Punarbhaba and Atrai. Rice, jute, oilseeds, sugar cane and tobacco are the principal crops. Cotton weaving is the main industry. Balurghat (pop. [1951] 18,121), the headquarters of the district, stands on the Atrai river. It has an airport. Raiganj (15,473), about 80 mi. W. of Balurghat, has considerable trade in jute and oilseeds. Hili on the Pakistan border is a rice-trading centre. (S. P. C.)

DINAN, a town of northwestern France in the *département* of Côtes-du-Nord, stands in a dominating position on a height above the left bank of the Rance river, 22 km. (14 mi.) S. of Dinard by road. Pop. (1954) 11,550. The walls of the 11th-century town, with 15 towers and 4 gates, have survived the fire of 1257, the storming of the town by Thomas d'Agworth in 1342 and by the duke of Lancaster about 20 years later, when Bertrand du Guesclin defended it, and the plundering by Olivier de Clisson in 1380. In the southern side of the walls Duke John IV of Brittany began building a castle (1382) which became a fortress when Dinan was a stronghold of the dukes of Brittany. Later the castle was used as a prison and it is now a museum. The walls surround the original streets where medieval timbered houses stand side by side with 18th-century granite buildings, the whole town being dominated by the Tour de l'Horloge, a 15th-century belfry. St. Sauveur's church is partly Norman and St. Malo's is late Gothic. The Jardin Anglais overlooks the deep valley of the Rance where it is crossed by a Gothic bridge and a modern viaduct (1852). Small boats ply down the Rance to Dinard and St. Malo, and there is an airport at Trelivan (4 km. [2½ mi.] E.S.E.). Dinan is an administrative and tourist centre and a market town trading in grain, cattle, honey, butter and agricultural machinery. The annual fair, the Liège, is held during Lent. In World War II the town was in German hands from June 1940 until Aug. 1944.
(J. UR.)

DINANT, a town of southern Belgium, province of Namur, is strung out along the east bank of the Meuse below high limestone cliffs, 28 km. (17.4 mi.) by road S. of Namur city and 15 mi. from the French border. Pop. (1955 est.) 6,843. The 11th-century citadel on the cliff, 300 ft. above the river, can be reached by a cable railway or by a stairway of 408 steps. It contains a museum of weapons and historical objects among which is the carriage of the marquise de Maintenon, second wife of Louis XIV. Behind the citadel is the French military cemetery. Over 1,400 years old, the town has many ancient buildings, among them the Collegial church on the site of a chapel founded in 934 and restored in 1697. "La Merveilleuse" grotto is famous for its transparent calcareous stalactites, while above it on the cliff is the 13th-century Montfat tower. There is a summer boat service on the Meuse northward to Namur and southward to Givet in France. The town is a tourist centre with its casino, swimming baths and sports facilities. Dinant has produced fine copperwork (dinanderic) since the middle ages, and decorated biscuits, known as *couques de Dinant*, are also made there.

A dependency of the bishop of Tongres in the 7th century, Dinant was a fief of the prince-bishopric of Liège from the 10th century until the French Revolution. In the 15th century it was a flourishing copper-manufacturing town until stormed by Charles the Bold in 1466. In 1675 it was taken by Louis XIV and remained French for nearly 30 years. It was again in French hands during the Napoleonic Wars. It was almost destroyed during the German invasion in World War I, and was again damaged in World War II. (E. M. A. R.)

DINAR, the monetary unit of Serbia and, from the end of World War I, of Yugoslavia, equal to 100 paras. Before its conquest by the Turks in 1389 the kingdom of Serbia had a silver coin, derived from the Roman denarius, which was called dinar. This coin was struck by King Vladislav (1234–41) at the rate of 144 dinars to one pound of silver. When Serbia became independent of Turkey in the 19th century it reintroduced its former currency and, in 1868, the dinar was revived as the national money of account. Although Serbia officially had a gold currency, only paper money circulated and gold coins were sold at a premium. After 1890 Serbia followed the example of Austria-Hungary and

maintained up to the outbreak of World War I a fairly successful gold exchange standard.

During World War I Serbia was occupied by the Central Powers and its own monetary system was suspended. After the war the dinar was reintroduced. At first Austro-Hungarian and Serbian currencies circulated side by side but in 1920 the former was converted at a rate of four kronen for one dinar while, at the same time, rapid inflation of the new Yugoslavian currency took place. Finally, in 1925, the dinar was stabilized; its exchange value was maintained at 9.15 dinars per Swiss franc or 56.70 dinars per U.S. $1.

In 1931 Yugoslavia redefined the dinar in terms of gold as .00275 g. of gold. These measures kept the exchange value of the dinar essentially stable until the occupation of Yugoslavia by Germany in 1941. When Yugoslavia regained its freedom in 1945 the dinar was again reintroduced and its official gold value defined at .0017773 g. of gold—an exchange rate of 2 cents per dinar. This constituted a serious overvaluation of the dinar and on the free market the dollar rose to between 400 and 600 dinars by 1951–52. On the advice of the International Monetary fund a new exchange rate of 300 dinars per U.S. $1 (.002962 g. of gold) per unit was fixed on Jan. 1, 1952, but free market rates of the dollar continued somewhat above that value. By Jan. 1960 the official rate of 300 dinars applied only to some government transactions, such as foreign debt service. All other transactions occurred at a large number of administered rates according to country and commodity. The system included a "settlement" rate of 632 dinars per U.S. $1 and its equivalent at internationally agreed par values for convertible currencies; reductions of 1% to 5% for most clearing currencies, and larger reductions for Egyptian and Turkish currencies; and a set of "coefficients" for all export and import commodities used to multiply the settlement rates. The tourist rate was 400 dinars per U.S. $1 and that for emigrant remittances and other gifts to Yugoslav citizens 600 dinars.

See also YUGOSLAVIA: *National Economy*.

(B. F. H.; Jo. M. L.)

DINARCHUS (DEINARCHUS) (*c.* 360–after 292 B.C.), a professional speech writer at Athens whose work reflects the incipient decline of Attic oratory. He was a native of Corinth, but as a young man settled at Athens where he is said to have studied under Theophrastus. About 336 B.C. he started his career as a professional writer of forensic speeches. Not being an Athenian citizen he was unable to speak himself in the law courts or assembly. He first became prominent in connection with the scandal which followed the flight to Athens in 324 B.C. of Harpalus, treasurer of Alexander the Great, who brought with him considerable wealth derived from Alexander's eastern spoils (*see* ALEXANDER III, THE GREAT). When Demosthenes and other well-known politicians were accused of misappropriating some of this money, Dinarchus was employed to write speeches for the prosecution. The three extant works ascribed to him—*Against Demosthenes*, *Against Aristogiton*, *Against Philocles*—are all concerned with these trials.

Under the pro-Macedonian oligarchy at Athens which followed Alexander's death in 323 B.C. Dinarchus had considerable success in his profession, but on the restoration of democracy in 307 B.C. he was forced to retire to Euboea. He returned to Athens in 292 B.C. through the influence, it is said, of his former teacher Theophrastus. It is not known when he died.

Dionysius of Halicarnassus (whose work *On Dinarchus* survives), records the titles of 87 speeches ascribed to Dinarchus, 20 of which he considered genuine. Further titles are mentioned by other ancient writers. Three speeches which have survived in the Demosthenic corpus (*Against Boeotus*, *Against Theocrines* and *Against Mantitheus*) have been ascribed to him. The three speeches extant under Dinarchus' name, *i.e.*, those connected with the Harpalus scandal, are now generally regarded as genuine. They provide no reason for dissenting from the low opinion of Dinarchus held by Dionysius. He has the conventional rhetorical accomplishments, but lacks taste, individuality and creative skill. Violent abuse takes the place of reasoned argument; plagiarism from other orators, particularly Demosthenes, is frequent.

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DINARD, a fashionable French seaside resort, in the *département* of Ille-et-Vilaine, Brittany, is situated on a rocky promontory on the Bay of St. Malo, 73 km. (45 mi.) N.N.W. of Rennes by road. Pop. (1954) 7,325. It is renowned for its mild climate, magnificent scenery, sandy beaches where bathing is safe and invigorating, and spectacular tides of 40 ft. which uncover thousands of rocks. There are numerous hotels and villas, a casino, a Breton museum and an aquarium. Small boats cross to St. Malo and in summer go up the Rance to Dinan. From Pleurtuit airport (5 km. [3 mi.] S.) there are summer services to Paris, London, Bristol, Exeter, Southampton, Jersey and Guernsey, and there are regular steamer services from St. Malo to Southampton. (RT. M.)

DINDIGUL (DINDU KAL, "Demon's rock"), a town in Madurai district, Madras state, India, on the Southern railway, lies 268 mi. S. of Madras city. Pop. (1951) 78,361. It is located at the foot of the Palni and Sirumalai hills at a height of 943 ft. above sea level, commanding the passes leading to Madurai from Coimbatore. It is famous for the manufacture of cigars from locally grown tobacco, and also of locks and safes. Because of its strategic position the small fort, now in ruins, was keenly contested in the 18th century, several times falling to the Mysore armies and the British before its final cession to the latter in 1792.

(G. KN.)

D'INDY, (PAUL MARIE THÉODORE) VINCENT (1851–1931), French composer and teacher who was remarkable for his attempted, and partially successful, reform of French symphonic and dramatic music along the lines indicated by César Franck (*q.v.*). Born in Paris on March 27, 1851, of an aristocratic family, he studied under Albert Lavignac, Antoine Marmontel and Franck (for composition). In 1874 he was admitted to the organ class of the Paris conservatory and in the same year his second *Wallenstein Overture* was performed at one of the Pasdeloup concerts. In 1876 D'Indy visited Bayreuth—an experience that confirmed and completed his musical creed: he considered French 19th-century music and the tradition of the Paris Opéra (Meyerbeer, Gounod, Massenet), of the Paris conservatory and of French "decorative" symphony (Saint-Saëns) to be superficial, frivolous and unworthy to compete with the teutonic Bach-Beethoven-Wagner tradition. Yet, paradoxically, this conviction meant, in D'Indy's case, not musical cosmopolitanism but musical nationalism: French musicians should revert to French and "Latin," Roman Catholic, medieval and Renaissance traditions; the serious and uncompromising principles of German symphony and of Bayreuth should be applied to French music, inspired by French legends and true to the spirit of French folklore. And, handled by a French composer, even the German *Wallenstein* should turn French—just as Celtic *Tristan*, handled by Wagner, turned unmistakably German. This dogmatic idealism made D'Indy a stimulating theorist and pedagogue, a convincing interpreter and a composer of undeniable though limited creative powers. He codified the practice of early 19th-century sonata form and of Franck's late 19th-century *principe cyclique* (unity of thematic material throughout the different sections of a sonata or symphony); yet he was among the first to promote the revival of Monteverdi; and if Wagner was his god, he nevertheless welcomed Debussy's pointedly anti-Wagnerian *Pelléas et Mélisande* (1892–1902). The music D'Indy wrote never lacks style, and moments of grandeur are to be found in almost every one of his compositions. On the other hand, even his warmest admirers cannot deny that there is often something unimaginative and naïve about his melody; that his harmony is too systematically Wagnerian and Franckist to be original; and that lack of charm is a price this composer has been too ready to pay for the unrelenting and almost puritanical seriousness and single-mindedness of his art.

D'Indy's most important stage works were *Le Chant de le Cloche* (1883), *Fervaal* (1895), *Le Légende de Saint Christophe* (1915) and *Le Rêve de Cinyras* (1923). Among his symphonic works *Symphonie sur un Chant montagnard* (1886), with solo

piano, based entirely on one of the folk songs D'Indy had collected in the Ardeche district, and *Istar* (variations, 1896) represent his highest achievement. His 105 scores also include keyboard works, secular and religious choral writings and chamber music. Among the latter are some of his best compositions: *Quintette* (1924), suite for flute, string trio and harp (1927) and the Third String Quartet (1928–29). He also made arrangements of the hundreds of folk songs that he collected in the Vivarais.

In 1894 D'Indy became one of the founders of the Schola Cantorum in Paris and it was through courses at this academy that he spread his theories and initiated the revival of interest in Gregorian plain chant and in the music of the 16th and 17th centuries (*see* his *Cours de Composition*, four volumes 1897–1907). D'Indy also published studies of Franck (1906), Beethoven (1911) and Wagner (1930). In France Paul Dukas, Albert Roussel and D. de Sévérac were among his disciples. Outside France his influence has been great and lasting: in Greece, in Bulgaria, in Portugal and in Brazil he has been the counselor of all those who from 1900 onward endeavoured to shape folk music into symphony.

D'Indy died in Paris on Dec. 1, 1931.

See L. Vallas, *Vincent d'Indy*, 2 vol. (1946, 1950). (F. E. G.)

DINES, WILLIAM HENRY (1855–1927), British meteorologist and designer of meteorological instruments, was born in London on Aug. 5, 1855, son of the meteorologist George Dines, inventor of the dew-point hygrometer. After serving an engineering apprenticeship he entered Corpus Christi college, Cambridge, and graduated as wrangler in 1881. Dines was an outstanding meteorologist of his generation, combining theoretical insight with remarkable practical inventiveness and experimental skill. Much of his work was concerned with the design of instruments, his contributions to anemometry being especially noteworthy.

Dines was also a pioneer in the investigation of the upper air by means of kites and free balloons and designed a remarkable meteorograph for upper air soundings weighing only about 2 oz. and costing about £1. This became the standard British instrument and gave much information on pressures, temperatures and humidities up to heights well into the stratosphere. His classical analysis of the data revealed striking correlations between the properties of the upper atmosphere and gave valuable insight into the dynamics of cyclones and anticyclones. Important contributions were also made in studies of terrestrial and solar radiation. His collected scientific papers with a full bibliography were published in 1931 by the Royal Meteorological society, of which he was president in 1901–02. In 1905 he was elected a fellow of the Royal society. He died at Benson, Oxfordshire, on Dec. 24, 1927.

(Rd. C. S.)

DINGELSTEDT, FRANZ FERDINAND, Freiherr von (1814–1881), German poet, playwright and theatrical producer, who became known for his biting political satires, was born at Halsdorf, Hesse-Kassel, June 30, 1814. He joined the liberal Young German movement and wrote satires against the princes (*Lieder eines kosmopolitischen Nachtwächters*, 1841): after his political conversion he was made intendant of the court theatres at Munich and Weimar and, finally, director of the opera and the Hofburg theatre at Vienna, and was ennobled. A founder of the German Shakespeare society, he produced the whole cycle, and translated many of Shakespeare's plays. He also wrote novels (*Die Amazone*, 1868; *Künstlergeschichten*, 1877); an autobiographical sketch, *Münchener Bilderbogen* (1879); and a tragedy (1850). He died in Vienna, May 15, 1881.

DINGHY: *see* Boat.

DINGO (Warrigal), the Australian wild dog (*Canis dingo*), was introduced by the aborigines from Malaya when they first settled the continent. It is of the same genus as the wolf, coyote, jackal and domestic dog, which last-named canid it closely resembles in structure and habits. The dingo is a stout animal about the size of a small collie, with short soft fur, a bushy tail and erect pointed ears; its colour is generally tan, with white markings on the belly, feet and tip of tail. Its skull structure is much like that of the earliest domestic dogs of Europe.

Wild dingoes, which yelp and howl but do not bark, can, in domestication, learn to imitate the bark of dogs. They are suspicious, fierce and bold, and have a high degree of cunning. However, they can be tamed and are easily bred in captivity; those raised from puppies may become affectionate pets. Wild dingoes hunt singly, or in pairs or small packs of five or six. Kangaroos were once their principal prey. Through competition they contributed to the extermination of the native Tasmanian wolf and Tasmanian devil (both marsupials) on the Australian mainland.

W. SUSCHITZKY

DINGO (CANIS DINGO), THE WILD DOG OF AUSTRALIA

With the settlement of Australia by white men, the dingo became very destructive of sheep and poultry, and man's hunting nearly eliminated it in some areas. Near settlements it interbred with domestic dogs, and pure dingoes became rare in many regions. The introduction of the rabbit afforded it a staple food supply; the dingo then increased in numbers and again became a serious liability.

Fossil remains of the dingo from the Australian Pleistocene (beginning about 1,000,000 years ago) are mingled with those of giant marsupials. (R. H. Ma.)

DINGWALL, a royal and small burgh and the county town of the shire of Ross and Cromarty, Scot. Pop. (1961) 3,752. It is near the head of Cromarty firth where the valley of the Peffery unites with the alluvial lands of Easter Ross at the mouth of the Conon, 22 mi. N.W. of Inverness by road. Its name, derived from the Scandinavian *Thingvöllr*, "field or meeting place of the *thing* or local assembly," preserves the Norse origin of the town; its Gaelic designation is Inverpefferon, "the mouth of the Peffery." The 18th-century townhouse (largely rebuilt in 1905) and some remains of the ancient mansion of the once powerful earls of Ross still exist. A tower on Mitchell hill commemorates Maj. Gen. Sir Hector Macdonald (1853–1903), born at Muir near Dingwall. The town is the centre of a wide and fertile agricultural country. Some shipping is carried on at the harbour at the mouth of the Peffery, about a mile below the burgh. Alexander II created Dingwall a royal burgh in 1226, and its charter was renewed by James IV. On the top of Knockfarrel, a hill about 3 mi. to the west, is a large and very complete vitrified fort with ramparts. *See* Vitrified Forts.

DINIS, JÚLIO (pseudonym of Joaquim Guilherme Gomes Coelho) (1839–1871), the first great novelist of modern Portuguese society, was born in Oporto of a middle-class family on Nov. 14, 1839, and completed a brilliant career as a medical student there in 1861. Four years later he was selected as demonstrator in the medical school and in 1867 he was promoted deputy professor and appointed secretary and librarian. He had already experienced the first attacks of tuberculosis, which had claimed his mother and some of his brothers and was to claim Dinis himself at the age of 31.

In 1862 his first tales had begun to appear in the *Jornal do Pôrto:* they were later collected in one volume, *Serões da Província* (1870). In Ovar, where he spent some time in search of relief from the disease which was sapping his strength, he wrote his famous novel of country life, *As Pupilas do Senhor Reitor*, which appeared in the *Jornal do Pôrto* in 1866 and as a book in the following year. It was a resounding success: 14 editions had been published by 1900. Encouraged, he published first as a serial, then in book form (1868) *Uma Família Inglêsa*, on which he had begun work before 1860.

In 1868 Dinis began to publish, also in the *Jornal do Pôrto, A Morgadinha dos Canaviais*, which appeared as a book in the same year. During 1871, the year of his death (at Oporto, Sept. 12) he was revising the proofs of his last novel, *Os Fidalgos da Casa Mourisca* (1872; Eng. trans. by R. L. Dabney, 1891), which was based on his sojourns in Madeira. His poems were edited posthumously, *Poesias* (publ. 1873, dated 1874). Other posthumous

publications included *Inéditos e Esparsos, Cartas e Esbôços Literarios* and *Teatro Inédito*.

Dinis devoted himself as a writer to stressing the superiority of the middle class and its work over the aristocracy and its prejudices. His novels reflect a simple, kindly, grateful nature, prone to good works and self-sacrifice. One of his critics (Sampaio Bruno) wrote that his novels were amplifications of a moral theme in which the thesis dominates the narrative simplicity. Reading the English sociological novelists decisively influenced his outlook. His village tales, which express his love for the simple life, for loyal and sincere characters and for gentle scenes, were written in a style within the comprehension of a large public and retain the invigorating qualities which made him one of his country's most popular writers.

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(A. J. DA C. P.)

DINIS DA CRUZ E SILVA: *see* CRUZ E SILVA, ANTONIO DINIS DA.

DINIZ (DENIS) (1261–1325), king of Portugal from 1279 to 1325, was born on Oct. 9, 1261, the son of Afonso III and of Beatriz, an illegitimate daughter of Alfonso X of Castile. In 1282 he arranged his marriage with Isabella, daughter of Peter III of Aragon; she was canonized in 1625. Educated at a court subject to both French and Castilian cultural influences, Diniz was a competent poet. He encouraged the use of the vernacular by making Portuguese the language of the judiciary, and he arranged for the translation of the *Siete Partidas*, the famous legal code of his grandfather Alfonso X. He founded the first university in Portugal—in Lisbon in 1290. A skilled negotiator, Diniz was able to establish with Castile a definitive frontier for Portugal. At home, he made the authority of the crown supreme, intervening in local government, reducing the power of the nobility and combating the supremacy of the clergy, particularly in regard to their territorial wealth (laws of disentail in 1286, 1291 and 1309). Concordats with the papacy (1289 and 1290) ended the struggle with the church. Diniz took a special interest in the land, encouraging forestry plantation and the fuller development of the country's agricultural resources. He also showed great concern for shipbuilding, and for the extension and protection of commerce, and under Diniz Portugal developed close economic relations with France, Italy, Flanders and England. The last years of the reign were disturbed by a rebellion of his son, the future Afonso IV, who succeeded to the throne on his father's death on Jan. 7, 1325.

(V. R. R.)

DINKA, a Nilotic-speaking people, closely related to the Nuer (*q.v.*), who live in the savanna country surrounding the central swamps of the Nile basin in the south of the Republic of the Sudan. They number about 900,000 and are divided into independent tribes of between 1,000 and 30,000 persons. These are grouped on a regional, linguistic and cultural basis into congeries, of which the best known are the Agar, Aliab, Bor, Rek and Malual. The Dinka are primarily transhumant pastoralists, moving their herds of cattle to riverain pastures during the dry season (December to April) and back to permanent settlements in savanna forest during the rains, when their food crops, principally millet, are grown. Each tribe is internally segmented into smaller political units with a high degree of autonomy. By tradition, certain of their patrilineal, exogamous and totemic clans provide priest-chiefs ("masters of the fishing spear") who are spiritual leaders of tribes and sections and whose position is validated by elaborate myths. The Dinka have been receptive of modern education, and the Gogrial rural-area council, the first notable experiment in local government in the southern Sudan, was established successfully in 1946. *See* also NILOTES.

BIBLIOGRAPHY.—C. G. Seligman and B. Z. Seligman, *Pagan Tribes of the Nilotic Sudan* (1932); J. Middleton and D. Tait (eds.), *Tribes Without Rulers* (1958); G. Lienhardt, *Divinity and Experience: the Religion of the Dinka* (1961).

(GO. L.)

DINOCRATES (DEINOCRATES), a famous and original architect of the 4th century B.C., flourished under Alexander the Great. He tried to captivate the ambitious fancy of that king with a design for carving Mouth Athos into a gigantic seated statue.

This plan was not carried out, but Dinocrates designed for Alexander the plan of the new city of Alexandria (*c.* 330 B.C.), and constructed the vast funeral pyre of Hephaestion. Alexandria was, like Piraeus and Rhodes (*see* HIPPODAMUS), built on a regular plan in contrast to the narrow and irregular streets of most earlier towns.

DINOFLAGELLATE, any of certain one-celled aquatic organisms bearing two flagella and having characteristics of both plants and animals. Most are microscopic and most are marine. Botanists consider them a class, the Dinophyceae, of the Algae (*see* ALGAE: *Pyrrophyta*); whereas zoologists claim them as an order, the Dinoflagellata, of the Protozoa (*see* PROTOZOA). The size range is from about 5 to 2,000 microns. Nutrition among dinoflagellates is plantlike, animallike or mixed. Many species are parasitic in, or commensal with, marine animals (the zooxanthellae of many sea anemones, corals, jellyfishes, etc.). The group is an important component of the phytoplankton in all but the colder seas and is responsible for much of the luminescence in the sea. Fossil dinoflagellates are known from the Carboniferous (beginning about 285,000,000 years ago). Those species that are most plantlike (holophytic) contain a stigma and yellow, orange, brown or green pigment bodies. Noncontractile, coloured vacuoles called pusules are characteristic of marine forms. Many species have trichocysts and some have stinging bodies called cnidoblasts.

Around the body is a median or coiled groove, the annulus, which contains a bound flagellum. A longitudinal groove, the sulcus, extends from the annulus posteriorly to the point where a second flagellum is attached. There are variations of this basic pattern. Armoured dinoflagellates are covered with heavy cellulose plates, which sometimes have long spiny extensions; unarmoured species are naked or have a thin pellicle.

Sexuality has been demonstrated for only one genus; reproduction is largely by binary or multiple fission. Under favourable conditions their numbers may increase quickly to 60,000,000 organisms per litre of water. Such outbreaks, called "blooms" by biologists, result in the "red tides" that discolour the sea. Dinoflagellates produce a water-soluble poison, and heavy blooms result in vast kills of fishes and other marine animals; occurrences of this sort off the Florida Gulf coast (due to *Gymnodinium breve*) and off California (due to *Gonyaulax polyhedra*) are notorious. Certain mollusks become poisonous, and unfit for food, from feeding on toxic dinoflagellates.

See also OCEAN AND OCEANOGRAPHY: *Biological Oceanography: Mass Mortalities in the Sea;* PLANKTON.

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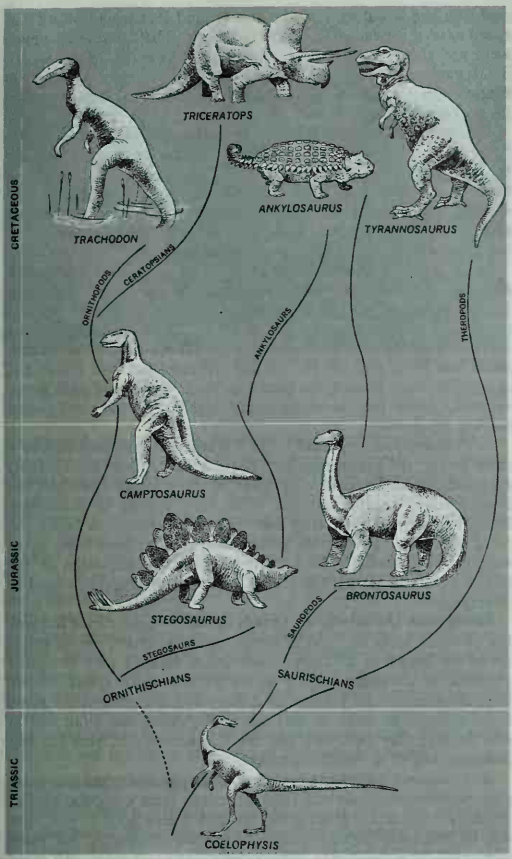
(G. GU.)

DINOSAUR, a term popularly used for the members of a great series of reptiles that were the dominant land animals during most of the Mesozoic era, the age of reptiles, but became extinct at its close. The term, derived from the Greek meaning "terrible lizard," refers to the gigantic proportion of these beasts; but although some of them were in fact the largest animals that ever walked the earth, the earlier or more primitive ones were of small size. Dinosaurs, commonly thought of as constituting a single natural group, actually belong to two distinct but related orders—the reptilelike Saurischia and the birdlike Ornithischia—that were akin to the crocodilians, flying reptiles and bird ancestors. A considerable number of dinosaurs were flesh eaters but a majority abandoned this primitive reptilian mode of life for a herbivorous diet. The early dinosaurs were bipeds, and many forms remained bipedal throughout the history of the group; in both orders however many plant-eating forms reverted to a four-footed gait.

The Mesozoic, the geologic scene in which the dinosaurs played the most important part, extended over a period of more than 100,000,000 years and ended about 70,000,000 years ago. The era is divided into three periods—Triassic, Jurassic and Cretaceous—of



ADAPTED FROM E. H. COLBERT, "DINOSAURS," E. P. DUTTON AND CO., 1961

FIG. 1.—EVOLUTION OF THE DINOSAURS

approximately equal length. Dinosaurs first appeared in the latter third of the Triassic, and are common in red rock deposits of that age in Europe, North America, western China and south Africa. For most of the following Jurassic period the sediments are dominantly marine and dinosaur remains consequently rare. At the end of the Jurassic, however, continental Morrison beds, widespread in the western United States, were laid down with a major dinosaur fauna; a comparable bed is found in the Tendaguru formation of Tanganyika. Early phases of the Cretaceous are, again, mainly marine, but Lower Cretaceous dinosaurs are present in the Wealden beds of southeastern England and adjacent parts of the continent. In the later Cretaceous continental dinosaur-bearing strata are widespread; Alberta and the Rocky mountain states in North America and Mongolia in the old world have yielded abundant remains.

Dinosaur Characters.—The dinosaurs belong to a major subdivision of the reptiles termed the Archosauria, or ruling reptiles. Like the lizards and snakes, and *Sphenodon* of New Zealand, the archosaurs differed from various other reptile groups (such as the ancestors of mammals) in the diagnostic construction of the temporal region of the skull, in which the surface is pierced by two openings (fenestrae), each bounded below by a bony arch—the diapsid condition. In addition, however, archosaurs showed characteristic features of the limbs and limb girdles associated with the fact that early members of the group tended strongly toward bipedal habits. Not only certain dinosaurs but some other archosaurs, notably the crocodilians, tended to revert from incipient bipedalism to a four-footed gait; on the other hand, other dinosaur "cousins," pterosaurs (flying reptiles) and birds, progressed onward from bipedalism to flight.

The bipedal trend was responsible for a series of changes in body build that may have persisted even in a dinosaur that became secondarily quadrupedal. (The front legs are not used, of course, in fully bipedal animals and tend to become more slender and shorter, with, frequently, a trend for reduction in the number of digits). In most four-footed dinosaurs a clue to the preceding bipedal stage is readily seen in the fact that the front legs remained much shorter than the hind. The entire weight of the body came to be supported on the hip girdle (the pelvic girdle) and the hind legs. The girdle was powerfully constructed and had specializations which, however, differed in the two dinosaur orders. In primitive reptiles the limbs sprawled out widely to the side; in dinosaurs the powerful hind legs were rotated to a position directly underneath the body, thus giving more effective support and, since the main limb motion was a fore-and-aft one, giving a more efficient and speedy gait. In many bipedal dinosaurs there was a tendency for the loss of both inner and outer digits in the hind foot, with the development of a three-toed foot closely comparable to that of many of their avian relatives. In consequence it is not to be wondered at that, far back in the last century, when dinosaur skeletons were unknown, footprints of dinosaurs found in the Triassic rocks of the Connecticut river valley and other areas were attributed to gigantic extinct birds.

Dinosaur Stocks.—The names for the two dinosaurian orders, Saurischia and Ornithischia, although not too well chosen, do refer to the most obvious differences between the two groups—differences in the construction of the pelvic girdles. In both groups the ilium, the upper of the three bones forming the girdle, was stoutly built and firmly bound to the backbone. As in all reptiles, there were two lower elements, termed pubis and ischium. In primitive reptiles these two formed a ventral plate. In dinosaurs and related types they were much modified, and more or less rodlike in form, in relation to changed limb posture and consequent change in muscle attachments.

In the Saurischia the pubis extended downward and forward from the limb socket, the ischium ran down and back thus giving (with the ilium) a triradiate appearance to the girdle. In the Ornithischia the structure was still more modified to a tetraradiate pattern. The pubis swung backward to parallel the ischium (as in birds), but developed a paddle-shaped anterior process as an aid in belly support. This contrast in girdle structure is so marked that members of the two groups can be readily observed in casual inspection of mounted museum skeletons or even figures of skeletal reconstructions. Although pelvic build is the most obvious diagnostic feature, the two orders may be contrasted in other regards. For example, saurischians (as is true of reptiles generally), had pointed teeth of simple construction that were generally present the length of the jaws; in ornithischians the front teeth were generally lost and presumably replaced in life by a birdlike bill, and the cheek teeth were leaf-shaped structures. These differences

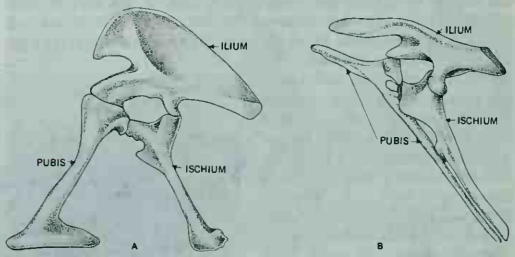


FIG. 2.—LEFT PELVIC GIRDLE OF (A) SAURISCHIAN DINOSAUR AND (B) PRIMITIVE ORNITHISCHIAN. IN A SAURISCHIAN THE THREE PELVIC ELEMENTS FORM A TRIRADIATE STRUCTURE, CENTRED ON THE SOCKET FOR THE THIGH BONE. IN MOST ORNITHISCHIANS THE PUBIS IS TWO-PRONGED, GIVING THE GIRDLE A TETRARADIATE APPEARANCE

RECONSTRUCTION DRAWING BY C. R. KNIGHT BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 3.—ORNITHOLESTES, A JURASSIC COELUROSAUR OF THE SAURISCHIAN GROUP, CATCHING AN ARCHAEOPTERYX, ONE OF THE EARLIEST KNOWN BIRDS

are to be associated with differences in diet. The majority of saurischians were flesh eaters; all ornithischians were plant eaters.

REPTILELIKE DINOSAURS (SAURISCHIA)

Saurischian Bipeds.—The saurischians were the first of the two great groups to assume prominence. In the earlier Triassic there appeared small bipedal archosaurs called thecodonts, of relatively primitive build. From certain of these forms the saurischians were definitely derived. By the time of formation of the red beds of the Late Triassic a large series of saurischians had made their appearance. All of them were bipeds, as were the majority of later members of the order, and to these and later bipeds as a whole the subordinal term Theropoda is applied. Even at their first appearance, however, there were clearly distinguishable three types of bipeds; the later history of the three types may be followed in turn.

1. Coelurosaurs.—These were a series of relatively small flesh-eating bipeds that are found in every major dinosaur-bearing bed from the Late Triassic to the Late Cretaceous. The coelurosaurs as represented by the Triassic *Coelophysis*, were slender-limbed, lightly-built (even many of the bones are hollow) and obviously fast-running forms that appear to have preyed upon their smaller reptilian contemporaries. Most members of this group were persistently tiny; for example, a well-known Jurassic form, *Compsognathus*, was no bigger than a rooster. However, Late Cretaceous coelurosaurs followed to some degree the dinosaurian trend for increased size, although retaining the light build characteristic of the group.

An interesting end form is *Ornithomimus* (*Struthiomimus*), the "ostrich dinosaur" of the Late Cretaceous. This reptile was about the size of an ostrich and resembled a bird of this sort in such features as the presence (unusual in this order) of a horny bill rather than teeth, small head, long slender neck and powerful legs. It was, however, obviously different from its avian analogue in the presence of a long reptilian tail and of long arms with a clutching power in the fingers. The probable habits of this creature have been a subject of considerable debate. It appears, however, that the animal probably lived by eating the eggs of other dinosaurs. Although teeth would not be needed in eating the egg contents, a beak would help in breaking the shell. The grasping powers of the arms would be useful in egg handling, and the strong hind legs would afford the speed needed for escaping enraged parents. That these egg thieves were not always successful, however, is shown by the discovery in Mongolia of a crushed skull of a member of this group at a nesting site of horned dinosaurs. This individual had probably been caught pillaging a nest.

2. Carnosaurs.—A main line of flesh eaters tended to large size. Some large carnivores were already present in the Triassic, and by the Late Jurassic such large forms as *Allosaurus* (*Antrodemus*) were found, with a massive skull close to a yard in length, and an over-all length of about 34 ft. Such an animal was powerful enough to attack any one of its dinosaurian contemporaries—even the great amphibious forms described below.

In the Late Cretaceous some of the carnosaurs were even more gigantic. *Tyrannosaurus*, best known of the group, was as large a carnivore as ever walked the earth, rising, in the normal slanting pose of the body, to a height of 19 ft. The degenerate front limbs—so greatly reduced that they could not reach the mouth, much less be of any use in walking—retained but two feeble fingers. The huge skull, more than 4 ft. long, was armed with many sabrelike teeth that were probably highly effective biting and tearing weapons.

3. Prosauropods.—Found in the Triassic only are members of a third group, the prosauropods. These animals, best known from *Plateosaurus* of Europe, were often of even larger size than the contemporary carnosaurs; but while they appear to have been bipedal to some degree, they were relatively clumsy in build, the front legs showing relatively little reduction, the head being small and the teeth feeble. These animals were the ancestors of the largest of all dinosaurs, the great amphibious sauropods, found in later periods.

Sauropods (Saurischian Quadrupeds).—Less varied in number of forms than the bipedal members of the order, but of interest as the largest of all known four-footed animals were the great amphibious dinosaurs classed as the suborder Sauropoda. They were abundant in the Jurassic, and many fine specimens have come from quarries in rocks of that age in Wyoming and Utah and in east Africa; they persisted into the Cretaceous but were far less common and of a restricted range.

Brontosaurus (*Apatosaurus*) and *Diplodocus* are among these giant reptiles whose skeletal reconstructions form a popular exhibit of many museums. *Diplodocus* reached a length of 87½ ft., but was of relatively slender build; *Brontosaurus*, shorter but more ponderous, is estimated to have weighed up to 35 tons. All these forms had a massive body, powerful limbs with a secondarily acquired four-footed pose (however, the forelegs were usually much shorter than the hind), a long tail and a long neck. The head was preposterously small in proportion to the body, the jaws short and weak, the teeth feeble and few in number; it is difficult to believe that such an apparatus could have served to feed such a great body unless the fodder was very soft water vegetation that could be cropped with little effort. The brain was tiny. Eyes and nostrils were high up toward the top of the skull, one of many reasons for believing that these giant reptiles were water dwellers—the animal could see and breathe with only the top of the head above the surface.

In keeping with sound engineering principles—necessary to carry

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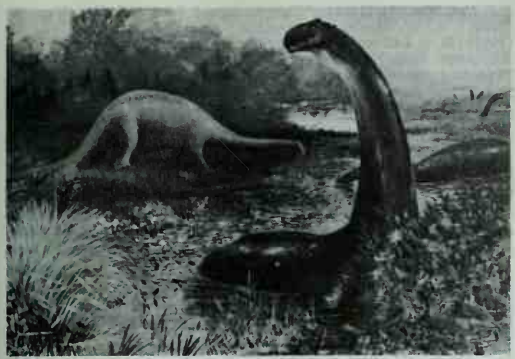
FIG. 4.—(LEFT) TRICERATOPS, A CERATOPSIAN OF THE ORNITHISCHIAN GROUP, AND (RIGHT) TYRANNOSAURUS, A CARNOSAUR OF THE SAURISCHIAN GROUP, IN A LATE CRETACEOUS LANDSCAPE



RECONSTRUCTION DRAWING BY C. R. KNIGHT, BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 5.—BRONTOSAURUS, A SAURISCHIAN QUADRUPED, IN A JURASSIC SWAMP

the tons of weight of the enormous body and transfer it to the legs—the backbone was built as an arch, strongest at its centre above the supporting columns formed by the massive hind legs. As a weight-reducing measure, the elements of the vertebrae were hollowed out at the sides, leaving only the essential framework of the bones. But even with such adaptations, it is difficult to imagine how such ponderous animals ever could have walked on land. It is reasonable to believe that these animals were amphibious, spending much of their lives in lowland swamps and lagoons where, buoyed up by the water, problems of support and locomotion were greatly simplified. The largest sauropod was *Brachiosaurus*, known both from North America and east Africa, which may have reached a live weight of 50 tons. Unusual among dinosaurs, the front legs were long, and the neck appears to have stretched almost directly upward. Were it alive today, this dinosaur could look over the top of a three-story building; it was probably adapted for living in waters of considerable depth.

BIRDLIKE DINOSAURS (ORNITHISCHIA)

Ornithischian Bipeds.—The Ornithischia, like the saurischians, are surely descended from primitive thecodont ancestors of the earlier Triassic, but connecting links are as yet unknown. Reported remains of the order in the Late Triassic are few in number, fragmentary and dubious in character. It is not until late in the Jurassic period that any adequate representation of the order is to be found. By that time several distinct types were present, the more primitive of which belong to the suborder Ornithopoda. As in the case of the primitive saurischians, these were bipeds; however, since there was relatively little reduction of the front legs, they probably could amble about on all fours when at leisure. Like all members of the order, these bipeds were herbivores.

In Jurassic and even Cretaceous times certain ornithopods remained relatively small in size. But as in other groups there was a trend toward gigantism. Well known from the Early Cretaceous of Europe is *Iguanodon*, which reached about 15 ft. in height in standing pose. In the Late Cretaceous there flourished a series of large forms technically called the hadrosaurs, the duck-billed dinosaurs.

Numerous fine skeletons of hadrosaurs have been recovered from North American rock beds, particularly from the plains of western Canada. The hadrosaurs, exemplified by *Trachodon*, owe their popular name to the fact that the toothless front ends of both upper and lower jaws were broadened to form a ducklike bill. It is probable that their diet consisted of some hard type of vegetable material; for although individual cheek teeth (small leaf-shaped structures) were present, as in other ornithischians, each cheek contained, in both upper and lower jaws, large numbers of such teeth cemented together to form a powerful grinding plate. It is estimated that a duck-billed dinosaur's mouth may have contained as many as 2,000 teeth.

A curious evolutionary trend among the hadrosaurs was the development of crested-beaked forms. In some the crest had merely the curve of a "Roman nose"; in another form this bony crest was a thin high swelling in the shape of a rooster's comb over the top of the head. In others the crest grew farther back to form a sort of horn extending over the neck region. It is uncertain what the function of these curious structures was, but it is of interest that they were formed of the bones that usually lay about the animal's nose, which had been, so to speak, pulled backward over the top of the head. In one instance dissection of a fossil skull shows that these bones contained a long, looped air passage between the nostrils and the back of the mouth. Possibly these structures were an adaptation for underwater feeding. This suggestion is reinforced by the fact that in several hadrosaur specimens in which skin impressions are preserved, the feet are seen to be webbed, indicating amphibious habits.

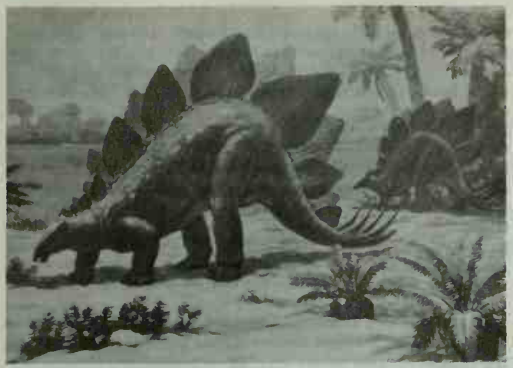
Armoured and Horned Dinosaurs.—Although bipedal members of the ornithischians flourished throughout the latter part of the Mesozoic, many others reverted to a quadrupedal condition. For a herbivore, speedy running is useful only as a means of escape from enemies, and if defensive measures of other sorts were developed, reversion to a more leisurely four-footed gait could take place. In the remaining three suborders of ornithischians defense against carnivorous dinosaur contemporaries was developed in the form of armour or horns.

Characteristic of the Late Jurassic and Early Cretaceous was a group of which *Stegosaurus* is typical. The general body proportions of stegosaurs were most unusual. The front legs (no doubt reduced during an earlier bipedal phase) were very short; in consequence, the contours of the back rose steeply from the small head to a considerable height above the long and powerful hind legs before sloping downward to the tail. The flanks appear to have been unprotected except, it is assumed, for a stout and leathery skin. Down the back was present a double row of large vertical bony plates, and the tail was armed with two pairs of long, pointed, bony spikes.

In the Cretaceous, *Stegosaurus* and its relatives were replaced by a second type of armoured dinosaur of which *Ankylosaurus* was representative. The ankylosaurs were at one time grouped as armoured dinosaurs with their stegosaurian predecessors, but they are now known to have been very different in basic structural characters as well as in protective adaptations and body proportions. These dinosaurs have been not inaptly termed "reptilian tanks." In these forms the head was massive and covered with extra bony plating in addition to the normal skull bones. The body, in contrast with that of the stegosaurs was low and broad. The entire back was solidly covered with stout bony armour which in some areas was made up of a mosaic of small bones, and in others was principally formed of large oval flat-lying plates. The tail, further, was armoured, and although the limbs had no bony covering, they were protected from attack by stout

RECONSTRUCTION DRAWING BY C. R. KNIGHT, BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 6.—TRACHODON, HADROSAUR OF THE ORNITHISCHIAN GROUP, IN A TROPICAL WYOMING LANDSCAPE DURING THE CRETACEOUS PERIOD



RECONSTRUCTION DRAWING BY C. R. KNIGHT, BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 7.—STEGOSAURUS, AN ARMOURED ORNITHISCHIAN, OF THE LATE JURASSIC AND EARLY CRETACEOUS PERIODS

spines extending out from the dorsal armour shield.

A final type of four-footed ornithischian was that of the horned dinosaurs, such as *Triceratops,* which abounded in the Late Cretaceous. In them the trunk appears to have been barren of any defensive structures; everything was concentrated on head development. A broad frill of bone extended out from the back of the head and protected the neck from attack. In addition large bony horns were generally developed on the skull. Two were usually present above the eyes, much as in modern cattle, and a third above the nose. The face terminated in a powerful parrotlike beak.

Ceratopsians, best known from North America, were generally large and powerful animals; from the Cretaceous of Mongolia, however, comes *Protoceratops,* a small and primitive form only a few feet in length with a well-developed neck frill but almost no trace of horns.

DECLINE AND EXTINCTION OF DINOSAURS

Most types of dinosaurs continued to flourish until the very latest phases of the Cretaceous, last of the Mesozoic periods. Then they disappear completely from the geologic record; the earliest beds of the Cenozoic, the age of mammals, which appear to follow closely in time, show not the slightest trace of a dinosaur. What caused this sudden extinction? The answer is not at all clear. Temperature changes, epidemics, eating of dinosaur eggs by early mammals, have all been suggested but are far from satisfactory.

It appears probable that a major cycle of mountain building that began in the Cretaceous may have been a major factor. Higher land levels would tend to reduce the lowland areas where dinosaurs flourished; new mountain chains would change climates and may have been important in stimulating evolutionary changes in the plant life upon which dinosaurs fed. Decline of herbivorous dinosaurs would have been disastrous to the flesh eaters that fed upon them. The decline of dinosaurian life can, thus, be reasonably accounted for. However, there is no really satisfactory explanation for the sudden and complete extinction of the most spectacular animal fauna the earth has ever known. *See* PALEONTOLOGY; REPTILE; *see* also references under "Dinosaur" in the Index.

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(A. S. RR.)

DINOSAUR NATIONAL MONUMENT, in northwestern Colorado and northeastern Utah, part of which was set aside in 1915 to preserve rich fossil beds, including remains of dinosaurs. The monument was enlarged from its original 80 ac. to approximately 200,000 ac. in 1938 in order to protect the spectacularly beautiful canyons of the Green and Yampa rivers which cut through 21 tilted and highly coloured geological formations of the Uinta plateau, representing at least 20,000 vertical feet, in deeply incised meanders. The rivers join near famous Steamboat rock, near the centre of the monument, and flow westward as the Green. The colourful canyon walls, rising nearly 2,000 ft. from the water, sometimes vertically and sometimes in varicoloured terraces and steps, can best be seen from the rivers. A 90-mi. river trip, alternating peacefully flowing current and exhilarating white water, can be made under the guidance of concessionaire boatmen in five or six days. Wildlife seen in the monument include deer, beaver, bighorn sheep, antelope, Canada geese, and many others. Pictographs and other evidences of prehistoric Indian life are found in the canyons. Nature trails, campsites and picnic grounds are provided for visitors. The fossil quarry and museum, both open to the public all year, are located at the monument headquarters in the southwestern corner of the monument.

The proposed construction of dams in the monument at Echo park and Split mountain gorge as a part of the upper Colorado river basin storage project resulted in delay from 1950 to 1956 of congressional authorization because of opposition by conservationists and an aroused public opinion on the basis that the dams would destroy the unique features of the monument and set a precedent for similar invasions of other national parks and monuments. The controversy was finally resolved when the bill was so amended as to ensure that no violation of a national park or monument unit would be permitted.

See Wallace Stegner, *This Is Dinosaur* (1955). (HA. C. B.)

DINWIDDIE, ROBERT (1693–1770), British colonial administrator and lieutenant governor of Virginia during the French and Indian War. He was born in 1693 at Germiston, a few miles from Glasgow, Scot., and was trained in the countinghouse of his father. He later attended Glasgow university. In 1721 he was appointed Britain's representative on the island of Bermuda in charge of admiralty affairs. There he gained experience as a colonial administrator, and in 1738 assumed the post of surveyor general of customs of the southern district in America, which included the continental colonies from Pennsylvania southward and the Bermudas and Jamaica. During the 1740s Dinwiddie made at least two detailed reports on the state of the colonies which exhibited his ability as a governmental statistician on economic and military affairs. In 1751, two years after Dinwiddie resigned from the customs service, he accepted the appointment as lieutenant governor of Virginia. (Dinwiddie was in fact governor, since the titular governorship was a sinecure belonging to William A. Keppel, the second earl of Albemarle.) In Williamsburg, Va., where Dinwiddie made his home with his wife and two daughters, he quickly immersed himself in the affairs of the colony, especially the problems relating to Indian diplomacy and threats of French occupation in the west. Even before assuming the governorship Dinwiddie had become a member of the Ohio Company of Virginia which hoped to bring settlers to occupy a large tract of land that included the area of the forks of the Ohio river where the city of Pittsburgh now stands. Alarmed at what he believed to be encroachments on Ohio company lands, Dinwiddie in 1753 sent young George Washington to warn the French that they were occupying lands claimed by the English. After learning of French plans for further occupation of the Ohio area, Dinwiddie in Feb. 1754 sent Washington back to the frontier with troops, and following Washington's capitulation to the French at Ft. Necessity, he made efforts

to obtain Virginia financial support for another expedition against the French.

After the defeat of Gen. Edward Braddock's army in July 1755, defense against marauding Indians on the wide Virginia frontier devolved on Dinwiddie. He raised ranger companies and a regiment under Washington, built fortifications, and with little success sought intercolonial co-operation for defense. Finally after extended negotiations, he brought together about 400 southern Indian tribesmen for a conference at Winchester in 1757 which resulted in temporary pacification on the Virginia frontier.

Because of failing health Dinwiddie left Virginia at his own request on Jan. 12, 1758, and died on July 27, 1770, in Bristol, Eng. He has often been called one of the ablest governors in the American colonies.

See Louis Knott Koontz, *Robert Dinwiddie, His Career in American Colonial Expansion* (1941); Wilbur R. Jacobs, *Diplomacy and Indian Gifts* (1950). (W. R. J.)

DIO CASSIUS (Cassius Dio) **COCCEIANUS** (*c.* A.D. 150–235), Roman administrator and historian, was the author of *Romaika*, a history of Rome, which is a most important authority for the last years of the republic and the early empire. It was written in Greek. He was born at Nicaea in Bithynia, the son of Cassius Apronianus, governor of Dalmatia and Cilicia under Marcus Aurelius, and on his mother's side he was the grandson of Dio Chrysostom. After his father's death Dio Cassius went to Rome (180) and became a member of the senate. During the reign of Commodus, he practised as an advocate and held the offices of aedile and quaestor. He was raised to the praetorship by Pertinax but did not assume office till the accession of Septimus Severus with whom he was for long on intimate terms. By Macrinus he was entrusted with the administration of Pergamum and Smyrna, and on his return to Rome he was made consul. After this he obtained the proconsulship of Africa, and again on his return was sent as legate successively to Dalmatia and Pannonia. He was granted a second consulship by Alexander Severus, in 229, but soon afterward retired to Nicaea, where he died. Before writing his history Dio Cassius had dedicated to Severus an account of various prodigies which had presaged his elevation to the throne (perhaps the *Enodia* attributed to him in the Suda lexicon), and had also written a biography of his fellow-countryman Arrian. The history of Rome consisted of 80 books beginning with the landing of Aeneas in Italy and ending in the reign of Alexander Severus (222–235). Books 36–60 (68 B.C.–A.D. 47) have survived; books 36 and 55–60 are imperfect. Part of 35 and 36–80 are included in the epitome of Joannes Xiphilinus, an 11th-century Byzantine monk. For the earlier period the loss of Dio's work is partly supplied by the history of Zonaras, who followed him closely. Numerous fragments are also contained in the excerpts of Constantine Porphyrogenitus. Dio's industry was great and the various offices he held gave him opportunities for historical investigation. His narrative shows the hand of the practised soldier and politician; the language is correct and free from affectation. But his work, although far more than a mere compilation, is not remarkable for impartiality, vigour of judgment or critical historical faculty.

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DIOCESE, the territorial area administered by a bishop. The original use of the word was entirely secular. The completion by Constantine I in the 4th century of the administrative reforms of the Roman empire begun by Diocletian divided the four prefectures of the empire into 13 dioceses governed by imperial vicars. The church, in its progressive expansion, adapted this secular pattern to its own requirements. The secular diocese was subdivided into provinces each under its own governor, but in the ecclesiastical adaptation the province became the larger territorial unit, administered by a metropolitan bishop and subdivided into dioceses. The original unit of ecclesiastical administration was the parish (Gr. *paroikia*), which in the Orthodox Eastern Church still remains the designation of the area administered by the bishop, the diocese being the area administered by the patriarch. The use of these terms was still fluid in the west in the 9th century, when Hincmar, archbishop of Reims, referred to the province as his diocese and his immediate bishopric of Reims as his parish. But by the 13th century "diocese" had settled down to mean the bishop's territorial area.

In the Roman Catholic Church only the pope can divide or merge dioceses, or create new ones (*e.g.*, in missionary territory). All dioceses are divided into parishes, and some large ones into rural deaneries also. The clergy share in diocesan administration and normally attend a diocesan synod once a year.

In the Church of England new dioceses have been created by statute as a result of dividing existing ones in the 16th, 19th and 20th centuries. To give effect to the spiritual charge which the bishop has over all the inhabitants of his diocese, the diocese is subdivided into parishes in each of which is a priest who has the "cure of souls" under licence from the bishop. Parishes are grouped in rural deaneries, and rural deaneries in archdeaconries.

(J. W. L.)

DIO CHRYSOSTOM (Dion Chrysostomus, the "golden-mouthed") (*c.* A.D. 40–after 112) also called Dio Prusaeus and Dio Cocceianus, Greek rhetorician and philosopher, won fame in Rome and throughout the empire for his writings and speeches. Born at Prusa in Bithynia of well-to-do parents *c* A.D. 40, he was banished in A.D. 82 on political grounds both from Bithynia and Italy, and wandered for 14 years through the lands near the Black sea, adopting the poverty-stricken mode of life advocated by the Cynics. With the death of the emperor Domitian his exile ended and he made a new career as a public speaker and philosopher.

A collection of 80 "orations" with fragments of others survives, but some are dialogues or moral essays, and two (xxxvii and lxiv) are spurious, being probably the work of a pupil, Favorinus of Arelate (Arles). Four are speeches addressed to Trajan *On Kingship* (i–iv); the *Olympicus* (xii) shows the sculptor Phidias explaining the principles followed in his famous statue of Zeus, one passage being supposed by some to have suggested the German dramatist G. E. Lessing's *Laocoon; On Aeschylus, Sophocles and Euripides* (iii) compares the treatment of the story of Philoctetes by each tragedian. Best known is the *Euboicus* (vii), depicting country life on the island of Euboea, an important document for social and economic history.

A patriotic Greek who accepted Roman rule, Dio typifies the revival of Greek self-confidence under the Roman empire which marks the beginning of the new or second sophistic movement in the 2nd century A.D. In style he belongs to the archaizing Atticist school. As a philosopher he was not original, but blended elements from Stoicism and Cynicism.

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DIOCLES (fl. 4th century B.C.), of Carystus in Euboea, Greek physician, second only to Hippocrates in reputation and ability according to tradition, was a pioneer in more than one department of medicine. He resided at Athens and was the first to write medical treatises in Attic Greek, breaking with the tradition of using Ionic for such writings; only fragments, however, of his works survive. He is usually regarded as the chief representative of the "dogmatic" school, but this description is scarcely informative. He wrote on a variety of subjects, including animal anatomy (the first systematic textbook on this subject, in connection with which he practised dissection), dietetics (zoological questions were also discussed in the same work), physiology, embryology and medical botany (here again his book was probably the first work of its kind and may have been used by Theophrastus).

It was once supposed that Diocles was a contemporary of Plato, but W. Jaeger, interpreting the evidence in relation to the philosophical background, has shown that he must have been a contemporary, perhaps a slightly younger contemporary, of Aristotle;

Valentin Rose, however, had already stated (*Aristoteles pseudepigraphus*, 1863, p. 380) that there was no ground for dating Diocles earlier than Aristotle. His most probable dates are 375–300 B.C. (Jaeger's subsequent arguments for a date 30 to 40 years later are less cogent).

In doctrine, Diocles shows a "synthetic" tendency, combining the influence of Hippocratic medicine and that of the Sicilian school, of which Archidamus, his father, had been an adherent; and in his terminology and methodology there are clear indications of Aristotelian influence. It seems certain that he had at his disposal some sort of corpus of Hippocratic writings; it may have been put together by him. He was, however, much more than a compiler and systematizer, although his work in reorganizing medicine on the theoretical side was of the first importance; on the practical side he undoubtedly struck out on original lines. His work on zoology may have been used by Aristotle.

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DIOCLETIAN (GAIUS AURELIUS VALERIUS DIOCLETIANUS), Roman emperor A.D. 284–305, effected an administrative and financial reorganization of the Roman empire and also ordered the last great persecution of the Christians. Originally called Diocles, he was a Dalmatian of very humble birth who rose by military service to be commander of the *protectores* under the emperor Numerian. When it was discovered that Numerian had been murdered, the army at Nicomedia (Izmit, on the sea of Marmara near the Bosporus) proclaimed Diocletian emperor (Nov. 20, 284). His first act was to kill with his own hand the alleged assassin, the praetorian prefect Aper. He then marched against Numerian's brother, Carinus (*q.v.*), who was ruling in the west. They met at the Margus river (Morava in Yugoslavia) in 285 and Carinus was killed in the battle. Diocletian ruled for over 20 years, abdicating on May 1, 305, and during his long reign carried through a great reorganization of the empire which gave it a new lease of life after the disastrous civil wars and invasions of the mid-3rd century.

The Tetrarchy.—The most crying need of the empire was to check the succession of military pronunciamentos which had produced usurper after usurper in the past 30 years. Diocletian did something to this end by emphasizing the divine sanctity of the emperor's person and introducing a more dignified court ceremonial, derived from the Persian monarchy. In this, however, he was merely developing tendencies long current—indeed his immediate predecessors had claimed divinity more expressly than he did—and it is doubtful if these measures would by themselves have protected him against rebellions and mutinies any more than they did his predecessors and successors. More important was his creation of a team of emperors to share the rule of the empire. Immediately after the battle of Margus he appointed a trusted friend, Maximian (*q.v.*), as Caesar to take charge of the Gauls where the peasant Bagaudae had revolted, and early the following year he made him his full colleague as Augustus. Constitutionally the two Augusti were equal, Diocletian being merely the senior of the pair, but in practice he dominated his colleague. Their relation was symbolized by the divine surnames which they adopted. Diocletian was Jovius, the representative on earth of Jupiter, king of the gods, Maximian Herculius, the counterpart of Hercules who by his heroic labours fulfilled Jupiter's will. Seven years later on March 1, 293, Diocletian created two Caesars, Galerius (*q.v.*) to serve under himself and Constantius I Chlorus (*q.v.*) under Maximian. The Caesars were adopted into the Jovian and Herculian families and married to daughters of their respective chiefs. In theory the four emperors ruled the empire as colleagues, all official pronouncements being made in their joint names. In practice they administered separate zones with their own governments and armies. Maximian ruled Italy and the western provinces, and Constantius took over Gaul and Britain from him. Diocletian ruled Illyricum, Egypt and the east; his Caesar, Galerius, seems to have been assigned various tasks in this area according to the needs of the moment.

This tetrarchy produced the desired stability. Four emperors could more effectively maintain touch with the widely separated army groups than could one, and in the event of a rebellion or other crisis one of the colleagues could deal promptly with it while the others held the fort elsewhere. In fact there were only two serious revolts, that of Carausius (*q.v.*) and Allectus in Britain (286–296), ultimately suppressed by Constantius, and that of Domitius Domitianus (or Achilleus) in Egypt (296–297), promptly crushed by Diocletian himself. The success of the tetrarchy, however, depended on the concord of its members, and this was ensured by Diocletian's dominating personality. This was demonstrated by the course of events after his retirement, when the emperors soon quarreled among themselves and another series of civil wars followed.

The tetrarchy was also designed to solve the problem of the succession. When Diocletian abdicated he forced Maximian to do so simultaneously: the two Caesars were proclaimed Augusti, and two new Caesars were nominated. There would thus always be two experienced rulers ready to take over. The succession would go by appointment and adoption; the claims of sons of emperors were ignored. The scheme was too artificial to work and broke down at once. It made no allowance for accidents, such as the death of Constantius after one year's rule as Augustus. It did not take into account the natural ambition of emperors' sons or the strong preference of the army for them: Constantius' son Constantine I and Maximian's son Maxentius (*qq.v.*) had no difficulty in getting the armies to proclaim them.

Diocletian was no more than a competent general and left most of the fighting to his colleagues. The only war in which he is known to have personally taken command after the nomination of the Caesars is that against Domitius Domitianus and when hostilities with Persia broke out in 296 he entrusted the command to Galerius. In military affairs he was somewhat conservative. He greatly increased the size of the army, perhaps doubling its numbers, but maintained in principle the traditional policy of stationing it along the frontiers, which he greatly strengthened with roads and forts. Each emperor had a field army (*comitatus*) at his disposal, but these armies seem to have been very small, and for any major compaign had to be strengthened by detachments drawn from the frontier forces.

Reorganization of the Empire.—It was as an administrative and financial reformer that Diocletian made his mark upon the empire. He approximately doubled the number of the provinces, subdividing the largest into as many as six, as he did in Asia. The object was not to weaken over-powerful governors—the proconsul of Asia, who had no troops, was no danger—but to increase the efficiency of the administration. To lighten the work of the central governments the provinces, now numbering about 100, were grouped into twelve large divisions, called dioceses, each controlled by a deputy (*vicarius*) of the praetorian prefects, and by representatives of the two financial ministers, the *rationales rei summae* ("general treasurers") and *magistri rei privatae* ("masters of the privy purse"). In many of the frontier provinces he separated the military command from the civil administration, appointing a *dux* to command the forces of a province or group of provinces. Here again his object was probably to increase efficiency rather than to guard against rebellion; the *dux* of the three provinces of Egypt, the Thebaid and Libya commanded a very substantial army. The division of power was not extended to the praetorian prefects (and their *vicarii*), who combined military with administrative, judicial and financial functions.

Economic Reforms.—Diocletian found the currency hopelessly debased: the old silver *denarii* had been replaced by silver washed copper *nummi* and gold had gone out of circulation. He issued gold coins (at 70 and later 60 to the pound) and from 296 silver *denarii* (at the old rate of 96 to the pound) and larger and superior *nummi*. But he could not issue enough coins of gold and silver—which had vanished into hoards—and flooded the market with *nummi*. The result was that *nummi* depreciated in relation

to the gold and silver coins and prices continued to rise. In 301 Diocletian issued his famous edict on prices, whereby he endeavoured to fix maximum prices in detail for all varieties of goods (including gold and silver, whether in bar or coin), and maximum wages, by day or piece, for all kinds of services. The penalty for exceeding these prices or withholding goods from the market was death, but though there were many executions the edict proved unenforcible. Nevertheless, although he failed to stabilize the currency Diocletian put the state finances on a sound basis. During the inflation the government had come to pay its employees mainly in kind, obtaining the necessary foodstuffs and clothes by compulsory purchase or requisition (*indictio*). Diocletian organized these *indictiones*, hitherto irregular, into a system. By a series of censuses all landed property was assessed in fiscal units, generally known as *iuga*, which were of uniform value in each diocese (complete uniformity throughout the empire was no doubt unattainable for practical reasons), and the animal and human population was similarly assessed in fiscal units known as *capita*. It was the duty of the praetorian prefects to estimate the quantities of goods required in each year, and to issue an annual *indictio* stating how much would be required from each *iugum* and *caput*. The burden was thus (in theory at any rate) equitably distributed over all the land of the empire (including Italy, which thus lost its old fiscal immunity). The burden could moreover be adjusted annually according to the needs of the empire. Other levies were imposed on the same assessment of *iuga* and *capita*, of conscripts for the army and of forced labour for public works (Diocletian was a great builder; impressive remains survive of his huge baths at Rome and his vast palace at Split). It may be noted that house property and the urban population were not entered in the census and thus remained untaxed.

Religious Policy.—It is somewhat surprising that having for many years maintained his predecessors' policy of tacit toleration of the Christians, Diocletian should have taken drastic action toward the end of his reign, and it seems likely that, as stated by Lactantius, Galerius, who was undoubtedly a rabid pagan and whose influence increased in Diocletian's latter years, was the prime mover of the persecution. It is unlikely, however, that Diocletian acted contrary to his own convictions. He seems to have been a religious man of rather old-fashioned piety. There is extant a law of his against incestuous marriages which is strongly religious in tone: in it he declared that the continued favour of the immortal gods to the Roman empire was dependent on his subjects' leading pious, religious and chaste lives. In another law he enacted the severest penalties against the new sect of the Manichees, partly because they derived their doctrines from the hostile race of the Persians, but more on the general ground that the established religion was inspired by the immortal gods and that all innovation was impious. Diocletian is therefore unlikely to have viewed with favour a sect which denied all the gods in favour of a newfangled deity, but it was apparently with reluctance that he undertook the formidable task of trying to extirpate it.

According to Lactantius he was first roused to action when at an official sacrifice the priests, unable to obtain omens, declared that Christians present, by making the sign of the cross, had offended the gods. Infuriated by this contumacious obstruction of public worship, Diocletian ordered that all Christians be discharged from the army and civil service unless they sacrificed. This probably happened about 298, and it was not until about five years later that Diocletian, having consulted the oracles, issued his first general edict against the Christians (Feb. 23, 303). It enacted that all copies of the scriptures should be surrendered and burned, that all churches should be closed and meetings of Christians banned. Two fires in the palace at Nicomedia—alleged to have been engineered by Galerius—were imputed to Christian incendiaries, and a second edict was issued, ordering the arrest of all the clergy. Some months later the imprisoned clergy were all forced to sacrifice, and then, with the exception of a few obstinate recusants, released. Finally in the spring of 304 an edict was issued, ordering all the inhabitants of the empire to sacrifice. The persecution ceased in the west after Maximian's abdication, but in the east continued intermittently until 313.

Retirement.—In 303 Diocletian paid what was probably his first visit to Rome to celebrate his *vicennalia* (the twentieth anniversary of his accession). During his return journey in the following year he suffered a very severe and prolonged illness, and on May 1, 305, he abdicated at Nicomedia. He spent his last years in the magnificent palace which he built for himself near Salona in Dalmatia, now the town of Split (Spalato). Though pressed by Galerius to resume the throne in 308 he refused. The date of his death is uncertain (probably 313).

Diocletian was evidently a dominating personality, who commanded the implicit loyalty and obedience of his colleagues and ministers. He was ruthless in enforcing his will, and reserved, not to say secretive, in temperament, and was respected but not beloved by his contemporaries. He distrusted and disliked the senate, whose members he almost entirely excluded from the administration, but in many other ways he upheld Roman traditions, notably in religion and in the law. On the other hand he was a bold innovator where circumstances required it. He greatly strengthened the military and administrative structure of the empire, but the increased size of the army and civil service imposed a heavy strain on its manpower and financial resources. To fill the ranks of the army conscription was ruthlessly enforced and the sons of soldiers compelled to serve. To pay and feed it the taxes in money and kind were increased, and to make sure that the peasants paid their poll tax and produced the foodstuffs required they were compelled with their children to remain in the places where they were registered in the census. Diocletian has been much criticized for thus regimenting society. But in so doing he was only accentuating certain basic principles of Roman law and reinforcing existing social tendencies. Under Roman law every man owed certain obligations to the community to which he belonged by birth; in practice service in the army had long been largely hereditary; and in Egypt at any rate it was an old rule to recall the peasants to their place of origin at every census. To support the increased burden of defense against the barbarians every citizen had to play his full part, and the simplest and, to contemporary thinking, the most natural way of achieving this object was to insist that every citizen fulfilled the function to which he was born. *See* also references under "Diocletian" in the Index volume.

BIBLIOGRAPHY.—Original sources for Diocletian's reign are scanty. Apart from papyri and inscriptions, notably the edict on prices reproduced in T. Frank, *An Economic Survey of Ancient Rome*, vol. v, pp. 301–421 (1940), and laws preserved in the *Codex Justinianus* and elsewhere, the only contemporary sources are the last part of Eusebius' *Ecclesiastical History*, which describes the persecution, and Lactantius' *de mortibus persecutorum*, a highly biased but informative pamphlet. Among later historians there are only brief chapters in Aurelius Victor, Eutropius and Orosius. Modern studies are also few. The reign is treated in the *Cambridge Ancient History*, vol. xii, pp. 323–408, 661–667 (1956): there are good monographs on Diocletian by G. Costa in E. de Ruggiero, *Dizionario epigrafico*, vol. ii, pp. 1797–1888 (1912), and by W. Ensslin in Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, 2nd series, vol. vii, 2419–2495 (1948).

(A. H. M. J.)

DIODATI, GIOVANNI (1576–1649), Swiss Calvinist pastor known for his translation of the Bible into Italian, was born in Geneva, June 6, 1576, of a refugee Protestant family from Lucca. He became a pastor at Geneva in 1608, and professor of theology in 1609. He was a leader of the reformers, being an eloquent, bold and fearless preacher, and a rigid Calvinist. He conducted a mission to France in 1614 and was appointed to record the proceedings of the synod of Dort (1618–19). His Italian translation of the Bible was first published in 1603. He was also the author of a translation into French and of biblical annotations and polemical treatises. Diodati died on Oct. 3, 1649.

See E. de Budé, *Life of G. Diodati*, trans. by M. Betts (1905).

DIODORUS CRONUS (fl. 4th century B.C.), Greek philosopher of the Megarian school, born at Iasus in Caria, was a pupil of Apollonius of Cyrene; the surname Cronus, of uncertain meaning, was applied both to him and to his teacher. Through Apollonius he is linked with Eubulides (*q.v.*), and these three represent that branch of the Megarian school which was strong in formal logic. Diogenes Laërtius has a story that, at the court of Ptolemy Soter, Diodorus failed to solve a logical problem propounded by Stilpo and died of shame at his failure (*c.* 307 B.C.).

Diodorus raised difficulties about movement that resemble those of Zeno, but was prepared to admit that it is true to say that a thing has moved from *A* to *B:* it is the process of moving that is unintelligible. In connection with this, he maintained that there are atomic minima of physical substance. Departing from the earlier Megarian doctrine, he asserted that the possible is that which either is real now or will be real. His view of the meaning of conditional propositions (*see* LOGIC, HISTORY OF) was defended by a famous argument (the so-called *kurieuon logos*) the precise form of which is uncertain.

See I. M. Bocheński, *Ancient Formal Logic* (1951). (D. J. A.)

DIODORUS SICULUS (fl. 1st century B.C.), Greek historian, was the author of a universal history *Bibliotheca historica.* Born at Agyrium in Sicily, he lived in the time of Julius Caesar and Augustus, and his own statements make it clear that he traveled in Egypt during 60–57 B.C. and spent several years in Rome. The latest event mentioned by him belongs to the year 21 B.C. His history consisted of 40 books and was divided into three parts. The first treats of the mythic history of the non-Hellenic and Hellenic tribes to the destruction of Troy; the second ends with Alexander's death; and the third continues the history as far as the beginning of Caesar's Gallic War. Of this extensive work there are extant only the first five books, treating of the mythic history of the Egyptians, Assyrians, Ethiopians and Greeks; and also the 11th to the 20th books inclusive, beginning with the Greco-Persian War of 480–479, and ending with the history of the successors of Alexander, before the partition of the Macedonian empire (302). The rest exists only in fragments preserved in Photius and the excerpts of Constantine Porphyrogenitus.

The faults of Diodorus arise partly from the nature of the undertaking and partly from his use of an annalistic form which sets him chronological problems beyond his powers. He lacks the critical faculty; he repeats and contradicts himself; and his simple diction, intermediate between pure Attic and the colloquial Greek of his time, makes it possible sometimes to detect undigested fragments of his materials. Yet the *Bibliotheca,* invaluable where no other continuous historical source has survived, is of considerable value, too, as supplying to some extent the loss of the works of earlier authors, from which it is compiled. He does not always quote his authorities, but in the books which have survived his most important sources for Greek history were certainly Ephorus (for 480–340 B.C.) and Hieronymus of Cardia (for 323–302).

In particular sections (*e.g.,* for Sicily, or the reign of Alexander) Diodorus followed special authorities, who cannot always be named for certain. For chronology he used probably Apollodorus of Athens and Castor of Rhodes, and for geography Megasthenes (perhaps at second hand), Agatharchides and Artemidorus.

BIBLIOGRAPHY.—*Editio princeps* by H. Stephanus (1559); others by P. Wesseling (1746) not superseded and (text) L. Dindorf (1866–68), rev. by F. Vogel (1888–93) and C. T. Fischer (1905–06); text with Eng. trans. in "Loeb Series," 12 vol. (1933–57). *See* also Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft* (1903); A. von Mess in *Rheinisches Museum,* 244 ff. (1906); N. G. L. Hammond in *Class. Quart.,* 79 ff. (1937) and 137 ff. (1938); W. Kolbe in *Hermes,* 241 ff. (1937); S. Accame in *Rendiconti della Accademia dei Lincei,* 347 ff. (1938); S. Palm, *Über Sprache und Stil des Diodoros von Sizilien* (1955). (G. T. GR.)

DIODOTUS, the name of a satrap of the Seleucid province of Bactria in the 3rd century B.C. who, together with his son of the same name, may be reckoned as having founded the Greek kingdom of Bactria. In the later period of his life he was acting the part of an independent ruler. Indeed, Justin (3rd century A.D. or later) declares that he took the title of king after revolting against the Seleucid house. If this is correct, there is unfortunately no means of dating the occurrence. On the other hand, it has been conjectured on numismatic evidence (by W. W. Tarn) that the Seleucid king Seleucus II, in order to secure his friendship, married one of his sisters to Diodotus at a time (246) when the Seleucid empire was in chaos and Bactria one of its few stable parts. The death of Diodotus belongs shortly before the expedition of Seleucus II against the Parthians, the date of which is uncertain (possibly 228). He was succeeded by his son Diodotus II who unquestionably ruled as a king, since he coined in his own name; he was overthrown by the rebel Euthydemus (*q.v.*).

Diodotus I had been the enemy of the Parthians, which is consistent with the supposition that he remained on friendly terms with the Seleucid kings; in contrast, his son, by joining hands with the Parthians against Seleucus II, proclaimed unmistakeably the independence of Bactria. Diodotus I was called after his death by the cult-name *Soter* ("saviour"). It is not clear whether there is in this name the commemoration of any historical event. *See* also BACTRIA. (R. H. SI.)

DIOGENES (fl. 4th century B.C.), originator and archetype of the sect of the Cynics (*q.v.*), was born at Sinope on the Black sea, and died as an old man about 320 B.C., probably at Corinth, where his monument was surmounted by a marble dog, the emblem of the sect. A picturesque figure, he became the centre of a legend, some of which seems attributable to the invention of Menippus (*q.v.*). Many of the best-known stories about him are apocryphal: for instance, how the only boon that he would beg of Alexander the Great was that he should stand out of his light; and that, sold into slavery, he declared his trade to be that of governing men and was appointed tutor to his master's sons. It is virtually certain that he was exiled with his father from Sinope; he had probably already adopted his life of asceticism when he reached Athens (at an unknown date); and not later than 330 B.C. Aristotle refers to him as a familiar figure, nicknamed "the Dog." He made it his mission to "deface the currency," perhaps meaning "to put false coin out of circulation"; *i.e.,* to expose the falsity of most conventional standards and beliefs. In so far as he had a positive ideal, it was one of a self-sufficiency unshaken by fear, pain or desire, to be won by an unremitting discipline of body and mind. Tradition, untrustworthy in detail, cannot be wrong in portraying him as the possessor both of a biting wit and of showmanship, exemplified by the story of his going out in broad daylight with a lantern "in search for an honest man." He relied on example as well as on words, and his actions were designed to show how few were man's needs. His dress, later to be Cynic uniform, was that of a vagabond beggar, with a stick, a wallet for alms and a cloak, which, when doubled, served at night as a blanket. He needed no roof over his head but what he could find in public buildings, or made (as familiar legend has it) his home in a tub. His famous claim to be a "citizen of the world" is another aspect of the same denial of supposed necessities; the ordinary Greek could not imagine a good life except as a member of the exclusive community that he called a *polis.* The authenticity of the writings (now lost) attributed to him—dialogues, plays and the *Republic*—was disputed; one reason was that they contained shocking passages in defense of cannibalism, incest, etc., appropriate to the historical Diogenes but embarrassing to later followers. The *Republic* at least can hardly be doubted; it described an anarchist Utopia, in which men lived "natural" lives. (F. H. SH.)

DIOGENES APOLLONIATES (5th century B.C.), Greek eclectic philosopher, interesting for his cosmology and for his physiology, was born at Apollonia (whether the Cretan Apollonia or the Phrygian is uncertain), but moved to Athens. In Athens his opinions once caused his life to be in danger; and they were derided, as those of Socrates, by Aristophanes in *The Clouds.* He wrote in Ionic Greek, and considerable fragments of his work are extant. His most important book was *On Nature;* writings *Against the Sophists* and *On the Nature of Man* may have been sections of it. Diogenes is notable for his reconciliation of the doctrines of Anaximenes of Miletus with those of Anaxagoras (*qq.v.*), which he achieved by taking the former's theory that air is the one source of being and attributing intelligence to it as well. Aristotle in his *Historia animalium* quotes a long passage from Diogenes on veins.

BIBLIOGRAPHY.—For the fragments *see* H. Diels and W. Kranz, *Fragmente der Vorsokratiker,* ii, 8th ed. (1956); F. W. A. Mullach, *Fragmenta philosophorum graecorum* (1860). *See* further G. P. Weygoldt, "Zu Diogenes von Apollonia," *Archiv für Geschichte der Philosophie,* i, pp. 161 ff. (1888); E. Krause, *Diogenes von Apollonia* (1908); H. Diller, "Die philosophiegeschichtliche Stellung des Diogenes von Apollonia," *Hermes,* pp. 359–381 (1941); J. Zafiropulo, *Diogène d'Apollonie* (1956); and general histories of early Greek philosophy.

DIOGENES LAËRTIUS (3rd century A.D.) is best known

as the author of a history of Greek philosophy, which, being the only one of its kind the bulk of which is extant, constitutes the most important single secondary source of our knowledge in this field. One of its traditional titles, *Lives and Opinions of Famous Philosophers*, is indicative of its scope. A compilation, it is often analyzable into its original excerpts, many of which are inserted in the wrong place (whatever the explanation of this may be). These excerpts range from insignificant gossip to valuable biographical and bibliographical information, competent summaries of doctrines and reproductions of important documents (*e.g.*, wills) or philosophical writings (*e.g.*, three letters of Epicurus). Diogenes quotes hundreds of authorities, but most of them he knows from second hand only; his true sources (some of which must themselves have been compilations) have, with some exceptions, not been ascertained. The whole work, in ten books, after a kind of introduction (book i), presents Greek philosophy as divided into an Ionian and an Italic branch (books ii–vii; viii) with "successions," that is to say schools, within each and with "stray" philosophers appended (books ix–x). In all extant manuscripts (the oldest belongs to the 12th century) part of book vii is missing.

Bibliography.—There are useful editions of Diogenes Laërtius by C. G. Cobet (1850) and by R. D. Hicks, 2 vol. with Eng. trans. and bibliography (1925); the Ger. trans. by O. Apelt, 2 vol. (1921), is also of some importance. *See* further R. Hope, *The Book of Diogenes Laërtius: Its Spirit and Its Method* (1930); M. Dal Pra, *La Storiografia filosofica antica* (1950); P. Moreaux, "La Composition de la 'Vie d'Aristote' chez Diogène-Laërce," *Revue des études grecques*, 63 (1955), on a special topic but illustrative of certain methodological problems. (Pp. M.)

DIOGNETUS, EPISTLE TO, an early Christian apologetic work, of unknown authorship (though once attributed erroneously to Justin Martyr), dating probably from the 2nd or 3rd century. It survived antiquity in one 13th–14th-century manuscript, which perished by fire at Strasbourg in 1870. *See* Apostolic Fathers.

DIOMEDEIDAE, the albatross family of large, stout-bodied birds remarkable for their almost exclusively oceanic life and their seemingly effortless flight. *See* Albatross.

DIOMEDE ISLANDS, two small islands in the Bering strait, lying about 2½ mi. apart and separated by the international boundary between the United States and the Union of Soviet Socialist Republics, which coincides there with the international date line. They were discovered by Vitus Bering on Aug. 16, 1728 (St. Diomede's day) and are icebound six to seven months of the year. The larger, Big Diomede or Ostrov Ratmanova (Ratmanov Island), belongs to the U.S.S.R. and is the site of an important Soviet weather station. Little Diomede is part of Alaska. Its population in 1960 was 88; that of Big Diomede is somewhat larger. (L. D. Bl.)

DIOMEDES, the name of two figures in Greek legend. Diomedes, son of Ares, king of the Thracian Bistones, was the owner of mares to which he fed human flesh. Hercules, as his eighth labour, killed Diomedes and captured the mares.

Diomedes, the son of Tydeus, whose death at Thebes he avenged, was commander of 80 Argive ships and one of the most respected leaders in the Trojan War. Homer represents him as younger than other leaders, entirely devoted to the heroic ideals of warfare; as such, he constitutes a perfect foil for the behaviour of Achilles. Diomedes' famous exploits include the wounding of Aphrodite, slaughter of Rhesus and his Thracians, seizure of the Trojan Palladium (*q.v.*) and concealment in the Trojan horse. After the war Diomedes returned to Argos, to find that Aphrodite had vengefully made his wife Aegialea unfaithful. He sailed to Italy and founded Arpi in Apulia, eventually making peace with the Trojans (*Aeneid*, 11, 243 ff.). Before or when he died, his men became herons (Ovid, *Metamorphoses*, 14, 457 ff.). Diomedes was worshiped as a hero in Argos and Metapontum. (Wm. S. A.)

DION (*c.* 408–354 B.C.), the son of Hipparinus, and brother-in-law of Dionysius the Elder, was intermittently master of Syracuse between 357 and 354. He combined serious intellectual interests with considerable military and administrative ability. When the younger Dionysius, who was weak and inexperienced, succeeded, Dion assumed control and persuaded Plato, whose friendship he had acquired when Plato visited the court of the elder Dionysius, to return to Syracuse and to train the new tyrant in the practical application of his philosophical principles. The experiment failed, and roused hostility among the supporters of the tyranny. The historian Philistus set Dion at variance with the tyrant, and procured his banishment on a charge of intriguing with the Carthaginians. Dion remained for a while at Athens but in 357, assembling a force of 1,500 mercenaries at Zacynthus, he sailed to Sicily and was received with demonstrations of joy. Dionysius, who was in Italy, returned to Sicily, but was defeated and obliged to flee. Dion himself was soon after banished through the intrigues of Heraclides (356). But the incompetence of the new leader soon led to Dion's recall; Heraclides submitted, and soon afterward the supporters of Dionysius surrendered. Dion retained his position as *strategos autocrator* (commander with unlimited powers) but suspected of aiming at tyranny, in 354 he was assassinated by Callippus, an Athenian who had accompanied him in his expedition. *See* also Syracuse and Sicily: *History*.

See Lives of Dion by Plutarch and Cornelius Nepos; Diodorus Siculus, xvi, 6–20. (R. Me.)

DION (Dioon): *see* Gymnosperms.

DIONAEA: *see* Venus's-Flytrap.

DIONE, in Greek mythology, was the cult-partner of Zeus of Dodona. The partner and wife of Zeus is normally Hera, so Dione was variously described: in the *Iliad* as mother by Zeus of Aphrodite; in Hesiod's *Theogony* as a daughter of Oceanus.

DIONNE QUINTUPLETS, the five daughters—Émilie, Yvonne, Cécile, Marie and Annette—born prematurely on May 28, 1934, near Callander, Ont., to Oliva and Elzire Dionne. The parents have had 14 children, 9 by single births. The Dionne quintuplets are remarkable in being the only medically and genetically documented set that has survived; not one member of any other authentic (identical) quintuplet set has lived more than a few days. The Dionne set had a sixth member that aborted during the third month of pregnancy, and this was reported by A. R. Dafoe, the physician who later attended the birth of the quintuplets. Much credit for the survival of the five premature infants is due to the Hospital for Sick Children, Toronto, which quickly made available to Dafoe modern incubators, mother's milk and other equipment. The University of Toronto conducted biological, psychological and dental studies of the quintuplets. The biological study established that the set originated from one fertilized egg (an Argentine set, commonly referred to as quintuplets, appears however to have originated from five separate eggs). The Dionne quintuplets arose through repeated twinning of the early single embryo; therefore, five children were produced instead of one child, and each inherited the same potentialities.

Émilie Dionne died suddenly in Aug. 1954.

See also Multiple Births.

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DIONYSIA, festivals of Dionysus (*q.v.*). They were numerous and widespread, the most famous being those of Attica, which were (1) the Little or Rustic Dionysia, a festival held in various country places in the month Poseideon (December) and characterized by simple, old-fashioned rites; (2) the Lenaea ("festival of Maenads"), in the following month, Gamelion, held at Athens, the chief rites being a festal procession and dramatic performances; (3) the Anthesteria (*q.v.*), in the next month, Anthesterion; (4) the Great or City Dionysia, in Elaphebolion (about the end of March), also accompanied by dramatic performances in the theatre of Dionysus (*see* Drama: *Greek Drama: Origins*), and the most famous of all; (5) the Oschophoria ("carrying of grape-clusters"), in Pyanopsion (about the end of October). The times and what is known of the ritual of these festivals show them to have been originally rites of a kind common in the worship of gods of fertility.

See L. R. Farnell, *The Cults of the Greek States*, vol. v, ch. vi (1896–1919); L. Deubner, *Attische Feste* (1956). (X.; H. W. Pa.)

DIONYSIUS, SAINT (d. 268), pope from 259 to 268. To him fell the task of reorganizing the church after the persecution of Valerian. At the protest of some of the faithful at Alexandria, he demanded from their bishop, Dionysius the Great, explanations touching his doctrine. He died on Dec. 26, 268, and his feast day is Dec. 26.

DIONYSIUS, SAINT, THE GREAT, OF ALEXANDRIA (*c.* 200–*c.* 265), was converted from paganism at an early age, and studied under Origen. In 231–32 he was elected head of the catechetical school of Alexandria, and in 247–48 elevated to the episcopal throne. Though highly esteemed and often cited by the leading Byzantine theologians, his works are known only from quotations, many of them extensive, preserved by Eusebius (d. *c.* 339) and other ecclesiastical writers. His feast is celebrated on Nov. 17, and he is commemorated in the canon of the Syrian and Maronite Mass.

Dionysius had a good knowledge of the ancient classics, and wrote a treatise, *On Nature*, against the atomism of Epicurus. But his major interest was theology. He denied that Revelation was written by the author of the Fourth Gospel, and denounced the chiliasts ("millenarians"), who argued, on the basis of a literal reading of Revelation, that after the resurrection the saints would enjoy a thousand years of happiness on earth.

During the Decian persecution (250–251), he was forced to flee, and was exiled again in the persecution under Valerian (257–260). Upon his return to Alexandria in 260 or 262, he favoured the readmission to the church, after repentance, of those who had lapsed under the strain of persecution, in opposition to the rigouristic party that would have excluded them permanently. Taking part in the bitter controversy over baptisms performed by heretics, he himself did not insist on rebaptizing converts who had received heretical baptism, but he recognized the right of communities to rebaptize if they chose to do so.

Dionysius was especially noted for his attacks on the Sabellians, who responded by accusing him of the doctrinal errors of separating the members of the Trinity from each other, denying the eternity of the Son, designating him as a creature (*poiema*) and refusing to describe him as consubstantial (*homoousios*) with the Father. He repudiated these charges, but insisted that the Trinity consisted of three *hypostases* ("persons"), which were not separated from each other. He admitted that he deliberately avoided the word *homoousios* (which in 325 became the touchstone of Trinitarian orthodoxy) because it was unscriptural, but claimed that he accepted the idea that lay behind it. His contemporary Dionysius of Rome objected to "three *hypostases*" as tritheistic, taking the Greek *hypostasis* to be the equivalent of the Latin *substantia*, which referred to the divine essence of the Godhead. But the Alexandrian bishop has been vindicated by the church, which defines the Trinity as consisting of three distinct but not separate *hypostases*.

Charles L. Feltoe, *The Letters and Other Remains of Dionysius of Alexandria* (1904), is the best edition of the Greek text; Feltoe's *St. Dionysius of Alexandria, Letters and Treatises* (1918) is an English translation.

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DIONYSIUS, the name of two tyrants of Syracuse.

DIONYSIUS THE ELDER (*c.* 432–367 B.C.), tyrant of Syracuse from 405, by his conquests in Sicily and southern Italy made Syracuse the most powerful among the western Greek cities. After working as a clerk in a public office he distinguished himself fighting in the war with Carthage and took advantage of a crisis in the war in 405 to make himself tyrant by demagogism. The next eight years were spent in strengthening his power. He fortified Epipolae, defeated his political opponents and removed the Greek citizens of Naxos, Catana and Leontini from their cities, settling Sicels and mercenaries there. He relied on large numbers of mercenaries as well as Greeks and Sicels from east Sicily. His first war with Carthage (397–396), during which the Greeks besieged Motya and the Carthaginians Syracuse, ended with a notable victory, and Carthage's power in Sicily was confined to the northwest. His second war with Carthage in 392 was ended by a treaty greatly in his favour. After 390 he led an expedition against Rhegium and the other Greek cities in southern Italy. Making an alliance with the Lucanians, with their help he devastated the territories of Thurii, Croton and Locri. After a protracted siege he took Rhegium (387) thereby making himself the chief power in Greek Italy; he established contacts also with Illyria, sending colonists there and possibly to northeast Italy as well. At Athens, although Isocrates hailed him as the champion of Hellenism, the brutality of his conquests made him unpopular and his literary pretensions were deplored: when he sent a splendid embassy to the Olympic festival of 384, the Athenian Lysias attacked him in a speech (a portion of which has survived) and the crowd pillaged the tents of his envoys. His third war with Carthage (383–*c.* 378) proved disastrous; he suffered a crushing defeat and was obliged to pay an indemnity of 1,000 talents and cede to Carthage the territory west of the Halycus river. Nevertheless he was engaged in yet another war against Carthage when he died. His son Dionysius who succeeded him made peace with Carthage on the terms established after the third war. Two Athenian inscriptions of 368 and 367 record respectively friendship and alliance with Dionysius; hence presumably the success of his tragedy at the Dionysia of 367.

An unscrupulous military despot, Dionysius harmed rather than promoted the cause of Hellenism, although he saved Greek Sicily from conquest by Carthage. *See* also SICILY: *History;* SYRACUSE.

See Diodorus Siculus, bk. xiii–xv; N. G. L. Hammond, *A History of Greece*, bk. v, ch. 2 (1959).

DIONYSIUS THE YOUNGER (ruled 367–356 and 354–343 B.C.), son of the above, whom he succeeded in 367. He lacked the vigour to maintain a military autocracy and did not profit by Plato's teaching and become a benevolent despot. In 356 he was driven from the kingdom by Dion and fled to Locri but during the commotions that followed Dion's assassination in 354 he made himself master of Syracuse. On the arrival of Timoleon he was compelled to surrender and retire to Corinth (343).

See Diodorus Siculus, bk. xvi; N. G. L. Hammond, *A History of Greece*, bk. v, ch. 3. (R. ME.)

DIONYSIUS THE AREOPAGITE, converted by St. Paul at Athens, acquired a notable posthumous reputation; in the 2nd century he was held to have been the first bishop of Athens, and in the 9th century he was identified with St. Denis (*q.v.*) of France. About A.D. 500, probably in Syria, some writings were forged in his name by a Christian Neoplatonist with moderate monophysite leanings. These writings, whose author is often referred to as Pseudo-Dionysius, became of decisive importance for the theology and spirituality of Eastern Orthodoxy and western Catholicism.

They are first quoted in a fragment from an undated letter written by the great monophysite theologian Severus, patriarch of Antioch (512–518; d. 538), and appeal to their authority was made by Severus' followers at a colloquy with orthodox Chalcedonians at Constantinople in 532. On that occasion their authenticity was denied by the orthodox leader, Bishop Hypatius of Ephesus, on the ground that they were unknown to Cyril of Alexandria. Photius mentions a defense of their genuineness by one Theodore, who attempted to meet the objections that the Dionysian writings are not quoted by earlier writers, in particular by Eusebius of Caesarea; that church customs are of gradual growth and "it is contrary to all probability, or rather wicked forgery, to represent Dionysius as alluding to things that only came to exist by a process of growth long after his death"; and that they quote from a letter of Ignatius of Antioch, martyred under Trajan.

The fact that, despite this strong case against their authenticity, the documents were rapidly accepted by the highest authorities of the Byzantine church from the 6th century onward speaks eloquently of the forger's brilliant success. Within a few years a Syriac translation was made. Maximus Confessor (*c.* 580–662) wrote a detailed commentary to disclaim the monophysite exegesis of the texts. The writings quickly reached the west; Pope Gregory I's 34th homily has an allusion to them, and at Pope Martin I's

Lateran council of 649 the monothelite appeal to their authority was rejected.

In 858 Erigena made a (very inadequate) Latin version, and commentaries on them were written by Hugh of St. Victor, Robert Grosseteste, Albertus Magnus, Thomas Aquinas and Bonaventura. Late medieval mystics (*e.g.*, Meister Eckhart, Tauler, Rolle of Hampole and the author of *The Cloud of Unknowing*) owe much to Pseudo-Dionysius' inspiration. Even in medieval times, however, occasional doubts were expressed; the authenticity was wholly denied by the Renaissance humanist Lorenzo Valla, by the Reformers and by a few Roman Catholic scholars of the 16th and 17th centuries. A long wrangle ended in the general recognition that the documents are a forgery by a writer intimately dependent on the pagan Neoplatonist Proclus (410–485). Western theologians commonly treat both Pseudo-Dionysius and his "apophatic" (negative) mysticism with reserve; but he remains normative for Eastern Orthodox spirituality.

The corpus consists of ten short letters, addressed to personages of the apostolic and subapostolic age, and four treatises dedicated to Timothy, namely: *Peri theion onomaton* ("Divine Names") discussing the names used of God in Scripture as evidence for the divine being and attributes; *Peri mystikes theologias* ("Mystical Theology") describing the ascent of the soul to the immediate vision of God in ecstasy; *Peri tes ouranias hierarchias* ("Celestial Hierarchy") describing the chain of angelic beings as divided into three groups each with three subdivisions (Seraphim, Cherubim and Thrones; Dominations, Virtues and Powers; Principalities, Archangels and Angels); *Peri tes ecclesiastikes hierarchias* ("Ecclesiastical Hierarchy") treating the church as the earthly counterpart of the angelic world, likewise containing three holy sacraments (baptism, eucharist, holy chrism), three holy orders (bishop, priest, deacon) and three lower orders (monks, laity, catechumens or penitents). The last-named treatise provides important information for liturgical history (*see* F. E. Brightman (ed.), *Liturgies Eastern and Western*, vol. i, pp. 487–490, 1896).

Pseudo-Dionysius' style is obscure and turgid, abounding in grandiose terminology. The writings give all the appearance of being an artificial construction in content as well as in form; and it is far from certain that the high-flown language about contemplation and ecstasy represents any genuine mystical experience in the writer. He is concerned with the theory rather than the practice, and the more impressive passages turn out to be closely dependent upon Gregory of Nyssa. The chief theme is the ascent of the soul by the negative way, stripping aside first the senses and then all inward thoughts and reasonings until the soul passes into "the darkness of unknowing" wherein it is more and more enlightened by "the ray of divine darkness" which is beyond all light and beyond all being. The writings provide an entire system of the cosmos, and take over the full-blown Neoplatonist notions of the hierarchy of being, and of evil as a privation of good, consequent upon inferiority in the hierarchy.

The actual identity of the author has baffled scholars. E. Honigmann suggested the monophysite Peter the Iberian (411–491).

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DIONYSIUS the Carthusian (Denys van Leeuwen or de Leeuwis, Denys van Rijkel) (1402/3–1471), theologian and mystic, in 1424 entered the Carthusian order, where he led a life remarkable for holiness and prodigious literary activity: the modern edition of his works runs to 42 folio volumes. Chiefly a compiler, he came to be known as a master of the spiritual life and was posthumously accorded the title of "Ecstatic Doctor" because of his especial authority in mystical theology. Yet his single properly mystical work, *On Contemplation*, was printed only once previous to the collected edition of his writings published by the Carthusians at the end of the 19th century. He is cited by Ignatius of Loyola, Francis of Sales, Alfonso dei Liguori and others, but solely in confirmation of positions already taken. An anomaly in the history of ideas, over the centuries Dionysius has enjoyed an enormous reputation and, except perhaps in his own order, no influence.

Bibliography.—There is no completely satisfactory edition of his works. The *Opera omnia* (1896–1935) is little more than a reprint of the *editio princeps* (1530 *et seq.*); the basic life, by Thierry Loer (1500–54), is given in vol. i, pp. xvii–xlviii. *See* also D. A. Mougel, *Dionysius der Karthäuser* (1898); D. and G. Mathew, *The Reformation and the Contemplative Life*, especially pp. 151–165 (1934). (E. O'B.)

DIONYSIUS of Halicarnassus (fl. *c.* 20 B.C.), Greek historian and teacher of rhetoric, wrote a history of Rome from the mythical period to the first Punic War. He went to Rome after the end of the civil wars and spent 22 years in studying Latin and preparing materials for his history. The date of his death is unknown. His history, translated as *Roman Antiquities*, was divided into 20 books, of which the first nine remain entire; the tenth and eleventh are nearly complete; and the remainder exist in fragments in the excerpts of Constantine Porphyrogenitus and an epitome discovered by Angelo Mai in a Milan manuscript. The first three books of Appian and Plutarch's *Life of Camillus* also embody much of Dionysius. His chief object was to reconcile the Greeks to the rule of Rome by dilating upon the good qualities of their conquerors. He carefully consulted the best authorities, and his work and that of Livy are the only connected and detailed extant accounts of early Roman history.

Dionysius was also the author of several critical treatises: *The Arrangement of Words; On Imitation*, a fragmentary work on the best models in the different kinds of literature; *Commentaries on the Attic Orators*, dealing with Lysias, Isaeus, Isocrates and (possibly by way of supplement) Deinarchus; *On the Style of Demosthenes; On Thucydides*, a detailed but rather unfair criticism of his treatment of subject matter and his style; two *Letters to Ammaeus* dealing with Demosthenes and Thucydides; and the *Letter to Pompeius Geminus*, dealing with Plato.

Bibliography.—For the full text of the *Roman Antiquities*, *see* C. Jacoby's edition, 5 vol. (1885–1925); and "Loeb Series" with Eng. trans. by E. Cary, 7 vol. (1937–50). For the lesser works *see* H. Usener and L. Radermacher (eds.), *Dionysii Halicarnasei opuscula*, 2 vol. (1899–1929); and W. Rhys Roberts (ed.), *The Three Literary Letters* (1901), and *On Literary Composition:* i.e., *The Arrangement of Words* (1910). *See* also M. Egger, *Denys d'Halicarnasse* (1902); J. W. H. Atkins, *Literary Criticism in Antiquity*, vol. ii, ch. 3 (1934); S. F. Bonner, *The Literary Treatises of Dionysius of Halicarnassus* (1939). (G. B. Kd.)

DIONYSIUS BAR-SALIBI: *see* Bar-Salibi, Jacob.

DIONYSIUS EXIGUUS, that is, Denis the Little, the surname having been adopted with humility by himself (*c.* 500–560); flourished as a scholar at Rome during the first half of the 6th century. Cassiodorus reports that he was born in Scythia and calls him merely a monk, but he is traditionally referred to as an abbot.

In high repute as a theologian, he was profoundly versed in the Holy Scriptures and in canon law (*q.v.*), and was also an accomplished mathematician and astronomer. To him are owed a collection of 401 ecclesiastical canons, including the apostolic canons and the decrees of the councils of Nicaea, Constantinople, Chalcedon and Sardis, and also a collection of the decretals of the popes from Siricius (384) to Anastasius II (498). Dionysius also translated many Greek works now lost, including *Life of St. Pachomius* and the *Instruction of St. Proclus of Constantinople*. His greatest influence upon posterity, however, was his introduction of the chronology still current, but he wrongly dated the birth of Christ on Dec. 25, 753, according to the Roman system (that is, 753 years after the founding of Rome, which took place in 753 B.C. according to tradition).

For the works of Dionysius, *see* Migne, *Patrol. Lat.*, 67:9–520; for the canons *see* also C. H. Turner, *Eccles. Occid. Mon. Iuris Ant.* (1899 *et seq.*, under each council); O. Bardenhewer, *Geschichte der altkirchlichen Literatur*, vol. v (1932). (G. E. McC.)

DIONYSIUS TELMAHARENSIS (d. A.D. 845), patriarch of the Syrian Jacobite Church during 818–845, was the author of

an important historical work, *Annals*, covering the years from the accession of the emperor Mauricius (582) to the death of Theophilus (842). His *Annals* have perished except for some passages quoted by Bar-Hebraeus and an extract found by Assemani in *Codex Vaticanus 144* and published by him in the *Bibliotheca orientalis*. He spent his earlier years as a monk at Ken-neshre on the upper Euphrates, and later moved to Kaisum in the district of Samosata. At the death of the Jacobite patriarch Cyriacus in 817, the church was disputing the phrase "heavenly bread" in connection with the Eucharist. An antipatriarch had been appointed in the person of Abraham, a monk from Kartamin, who insisted on the use of the phrase in opposition to the recognized authorities of the church. The council of bishops at Rakka in 818 elected Dionysius to the patriarchal chair, but the ecclesiastical schism continued unhealed during the 30 years of his patriarchate. The details of this contest, of his relations with the caliph Ma'mun and of his many travels—including a journey to Egypt—are to be found in the *Ecclesiastical Chronicle* of Bar-Hebraeus (*q.v.*).

In addition to the *Annals* Dionysius was credited with the authorship of a *Chronicle* narrating the history of the world from the creation to the year A.D. 774–775, later proved to be the work of an earlier writer, a monk of the convent of Zuknin near Amid (Diyarbekir) on the upper Tigris. Though the author had limited intelligence and little historical skill, the last part of his work has considerable value as a contemporary account of events during the middle of the 8th century.

Bibliography.—W. Wright, *History of Syriac Literature* (1894); Jean Baptiste Chabot's introduction to his translation of pt. iv of the *Chronicle;* A. Baumstark, *Geschichte der syrischen Literatur*, p. 275 (1922). (W. D. McH.)

DIONYSIUS THRAX (fl. *c.* 120 B.C.) was the author of the first Greek grammar. Apparently called "Thrax" because his father Teres (?) was a Thracian, he himself was a native of Alexandria where he attended the lectures of Aristarchus. Later he taught grammar and rhetoric at Rhodes, where he had the scholar Tyrannio the elder among his pupils. His grammar, which has survived, begins with the definition of grammar and its functions. Dealing next with accents, punctuation marks, letters and syllables, it goes on to the eight parts of speech and their inflections. No rules of syntax are given and nothing is said about style. The authorship of Dionysius was doubted even in antiquity, but such doubt seems unjustified; the great grammarians of imperial times, Apollonius Dyscolus and Aelius Herodianus, knew the work in its present form, though additions and alterations may have been made later. It is essentially an elementary-school grammar and, as such, was used everywhere in the Greek-speaking world till about the 12th century A.D., when it was replaced by catechisms (*erotemata*) based on it. Made known to the Romans, perhaps by Tyrannio, it served as a model for Latin grammars and through them for modern grammars. Dionysius also wrote commentaries on Homer and on Hesiod's *Works and Days* and various other works including an account of Rhodes. His grammar was translated into Syriac and Armenian, and versions in these languages are still extant.

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DIONYSUS (Dionysos), in Greek cult and mythology, a nature god of fruitfulness and vegetation, but tending to specialize as a god of wine. The origin of the Greek name is doubtful. The alternative names Bacchus (Bacchos, in use among the Greeks from the 5th century), Sabazius and Bassareus are Thracian.

There seems little doubt that Dionysus is a Thraco-Phrygian deity, introduced into Greece from Thrace or possibly from both Thrace and Phrygia, and, blending with native gods of similar character; *e.g.*, Iacchus at Eleusis. If the solitary occurrence of his name on a Linear B tablet (*see* Minoan Linear Scripts) is correctly deciphered, it was already known in Greece before 1200 B.C. In Homer, notwithstanding the frequent mention of the use of wine, Dionysus is never mentioned as its inventor or introducer, nor does he appear in Olympus; Hesiod is the first who calls wine the gift of Dionysus. On the other hand, he is spoken of in the *Iliad* as "raging," an epithet that indicates that already the orgiastic character of his worship was recognized. In his native country his worshipers sought to become possessed by or assimilated to him by wild dancing and the tearing in pieces and eating of animals; in Greece this was much toned down.

According to the usual tradition, he was born at Thebes and was the son of Zeus and Semele, the daughter of Cadmus. Before the child was mature, Zeus appeared to Semele (whose name is simply the Phrygian for "earth") at her request in his majesty as god of lightning, by which she was killed; but the infant was saved from the flames by Zeus (or Hermes). Zeus took him up, enclosed him within his own thigh until he came to maturity, and then brought him to the light, so that he was twice born; an allusion to this was found in the word *dithyrambos*, actually of unknown origin, but which became both a name of the god and of a hymn in his honour. Dionysus was then conveyed by Hermes to be brought up by the nymphs of Nysa, a purely imaginary spot.

As soon as Dionysus was grown up, he started on a journey through the world, to teach the cultivation of the vine and spread his worship among men. While so engaged he met with opposition, even in his own country, as in the case of Pentheus, king of Thebes, who opposed the orgiastic rites introduced by Dionysus among the women of Thebes, and, having been discovered watching one of these ceremonies, was mistaken for some animal of the chase and slain by his own mother; the story is the subject of Euripides' *Bacchae*. A similar instance is that of Lycurgus, a Thracian king, from whose attack Dionysus saved himself by leaping into the sea, where he was kindly received by Thetis. Lycurgus was blinded by Zeus and soon died, or became frantic and hewed down his own son, mistaking him for a vine. At Orchomenus, the three daughters of Minyas refused to join the other women in their nocturnal orgies, and for this were driven mad, tore in pieces the son of one of them, and were transformed into birds, or bats. These and similar stories may point to the vigorous resistance offered to the introduction of the mystic rites of Dionysus or to some ceremony in which the god, or a priest representing him, was killed and probably brought to life again (*see* below). On the other hand, when the god was received hospitably he repaid the kindness by the gift of the vine, as in the case of Icarius of Attica (*see* Erigone).

The worship of Dionysus continued to flourish in Asia Minor, particularly in Phrygia and Lydia. His cult is closely associated with that of numerous Asiatic deities, as Sabazius (*q.v.*), and from the time of Alexander he appears as conqueror of India. The other incidents in which he appears in a purely triumphal character are his transforming into dolphins the Tyrrhenian pirates who attacked him, and his part in the war of the gods against the giants. The adventure with the pirates occurred on his voyage to Naxos, where he found Ariadne abandoned by Theseus. At Naxos Ariadne (probably a Cretan mother goddess) was associated with Dionysus as his wife, and their marriage was annually celebrated by a festival. Having compelled all the world to recognize his divinity, he descended to the underworld to bring up his mother. Like most deities connected with vegetation, Dionysus, at least in Phrygia, died and rose again. This is reflected principally in Orphic mythology, not in normal Greek belief. Zeus had by Persephone a wonderful child, Zagreus. He was brought up secretly, watched over by Curetes; but the jealous Hera discovered where he was, and sent Titans to the spot; they, finding him at play, tore him to pieces, and cooked and ate his limbs, while Athena gave his heart to Zeus. This myth is probably to be connected with the savage rite of *omophagia* (eating of raw flesh) in the worship of Dionysus, in which a victim, perhaps originally human in some cases, incarnating the god, was torn in pieces and sacramentally eaten raw. It is variously reconciled with the tale of Semele. (*See* also Titans.)

Dionysus further possessed the prophetic gift, and at Delphi was received by the priesthood on almost equal terms with Apollo. His followers included spirits of fertility such as the satyrs, and in his ritual the phallus was prominent. He often takes bestial

shape, and is associated with the bull, the panther, the lion, the snake, the tiger, the ass, the goat and sometimes also the dolphin. His personal attributes are an ivy wreath, the thyrsus (*q.v.*) and the kantharos, a large two-handled goblet. His later representations in art show a youth of soft, nearly feminine form, occasionally an infant; but the earlier type is a bearded man. His title Dendrites ("he of the tree") arises most probably from his functions as a god of the productivity of nature and not of the vine only. For the connection of Dionysus with Greek tragedy *see* DRAMA: *Greek Drama: Origins.*

See MYSTERY; *see also* references under "Dionysus" in the Index volume.

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DIOPHANTINE EQUATIONS, or Diophantine analysis, is the name given to a branch of the theory of numbers. It treats the problem of finding the solutions, in whole numbers (integers) or rational fractions, of one or more conditional algebraic equations whose coefficients are rational. For example, the problem of finding the whole numbers x and y satisfying $x^2 - y^3 = 30$ is a Diophantine problem, and this equation is called Diophantine. The name comes from the Greek mathematician Diophantus, who probably flourished about the middle of the 3rd century A.D. He treated a number of problems such as the following: to find three rational numbers such that the product of any two added to the sum of these two gives a square; to find three squares such that their continued product added to any one of them gives a square.

The subject includes much material from a number of topics in the theory of rational integers, usually discussed separately, such as Waring's theorem, the theory of congruences, the theory of quadratic and higher forms (*see* NUMBERS, THEORY OF). This article is confined to the consideration of the parts of the subject which have not been so definitely classified.

Diophantus solved the problem of finding formulas giving all the right triangles whose sides are integral. To obtain these we may reason as follows: Let the triangle have the sides x, y and z; then we are to find an expression for all the positive integers which satisfy

$$x^2 + y^2 = z^2 \tag{1}$$

It may be shown that the formulas

$$x = 2kmn,\ y = k(m^2 - n^2),\ z = k(m^2 + n^2)$$

where k is an arbitrary positive integer, give all the positive integral solutions of (1).

A generalization of (1), namely the equation

$$x^n + y^n = z^n \tag{2}$$

$n > 2$, has received a great deal of attention (*see* FERMAT'S LAST THEOREM).

A particular topic in Diophantine analysis, which is now generally referred to as the theory of quadratic forms, treats, by the use of linear transformation, the problem of solving the equation

$$ax^2 + bxy + cy^2 = m \tag{3}$$

in integers x and y for a, b and c given integers. (*See* NUMBERS, THEORY OF.) An older method involves the use of continued fractions.

Continued-fraction methods are also known for expressing a prime p in the form $x^2 + my^2$, $m > 0$, for various classes of values of p and m. Such a method was first derived by Adrian M. Legendre (1824) for $m = 1$ and $p \equiv 1 \pmod 4$.

We now consider homogeneous quadratic equations. Using Joseph L. Lagrange's results on $x^2 - Dy^2 = n$, Legendre (1798) found the elegant result that if each of the positive integers a, b and c has no square factor, no two have a common factor; and if there exist integers λ, μ, ν such that

$$\frac{a\lambda^2 + b}{c},\ \frac{c\mu^2 - b}{a},\ \frac{c\nu^2 - a}{b}$$

are all integers, then $ax^2 + by^2 = cz^2$ has integral solutions not all zero; and if the three conditions are not all satisfied, then there are no integral solutions. Adolph Mayer (1884) gave a criterion that

$$ax^2 + by^2 + cz^2 + du^2 = 0 \tag{4}$$

with a, b, c and d integers none zero, without square factors, and such that no three have a common factor, has solutions in integers. He also arrived at the result that

$$ax^2 + by^2 + cz^2 + du^2 + ev^2 = 0 \tag{5}$$

is solvable in integers not all zero if the coefficients are odd and not all of the same sign. L. E. Dickson (1930) noted that Mayer's arguments concerning (4) and (5) were not complete. Thanks to his contributions (1930, 1939) and those of H. Hasse (1923) and L. J. Mordell (1931), the complete criteria for the solution of (4) for any nonzero integers a, b, c, d were obtained. Also Dickson (1930) gave the first complete proof that (5) is always solvable in integers if not all the nonzero integers a, b, c, d, and e are of like sign. Hasse (1923) obtained a number of elegant results concerning quadratic Diophantine equations by the use of congruences. An example is the theorem that the equation is solvable in integers if and only if

$$\sum_{ij} a_{ij}\, x_i\, x_j \equiv 0 \pmod M$$

is properly solvable for all integers M. In this statement the term properly solvable means that $(x_i, M) = 1$ for each i. E. T. Bell (1933) and Morgan Ward (1933) gave, when any exist, all the solutions of

$$A_i\, x_1^{a_{i1}} x_2^{a_{i2}} \dots x_k^{a_{ik}} = B_i\, y_1^{b_{i1}} y_2^{b_{i2}} \dots y_e^{b_{ie}}$$

in parametric form.

Thoralf Skolem (1938) gave a number of applications of the theory of algebraic numbers (*see* NUMBERS, THEORY OF) to Diophantine problems. In this connection he examined the equation

$$N(a_1x_1 + \dots + a_nx_n) = a \tag{6}$$

where the α's are integers in an algebraic field K of degree n, and $N(\omega)$ denotes the norm of ω in K (a being a rational integer), and treats by the use of units in K the problem of finding other sets of solutions of (6), given one set, as well as methods for determining if any set exists.

It is clear that if we have any Diophantine equation and we know all its rational solutions, then these solutions will include all the integral solutions. However, Dickson (1920) pointed out many cases in the literature where formulas had been given for finding all the rational solutions of equations and no method had been supplied for picking out any integral ones. In view of this he considered the problem of finding the integral solutions of

$$ax^2 + bxy + cy^2 = w_1\, w_2 \dots w_n \tag{7}$$

in integers x, y, w_1, w_2, . . . , w_n with a, b and c given integers, and gave a complete solution. Generalizations to forms of any degree were obtained by Wahlin (1924) and Skolem (1938). The special case of (7), namely

$$ax^2 + bxy + cy^2 = z^n$$

has been treated by many writers. Lagrange (1769) and Euler (1770) obtained an infinitude of solutions of

$$x^2 - my^2 = z^n \tag{8}$$

with m an integer. Morgan Ward (1935) applied the theory of quadratic algebraic fields to (8) and gave a set of formulas for its complete solution.

Considerable literature has resulted from the examination of equations of the type

$$f(x, y) = c$$

where $f(x,y)$ is a polynomial in x and y with integral coefficients and c is an integer $\neq 0$. These developments seem to have had their beginning in the work of C. Runge (1887), who proved among other results the following one: "Let $f(x,y)$ be a polynomial with integral coefficients irreducible in the rational field, the homogeneous part of f of highest degree not being the power of an irreducible polynomial. Then $f(x,y) = c$ has only a finite number of solutions in rational integers." This was followed by the work of A. Thue (1909), who proved the following celebrated theorem: "If $f(x,y)$ is a homogeneous polynomial with integral coefficients, irreducible in the field of rational numbers and of degree > 2, and c is an integer $\neq 0$, then $f(x,y) = c$ has only a finite number of integral solutions."

In view of the above results we may consider

$$f(x_1, x_2 \ldots x_k) = c$$

where f is a homogeneous polynomial in $x_1, x_2, \ldots x_k$, with integral coefficients, of degree n and irreducible in the rational field, c being an integer. We know from the theory of units in an algebraic field that for $k = n$ and $c = 1$ there exist equations of this type with an infinity of integral solutions. On the other hand, if $k = 2$, $n > 2$, Thue's theorem states that there cannot be more than a finite number of solutions. An interesting question is, how far must k be increased to obtain equations of this type with an infinity of solutions? If $n = 3$ we have $k = 3$. Related to this is a conjecture which Euler (1772) made, and which amounts to a generalization of Fermat's Last Theorem. He stated that, in his opinion, the equation

$$x_1^n + x_2^n + \ldots + x_k^n = y^n \tag{9}$$

has no integral nonzero solutions for $1 < k < n$. The particular case of $n = 4$ has been much studied. For $k = 2$ it is known that there are no such solutions; for $k = 4$ some solutions were found; but for the difficult case $k = 3$ the question of whether or not solutions exist remained a problem for further investigation. Ward (1945) proved that there is no nonzero solution of (9) with $k = 3$, $n = 4$ and $y < 10{,}000$.

The problem of finding rational solutions of certain types of equations has been successfully attacked by the use of geometric methods. This is often expressed as the problem of finding the rational points on a curve or surface. The curves

$$f(x,y) = 0 \text{ or } f(x,y,z) = 0$$

in homogeneous co-ordinates, are classified for arithmetical purposes according to their genus (*see* CURVES), the coefficients of the equations being integral. Two curves are called equivalent when they are connected with each other by a birational transformation with rational coefficients. Thus two curves

$$f_1(x,y) = 0,\ f_2(\xi, \eta) = 0$$

are equivalent if the co-ordinates x,y are rationally expressible with rational coefficients in terms of ξ, η, and conversely. If a curve is of genus zero, it was shown by David Hilbert and A. Hurwitz (1890) and by Jules H. Poincaré (1901) that it is equivalent to a straight line or a conic, from which the theory of the rational points on the original curve is easily derived.

For a curve of genus unity, Poincaré (1901) also proved that if it has a rational point, it is equivalent to a curve of the third degree, and, in particular, the cubic is equivalent to a curve whose equation can be written in the Weierstrass normal form

$$y^2 = 4x^3 - g_2x - g_3 \tag{10}$$

The latter statement was proved by Mordell in 1912.

Poincaré (1901) and A. Hurwitz (1917) noted that the equation (10) could be given in parametric form by the use of Weierstrass' elliptic $\mathbf{p}$ functions (*see* ELLIPTIC FUNCTIONS) so that

$$x = \mathbf{p}(u),\ y = \mathbf{p}'(u) \tag{11}$$

It was proved by Mordell (1922) with the use of these ideas that all the rational points on (10) could be found from a finite number of rational points, so that, using (11), if $u_1, u_2 \ldots, u_n$ satisfy (10) then all rational points are given by $m_1u_1 + m_2u_2 \ldots + m_nu_n$, where the m's are integers.

The subject of the rational solutions of cubic ternary equations was extensively investigated and general results obtained by the use of both geometric and algebraic methods. B. Segre (1943) took up this type of problem, using geometric ideas; and proved that if $f(x,y)$ is a given cubic polynomial in x,y with rational coefficients which is not expressible as a polynomial in a single linear function of x and y, the equation

$$z^2 = f(x,y)$$

has an infinity of solutions in x, y and z. From this he showed that an indeterminate ternary cubic equation which cannot be reduced to an equation involving less than three variables has either no rational solution or an infinity of rational solutions, and each case is possible. Mordell (1943) obtained similar results using algebraic methods exclusively.

Although this subject has been attacked by some of the most powerful weapons known to analysis, geometry and abstract algebra, it contains vast domains which have hardly been touched by investigators, and offers great opportunities for a mathematical pioneer. *See* also NUMBERS, THEORY OF: *Diophantine Approximation.*

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(H. S. V.)

DIOPHANTUS OF ALEXANDRIA, Greek mathematician, famous for his work in algebra. From a passage of Michael Psellus it may be assumed that he was not later than Anatolius, bishop of Laodicea from A.D. 270. It has been plausibly argued that Diophantus was contemporary with Hero of Alexandria (1st century A.D.). The *Arithmetica*, the great treatise on which the fame of Diophantus rests, purports to be in 13 books, but none of the Greek manuscripts which has survived contains more than 6 (though 1 has the same text in 7 books). They contain, however, a fragment of a separate tract on *Polygonal Numbers*. The missing books were apparently lost early, for there is no reason to suppose that the Arabs who translated or commented on Diophantus ever had access to more of the work than we now have. The difference in form and content suggests that the *Polygonal Numbers* was not part of the larger work. On the other hand the *Porisms*, to which Diophantus makes three references ("we have it in the Porisms that . . ."), were probably not a separate book but were embodied in the *Arithmetica* itself, whether placed all together or spread over the work in appropriate places. The "porisms" quoted are interesting propositions in the theory of numbers, one of which was clearly that the difference between two cubes can be resolved into the sum of two cubes.

Among the great variety of problems solved are problems leading to determinate equations of the first degree, in one, two, three or four variables, to determinate quadratic equations and to indeterminate equations of the first degree in one or more variables, which are, however, transformed into determinate equations by arbitrarily assuming a value for one of the required numbers, Diophantus being always satisfied with a rational, even if fractional, result, and not requiring a solution in integers. But the bulk of the work consists of problems leading to indeterminate equations of the second degree, and these universally take the form that one or two (and never more) linear or quadratic functions of one variable x are to be made rational square numbers by finding a suitable value for x. A few problems led to indeterminate equations of the third and fourth degrees, an easy indeterminate equation of the sixth degree being also found. The general type of problem is to find two, three or four numbers such that different expressions involving them in the first and second, and sometimes the third, degree are squares, cubes, partly squares and partly cubes, etc., *e.g.*, to find three numbers such that the product of any two added to the sum of those two gives a square (III 15); to find four numbers such that, if we take the square

of their sum + or − any one of them singly, all the resulting numbers are squares (III 19); to find two numbers such that their product + or − their sum gives a cube (IV 28); to find three squares such that their continued product added to any one of them gives a square (V 21). Book VI contains problems of finding *rational right-angled triangles* such that different functions of the parts (the sides and the area) are squares. A word is necessary on Diophantus' notation. He has only one symbol (written somewhat like a final sigma) for an unknown quantity, which he calls *arithmos* and which characterizes "an undefined number of units"; the symbol may be a contraction of the initial letters *ar*, as Δ^Y, K^Y, $\Delta^Y\Delta$, etc., are for the powers of the unknown (square, cube, fourth power, etc.). The only other algebraical symbol is $\wedge$ for minus (also occurring with Hero), plus being expressed by merely writing terms one after another. With one symbol for an unknown, it will easily be understood what scope there is for adroit assumptions, for the required numbers, of expressions in the one unknown which are at once seen to satisfy some of the conditions, leaving only one or two to be satisfied by the particular value of x to be determined. Often assumptions are made which lead to equations in x which cannot be solved "rationally," *i.e.*, would give negative, surd or imaginary values; Diophantus then traces how each element of the equation arose and formulates the auxiliary problem of determining how the assumptions must be corrected so as to lead to an equation (in place of the "impossible" one) which can be solved rationally. Sometimes his x has to do duty twice, for different unknowns, in one problem. In general his object is to reduce the final equation to a simple one by making such an assumption for the side of the square or cube to which the expression in x is to be equal as will make the necessary number of coefficients vanish. The book is valuable also for the propositions in the theory of numbers, other than the porisms, stated or assumed in it. Thus Diophantus knew that no number of the form $8n+7$ can be the sum of three squares. He also says that, if $2n+1$ is to be the sum of two squares, "n must not be odd" (*i.e.*, no number of the form $4n+3$, or $4n-1$, can be the sum of two squares), and goes on to add, practically, the condition stated by Fermat, "and the double of it increased by one, when divided by the greatest square which measures it, must not be divisible by a prime number of the form $4n-1$," except for the omission of the words "when divided . . . measures it."

In light of the discovery of highly developed algebraic methods in Babylonia (*see* MATHEMATICS, HISTORY OF), Diophantus' work no longer appears to represent a late and degenerate form of Greek mathematics. On the contrary, there can be no doubt that it was influenced by traditions common to the Hellenistic and Roman world. *See* also DIOPHANTINE EQUATIONS.

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(T. L. H.; O. E. N.)

DIOPSIDE: *see* PYROXENE.

DIOPTER, a unit of measurement used in optics to measure the power of a lens or lens system. The power of a lens is the reciprocal of its focal length, and when the focal length is expressed in metres the power of the lens is in diopters. Thus a lens whose focal length is 1 metre has a power of 1 diopter, a lens of focal length 50 cm. ($\frac{1}{2}$ metre), a power of 2 diopters, a lens of focal length 2 metres, $\frac{1}{2}$ diopter and so on. *See* EYEGLASSES.

DIOR, CHRISTIAN (1905–1957), Parisian fashion designer who dominated world fashion for a decade after World War II, was born at Granville, France, on Jan. 21, 1905. After a formative period in Paris when he was closely associated with the artistic life of the capital, he opened a picture gallery; but ill health and the financial crisis of the 1930s left him in straitened circumstances. It was at this time (1935) that he first tried his hand at fashion designing. In 1938 he entered the house of Robert Piguet. In 1942 he went to Lucien Lelong. Finally, in 1946, with the backing of textile manufacturer Marcel Boussac, he opened his own house. The overnight success of the "New Look," launched on Feb. 12, 1947, was the prelude to 10 years of outstanding success. Dior was the personality through whom Boussac was able to commercialize Paris fashion on a world-wide basis and on an unprecedented scale. Dior died suddenly at Montecatini, Italy, on Oct. 24, 1957. (P. W. HE.)

DIORAMA, a three-dimensional exhibit or presentation housed in a cubicle to be viewed through an aperture or frame. Its construction is basically dependent upon the laws of linear perspective (*see* PERSPECTIVE) which were formulated in the 15th and 16th centuries. While in all probability true dioramas—for peep shows, etc.—were constructed earlier, credit for their development is usually given to Louis Jacques Mandé Daguerre (1789–1851), a French scenic painter and physicist who later invented the daguerreotype. In 1822, with a co-worker named Charles Marie Bouton, Daguerre opened in Paris, and later in London, an exhibition he called the Diorama that showed many of these spectacular displays. Daguerre used translucent drops (curtains) and wings which gave the illusion of depth and, with a series of changing, coloured lights, attained artistically dramatic effects. His techniques survive in dioramas, which are widely employed and may be on any subject and of any size, with or without special lighting and with either an opaque or translucent background.

Basically a diorama is an exhibit with a flat or curved back cloth on which there is a scenic painting, photograph or other such illusory effect. In front of the cloths may be placed flat or solid objects to heighten the illusion, while coloured transparent gauze or plastic drop curtains will heighten the three-dimensional effect. Typical diorama effects are of stage settings, room interiors, gardens and other natural scenes. With the addition of stage borders or wings a considerable improvement in the perspective is effected. Usually the immediate foreground material is in the full round but when space limits the depth of an exhibit these objects may be made progressively smaller and lower in relief as they near the background surface. Then similar objects, repeated in the background painting, are also progressively diminished in size to take them into the distance as, for example, the pickets of a fence as it tapers off toward the horizon.

A diorama is not to be confused with a panorama (*q.v.*) or cyclorama. A panorama is a sweeping scene or painting on a flat or curved background which is considerably extended laterally. A cyclorama is a similar exhibit which forms a complete circle and is viewed from a central platform. Both may be with or without foreground objects.

In the theatre a cyclorama is any curved wall on which lights may be projected. (J. L. CK.)

DIORITE is a medium- to coarse-grained plutonic rock with granular texture composed commonly of about two-thirds plagioclase feldspar (*q.v.*) and one-third dark coloured minerals (hornblende, biotite). The presence of soda-rich feldspar (oligoclase or andesine) in contrast to calcium-rich plagioclase (labradorite or bytownite) is the principal distinction between diorite and gabbro (*q.v.*). The volcanic equivalent of diorite is andesite (*q.v.*).

Diorite has about the same structural properties as granite (*q.v.*); but, perhaps due to its darker colour and more limited supply, is rarely used as ornamental and building material. It is one of the dark gray stones that go by the commercial name "black granite" (*see* also DIABASE). Diorite occurs independently as small bodies (sills, dikes, stocks) or as more irregular masses associated with gabbro, granodiorite, or granite. Diorite may appear marginal to huge bodies (batholiths) of granodiorite and granite.

The plagioclase feldspar in diorite is white or gray and readily identified by fine, parallel striations (twin lines) on the surfaces of broken grains. Under the microscope thin sections of the rock commonly show roughly rectangular grains of plagioclase with zoned structure in which a crystal core appears encased by numerous concentric, rectangular shells of differing composition. Generally cores are calcium-rich and successive shells are progressively more sodium-rich toward the exterior as in diabase (*q.v.*). Dark hornblende as elongate or irregular grains appears green or brown under the microscope. Black biotite, brown under the microscope, may be the sole dark mineral and is generally most abundant in

those diorites carrying considerable quartz. Augite is not common and orthopyroxene, olivine and feldspathoids are rare. Quartz may be present in small amounts and is generally interstitial to plagioclase. With increase in quartz content, diorite passes into quartz diorite (tonalite). Potash feldspar, when present, may be closely associated with or intergrown (as micropegmatite) with quartz. With increase in potash feldspar content, diorite passes into monzonite. With increase in both quartz and potash feldspar content diorite passes into granodiorite. Accessory minerals not readily seen without magnification are magnetite, ilmenite, apatite, sphene and zircon.

Some diorites are truly igneous; they have crystallized from molten material (dioritic magma). Others represent the products of reaction between magma and included fragments of foreign rock. Many have been chemically transformed in the solid state from some older rock such as gabbro by loss of certain constituent atoms and gain of others.

An average analysis (in weight per cent) of diorite is as follows: oxides of silicon (SiO_2), 59.67; aluminum (Al_2O_3), 16.68; ferric iron (Fe_2O_3), 2.93; ferrous iron (FeO), 4.09; magnesium (MgO), 3.62; calcium (CaO), 6.22; sodium (Na_2O), 3.50; potassium (K_2O), 2.13; and titanium (TiO_2), 0.39; and water (H_2O), 0.77. For discussion of processes of crystallization of the igneous rock series extending from gabbro through diorite to granite *see* GEOCHEMISTRY: *Geochemistry of the Lithosphere: Crystallization of Magmas and Its Products.* (C. A. CN.)

DIOSCOREACEAE, the yam family of monocotyledonous herbs or shrubs composed of nine or ten genera, mostly with annual twining stems. Stems in many species arise from tubers of characteristic shape, and often with coloured flesh. They usually have heart shaped leaves, and perfect or unisexual, generally inconspicuous flowers with their parts in threes or multiples of three. Though usually small, the flowers, particularly the staminate, may be borne in great masses. The fruits are usually three-winged capsules and the seeds may be variously winged. The genera are small and of limited geographic distribution with the exception of *Dioscorea*, the genus of true yams, which is composed of about 600 species. The family occurs in the tropics and subtropics, with some members extending into temperate areas.

The economic importance of the family was based solely on a few edible species of *Dioscorea* (such as *D. esculenta, D. alata* and *D. bulbifera*) cultivated for their starchy underground organs, until the discovery about 1940 that the tubers of certain other species of this genus contain steroidal sapogenins, chemical compounds useful in the manufacture of cortisone and sex hormones, a synthesis previously thought to be possible only from compounds of animal origin. In South Africa *D. elephantipes*, the elephant's-foot, possesses these chemical constituents in its often enormous basal organ which develops above ground and has a leathery surface composed of more or less hexagonal platelike sections.

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DIOSCORIDES, PEDANIUS (fl. *c.* A.D. 50), Greek medical man whose *De Materia Medica* was the leading text on pharmacology for 16 centuries, was born in Cilicia and served in the armies of Nero. His treatise details the properties of about 600 medicinal plants and also describes animal products of dietetic and medicinal value. A Greek version of the work was published in 1906–14 and an English translation made by John Goodyer in 1655 was published in 1934.

See F. H. Garrison, *Introduction to the History of Medicine*, pp. 109–110, 4th ed. rev. (1929); Arturo Castiglioni, *A History of Medicine*, pp. 215–217, 2nd ed. rev. (1941).

DIP. In magnetism (*see* GEOMAGNETISM), the angle made by the direction of the earth's magnetic field and the horizontal is the angle of dip, commonly called the dip or inclination. In astronomy and surveying, the dip of the horizon (*q.v.*) is the angular distance between the true horizon and the apparent horizon, due to the observer's elevation. In geology it is the angle which the line of maximum slope of a stratum makes with the horizontal. *See* also FAULT: *Movement Along Faults.*

DIPAVAMSA: *see* PALI LITERATURE.

DIP CIRCLE, an instrument used for measuring the magnetic inclination or dip. It consists essentially of a magnetic needle pivoted at the centre of a graduated metal circle. The circle is mounted with its plane vertical, and the axis about which the needle turns, horizontal. If such an instrument is placed with the plane of the circle in the magnetic meridian, the needle will lie in the direction of the earth's magnetic field. *See* GEOMAGNETISM.

DIPHENYL or BIPHENYL, an aromatic hydrocarbon found in that fraction of the coal-tar distillate boiling between 240°–300° C., from which it may be obtained by warming with sulfuric acid, separating the acid layer and strongly cooling the undissolved oil. It can also be synthesized from simpler aromatic substances. It crystallizes in plates (from alcohol) melting at 70°–71° C., and it boils at 254° C. It has the structure $C_6H_5.C_6H_5$. The principal use of diphenyl itself is as a heat-transfer fluid, either alone or in the form of its eutectic mixture (Dowtherm A) with diphenyl ether $(C_6H_5)_2O$.

DIPHILUS (fl. late 4th century B.C.), one of the principal poets of Athenian New Comedy; he is credited with 100 plays, of which about 60 are known by title. An elder contemporary of Menander (342–291 B.C.), Diphilus came from Sinope on the southern shore of the Black sea; his brother Diodorus is also known as a writer of New Comedy in the early 3rd century. He is said to have died at Smyrna, but was buried in Athens, where he probably spent most of his life. His work survives both in Greek fragments and in Latin adaptations by Plautus (*Casina, Rudens,* probably *Vidularia,* and perhaps other plays) and by Terence (a scene in *Adelphi*, 155 ff.). He seems to have remained more faithful than Menander to the Middle Comedy tradition, and to have excelled in scenes of action and spectacle; his style is marked by its vivid imagery.

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DIPHTHERIA is a specific, localized and superficial bacterial infection that is associated with the formation of a characteristic membrane, composed of fibrin and necrotic tissue, and with the production of a powerful toxin. The lesion is normally situated in the upper respiratory tract but is occasionally related to previous wounds or ulcers of the skin.

Although primary localizations of the infection in the nose or nasopharynx and the larynx (voice box) are not uncommon, the tonsils and faucial pillars (folds of mucous membrane at the sides of the passage between the mouth and pharynx) are the sites at which the lesion most often appears. A tough, closely adherent membrane, which leaves a raw surface when torn away, is most characteristic, but there are a number of early or mild cases, especially those in the immunized that present scattered patches of softer, more readily detached membrane. These latter lesions are not easily distinguished from follicular tonsillitis. It is also noteworthy that the severest infections may cause a swelling that is more prominent than membrane formation.

Although there is no absolute relationship between the extent of membrane formation and the severity of the infection, the spread of membrane over the whole tonsil, with progressive involvement of the soft palate, uvula, pharynx and larynx, normally indicates a severe case. In rarer instances extension to the esophagus or to the bronchial tree is observed. Swelling of the lymphatic glands of the neck and edema of the periglandular tissue may be a marked feature; in the worst cases such enlargement is often called "bull neck." Nasal discharge and offensive odour are also common features of the severer cases. The membrane passes through three phases: an early one, not often recognized, in which it resembles raw white of egg; a second one in which it suggests coagulated white of egg; and a final one in which it suggests rubber, with all colour shades from gray to reddish-brown. Rare sites of membrane formation are the eye and vagina.

General Symptoms.—In moderate or severe cases there is usually initial fever, of very short duration, and sore throat; the latter, however, is not a commanding symptom. In the severest cases evidences of profound blood poisoning (toxemia) are discerned: pallor, soft and irregular pulse, general weakness and marked subjective consciousness of illness. Vomiting, a rapid fall in the pulse and hemorrhagic manifestations are all of grave prognostic significance. Evidences of toxic neuritis appear in a variable percentage of cases and are observed between the sixth day and the sixth or seventh week. In order of frequency and time of appearance, paralyses of the palate, eye, pharynx and muscles of the trunk and limbs are observed. The palate lesion is indicated by nasal voice and by regurgitation of fluids through the nose; that of the eye muscles by squint, failure of accommodation and, more rarely, drooping of the upper eyelid (ptosis); and that of the pharynx by difficulty in swallowing.

Causes of Death.—Death may result in four different ways: (1) a primary massive toxemia, which mainly affects the heart, may lead to death within three days; (2) a less profound toxemia may lead to heart failure within the first two weeks; (3) obstruction of breathing caused by membrane formation and edema of the upper respiratory tract; and (4) extensive paralytic manifestations, *e.g.*, diaphragmatic paralysis or inhalation pneumonia, that may be directly or indirectly responsible for many late deaths.

Diagnosis.—Although many well-developed cases of diphtheria can be diagnosed without hesitation by any experienced observer, a proportion of early, mild or unusual cases can only be diagnosed with certainty by bacteriological investigation. Even with a positive bacteriological result, there often remains the question of whether a diphtheria-carrier condition coincides with some other infection that is actually responsible for the clinical symptoms. Bacteriological diagnosis is usually made by combining the observation of morphology of mixed cultures on Löffler's blood serum medium and the appearance of individual colonies on one of the blood tellurite agar media. A rod-shaped form that may show clubbing of its ends and that displays granules or barring when stained with an alkaline solution of methylene blue is considered characteristic.

For fuller identification, resort is made to fermentation of carbohydrates and to virulence tests. Tests of virulence were originally made by inoculation of guinea pigs or rabbits, but have been generally replaced by in vitro determinations of toxigenesis. A positive reaction depends on the detection of lines of precipitation in agar gels, resulting from the meeting of antitoxin (diffusing from reservoirs) with toxin (from bacterial growths).

History, Etiology and Epidemiology.—Diphtheria was first recognized and described as a sharply defined disease by Pierre Bretonneau (1826). Fifty-seven years later (in 1883) E. Klebs demonstrated the presence of bacilli of peculiar morphology in the superficial layers of the false membrane on the throat, and F. Löffler soon afterward (in 1884) succeeded in the cultivation and identification of the bacillus, *Corynebacterium diphtheriae,* long known as the Klebs-Löffler bacillus or K.L.B.

The bacteriological diagnosis of diphtheria was carried out by Löffler's original method until the 1930s. The peculiarly severe diphtheria that appeared in Berlin in 1927, and later in other centres, was a stimulus to further investigation. In an outbreak of this kind in Leeds, Yorkshire, Eng., in 1930–34, a difference was observed between a variety of bacillus associated with most of the severe and fatal cases and a second variety that was usually associated with the milder cases.

The extension of this work to many other areas and countries led to the recognition of three main variants of *C. diphtheriae. C. diphtheria mitis* is associated more often with mild cases and carriers and is more likely to cause death by excessive membrane production and obstruction of the air passages than by profound toxemia. *C. diphtheria gravis* is associated more often with marked toxemia and with epidemic prevalence of diphtheria. *C. diphtheria intermedius* resembles *gravis* in its pathogenic action but is usually rather less formidable.

The three variants give distinctive colonies on blood tellurite agar. The *gravis* strains are further distinguished by fermentation of starch, and the *intermedius* strains by much restricted growth on most media.

Evidence for the special capacity of the *gravis* strains to cause epidemic diphtheria, even in communities in which prophylaxis has been extensively adopted, is found in the records for Tyneside, Eng. (1939), Halifax, Nova Scotia (1940), Dundee, Scot. (1942–44), and Copenhagen, Den. (1944–45).

The diphtheria of a very severe type observed in Germany about 1927 appeared later in many other countries, and a major epidemic developed that culminated during the latter years of World War II. The figures available do not cover the U.S.S.R., Poland and the Balkans and they are incomplete for Germany, where the incidence of the disease was probably higher than in any other country. The annual incidence of diphtheria in the war period in Europe was estimated at 600,000 cases and the total deaths at 150,000. In most countries the highest epidemic incidence was in 1944 or 1945.

In North America, and especially in the United States, however, the incidence of diphtheria was considerably lower for the five years prior to World War II than it was in most European countries. This lower rate persisted during the war, although the epidemic wave in Europe was reflected by a slightly greater diphtheria mortality in the United States in 1945 than in any year from 1940 to 1960.

The most remarkable feature of the postwar period was the abrupt decline of diphtheria in Europe. This was especially marked in Norway, Finland, Sweden, Denmark and Scotland, where one or more of the years 1952–57 passed without any death from diphtheria being recorded; and in England and Wales, with a much larger population, where both mortality and incidence became negligible. A similar but less marked recession of diphtheria was observed in many other countries during this period. In several areas of South America, however, and in Portugal, Spain, Italy, Yugoslavia, Japan, Egypt and South Africa, diphtheria remained at a much higher level from 1948 to 1958. In a broad way it may be stated that the countries that enjoyed a high immunity in the period 1948–58 were those in which diphtheria was epidemic in a number of the larger cities or greatly increased in the country as a whole in the period of World War II and in which the practice of prophylactic inoculation was followed most thoroughly. There is evidence in Polynesia that wound infection by *C. diphtheriae* is common and sets up an immunity that protects the community from faucial diphtheria.

Diphtheria Toxin and Toxin Production.—Observations following injection of cultures or culture filtrates in experimental animals show that a toxin with lethal, dermonecrotic and neurotoxic properties is the active agent in diphtheria. This was first demonstrated by P. P. E. Roux and A. Yersin (1888). From that time production of toxin for immunization of man and of horses was the subject of a vast amount of investigation, but it was only after 1930 that the underlying principles were so far elucidated that the perplexing irregularities in toxin yield from cultures were largely eliminated. The essentials for proper yield in bacterial cultures appear to be a suitable peptone as a source of nitrogen, combined with fatty acid and carbohydrate, especially maltose, which supply energy in such proportions as to ensure a slow reversal of the reaction, from slight acidification to a pH of about 8.6. Several days' incubation are necessary, under conditions in which there is a large exposure of surface relative to the volume of culture. The importance of limiting the iron content of the medium, first observed by J. Meuller (1939), came to be generally recognized.

The Park-Williams 8 strain maintained its place for more than 40 years as the most reliable source of toxin, notwithstanding the fact that its virulence on testing in animals was lower than that of many freshly isolated strains. The toxin appears to be a protein that contains sulfur but neither phosphorus nor carbohydrate. A ratio of 1/1,000,000 g. per kilogram of body weight of highly purified toxin will kill a guinea pig. Crystalline preparations of the toxin were obtained in the 1950s by A. M. Pappenheimer in the United States, C. G. Pope in England and M. Raynaud and E. H. Relyveld in France, but there was considerable controversy

about the purity of such preparations. The possibility that secondary toxic elements play a part in the diphtheria caused by *gravis* strains was suggested by R. A. Q. O'Meara (1940), H. Niggemeyer (1955) and Sara E. Branham, C. W. Hiatt, A. D. Cooper and D. B. Riggs (1959).

Treatment.—The existence of curative properties in the serums of animals that had recovered from infections was first observed by Emil von Behring in 1890. The correlation of his work with that of Roux led to the rapid development of antitoxin therapy with the serums of immunized horses. The therapeutic value of such serums was established beyond doubt by the halving of the death rate in the disease in Paris in 1894 (Roux and others) and by the results of treatment of alternate cases with and without antitoxin over a year in the Blegsdam hospital in Copenhagen by J. Fibiger in 1898.

Antitoxin was increasingly used thereafter and emphasis was put on large doses and early treatment. The former were facilitated by new methods of antitoxin purification—partial enzyme digestion followed by differential heat denaturation in acid solution. It is doubtful, however, whether the use of huge doses of concentrated serums give results much superior to those obtained in the early days in which smaller amounts of cruder preparations were employed. There are trustworthy records of death in the hypertoxic cases of diphtheria seen so much in Europe after 1925, notwithstanding intensive serum treatment within 24 hours of onset. Estimations of circulating toxin in such cases on admission may reveal amounts greater than a lethal dose for man. A. Tasman (1958) emphasized afresh the importance of early saturation of the body with antitoxin, the necessity of intravenous administration for this purpose and the precautions required. Variations in the avidity of antiserums for toxins have been recognized and may be related to variations in the globulins of the serum.

Cutting into the windpipe to allow breathing was much more common in the past and this was probably related to the higher incidence of the disease among infants and young children, although changes in the etiological agent may have played a part. The higher relative incidence of diphtheria in adolescents and adults after the end of the first quarter of the 20th century has been the subject of much comment.

Control.—Transmission occurs in several ways: (1) spread of contamination from infected nasal discharges (probably of first importance); (2) the ejection of infected droplets from the throats of cases or carriers; (3) persistence of *C. diphtheriae* in the dust of ward floors; (4) infection of milk or ice cream, to which several well-authenticated minor epidemics have been convincingly traced. The disease has not been effectively checked by the isolation of carriers.

Prophylactic Inoculation.—The basis of prophylactic inoculation was laid by B. Schick's demonstration (1913) that persons susceptible to diphtheria could be recognized by their reaction to the intradermal injection of minute amounts of diluted toxin. Immunization was at first attempted with toxin-antitoxin mixtures, but this method was abandoned on account of disasters due to destruction of the antitoxin in such mixtures, and their place was taken by toxoid immunization. Formalin-treated toxin is used as toxoid and is generally referred to as anatoxin in France, where it was specially studied by G. Ramon. In Great Britain most immunization has been done with alum-precipitated toxoid (A.P.T.) in children or, in the case of adults, toxoid antitoxin floccules (T.A.F.), which are less liable to cause severe local reactions. It has been shown that the administration of several doses of suitable preparations at intervals of four to six weeks produces a conversion of Schick positive to Schick negative in over 99% of those inoculated. Special emphasis has been laid on early immunization—at four to six months—and on booster doses where there is a low level of diphtheria in the community and a consequent lack of natural immunization by contact with mild cases or carriers.

It has been claimed that the elimination of diphtheria in many Canadian and U.S. cities and later throughout Great Britain is the result of prophylactic immunization. This may be partly misleading, because other factors such as mass immunization during epidemic periods and changes in the infective agent were also involved. The value of inoculation in saving life, however, was proved beyond any possible doubt.

A perplexing but most interesting series of observations, initiated by V. J. Freeman (1951), revealed some surprising effects of bacterial virus (bacteriophage) preparations on the diphtheria bacillus. It was shown that, under the influence of suitable bacteriophage taken from strains of *C. diphtheriae* or even from certain staphylococci (Hewitt, 1952), a nontoxigenic bacillus may be converted to a toxigenic and lysogenic form. This work obviously may contribute much to the elucidation of changes in the diphtheria bacillus and its pathogenic potentiality.

See also references under "Diphtheria" in the Index volume.

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DIPLODOCUS, a very large amphibious dinosaur found in the Upper Jurassic rocks of the Rocky mountain region; skeletons or replicas are to be seen in many museums. It reached a length of over 80 ft., but was relatively slender in build. *See* also DINOSAUR. (A. S. RR.)

DIPLOMACY is a word often used vaguely with different meanings. Sometimes it is used to express the whole content of international relations (*q.v.*); sometimes to express the manner in which personal affairs are conducted. Sometimes it is used in a derogatory sense; sometimes it is described as a highly commendable activity. Its proper and main meaning is, however, the manner in which international relations are conducted. Numerous definitions of it exist, but perhaps the best is that of the *Oxford English Dictionary:* diplomacy is "the management of international relations by negotiation: the method by which these relations are adjusted and managed by ambassadors and envoys; the business or art of the diplomatist." This definition should not be interpreted to exclude officials of higher rank, for a president, a prime minister or a foreign secretary negotiating in Washington, London or Paris is engaging in diplomacy as much as any ambassador or envoy. It stresses, however, the main point that it is the method, not the object, of the negotiation that is the subject of diplomacy. Bad objects may be sought by good diplomacy and vice versa. Still, diplomacy is in a sense a substitute for force; it is the means of obtaining the maximum national advantage without the use of violence and, perhaps one might add, with the minimum of friction and resentment. It is also true, however, that sometimes it is interspersed with the threat of coercion; and it always depends in some degree on the power, whether military, economic, moral or deriving from association with others, of the state for which the diplomat is acting. Some writers define it as a science, others as an art. It has, indeed, characteristics of both, though it is certainly more an art than a science.

Early History.—The word in the use defined above is comparatively a newcomer. It is derived through the French from the Greek word *diploma,* meaning a folded paper such as was early used for state papers, charters, etc.; and hence a privilege, licence or degree conferred on a person. Though the word is new, the thing itself has existed since the beginning of civilization—or even earlier. Distrust of foreigners was almost universal in the early ages of society. But if any negotiation were to take place, conventions safeguarding the security of heralds or envoys had to be

observed, and often some form of religious sanction was used for this purpose. When the sovereign states of the Mediterranean area grew in number and civilization, their contacts multiplied and the necessity for negotiation increased. In the Greek world the system, though intermittent, attracted to it some of the most skillful of Greek statesmen, who cultivated the art of persuasion, and a set of rules for diplomacy began to appear. The Romans took less from the Greeks in this than in some other arts, though they used diplomacy effectively both in their relations with the Greeks themselves and in obtaining the control of Egypt. But when the Roman empire was fully established diplomacy was mainly employed to divide and control the barbarians who surrounded it. In the middle ages diplomats were called by many different names such as legates, nuncios, procurators, agents or ambassadors. In all this development there was no permanent diplomatic machinery, even between states that had frequent relations with one another.

Permanent Missions.—The Italians were the first to establish permanent missions, in the 15th century. It is usual to attribute to this Italian pre-eminence that characteristic of unscrupulous diplomacy to which the term Machiavellian is given because Niccolò Machiavelli described it in remarkable language in his *Principe* and his *Discorsi sopra la prima deca di Tito Livio*. But in the age of the Renaissance rulers of other nationalities, Louis XI of France, for example, were no less unscrupulous than the Italians, though the latter produced more subtle and refined personalities. It is not known when the first resident embassy came into existence; the system grew out of the various methods of conducting international relations established during the middle ages among the countries of the Mediterranean area. It was Venice, which had vast connections in the eastern Mediterranean and was threatened by the rising power of the Turk after the fall of Constantinople in 1453, that extended the system into one that became European. When its efforts to lead an alliance of Christian states against the infidel failed, Venice used diplomatic methods at Constantinople itself with considerable success. Meanwhile Venice had begun to establish permanent missions in western Europe.

New types of monarchies were then arising as the power of the pope and of the emperor declined and new methods of organizing the central power of the state came into existence. These monarchies naturally began to negotiate with one another in the new way. For some time they regarded it with great suspicion. Henry VII of England, Ferdinand of Spain and Louis XI of France considered foreign agents as little better than spies.

It is also perhaps significant that permanent embassies arose at the same time as permanent armies. One could be regarded as the antidote of the other. At any rate in the first half of the 16th century, in the age of Thomas Wolsey, of Francis I and of Charles V, the system of permanent diplomatic missions became firmly established among the leading European states, and for reasons both of prestige and security smaller states had necessarily to follow their example. Thus arose in nearly all capitals a diplomatic body that came later to be called the diplomatic corps.

Diplomatic Customs.—Naturally such men could not be subjected to the ordinary laws of the state where they resided; as is described below, a system of special immunities was gradually worked out so that they could go about their business without interference. But they had also to establish their names and titles, their method of communication, ceremonial procedure and conventional language. The rules that were gradually adopted were part of the system later called international law, which grew up in the 17th and 18th centuries (*see* CONFLICT OF LAWS; INTERNATIONAL LAW, PUBLIC).

The term "ambassador" became the designation of the monarch's representative in the 16th century, except the representatives of the pope, who were termed nuncios or legates—though the latter were something more than diplomats. To save expense and for other reasons an inferior and less costly class of agents was instituted, at first called residents or ministers resident, later called envoys. Subsequently a further class, accredited not to the monarch but to his ministers, was used to fill up intervals or when some incident prevented full diplomatic representation; members of this class became known as chargés d'affaires. By the end of the 18th century there were four main classes, which were definitely recognized as such in an annex to the treaty of Vienna of June 9, 1815, and in a protocol of the congress of Aix-la-Chapelle (Nov. 21, 1818): (1) ambassadors, legates and nuncios; (2) envoys extraordinary and ministers plenipotentiary; (3) ministers resident; and (4) chargés d'affaires. (*See* AMBASSADOR.)

The language of diplomacy was originally the international language of medieval Europe, Latin. In the 17th century Latin was superseded by French, which remained the principal diplomatic language until the end of the 19th. The use of English had been carefully safeguarded, however, and the right to use English in diplomatic communications insisted upon by the government in Westminster, while other governments made analogous reservations. Not until the Paris conference of 1919 was the perfect equality of English with the French language accepted by other governments, largely because of the influence of the United States.

By the beginning of the 19th century diplomacy had developed in extent and technique. In some states the foundations of departments of foreign affairs had been established, and the ministers were assisted by professional advisers. Instructions to ambassadors were drafted with competent skill; courier services were organized; and ciphers, first used by the Venetians, were employed with imperfect success to guard the secrets of correspondence.

The ambassadors were much preoccupied with the dignity of their office. Not, however, until the above-mentioned agreements of Vienna and of Aix-la-Chapelle was precedence by date of appointment accepted by all states for the classes of diplomats then established. Alphabetical order in the French language was also agreed to in the signature of treaties and similar documents, each state coming first in its own copy. Conventional rules as to the form of correspondence and address had also been established, though each court had its own ceremonial practice for the reception and entertainment of diplomatic agents. As relations between states increased, practical questions occupied the minds of diplomats and etiquette was of less importance.

The 19th Century.—The diplomatic profession, while still largely in its higher ranks in the hands of the nobility, became in many countries a definite career. In the 19th century foreign affairs were dealt with in great departments, as other business of the state. By 1815 in France and in Austria permanent officials already managed much of this business. In Great Britain the foreign ministers for a longer period did most of the important work themselves, aided only by a few clerks. But in London also by the middle of the century the permanent officials had necessarily to do much more as the dispatches multiplied. First the railroad and then, to a much greater extent, the telegraph transformed the tempo of diplomacy.

The position of an ambassador became somewhat different when he could seek instructions from home and receive an answer in a matter of hours instead of days or even weeks. Technical questions, especially those of trade, occupied more of the time and energy of diplomats. Commercial treaties had for a long time been negotiated by special envoys working under the general direction of the ambassador and receiving their instructions from ministers of finance or of commerce. Finally, commercial attachés were appointed. There were also military and naval attachés to report on the ever-growing armies and navies.

In addition, an attempt had been made in 1815 to set up a permanent international organization of the great powers, the European alliance, often called mistakenly the Holy alliance, the latter name being that of the less practical treaty sponsored by Tsar Alexander I. The alliance broke down in 1823; but in 1830 began the system of ambassadorial conferences—mainly of the great powers —which persisted sporadically throughout the century. In 1899 and 1907 two conferences of wider scope met at The Hague to lay down rules for arbitration and revise the rules of war. A number of technical international organizations were also set up with their own conferences and secretariat. Thus originated what was later

called "diplomacy by conference."

Diplomatic Immunities.—As noted above, diplomats could not be governed by the same laws as the people among whom they dwelt, and from an early date it was recognized that they had special privileges. Hugo Grotius gave his great authority to the theory that these immunities were based on the fiction that the diplomat's dwelling was part of the territory of his own country and that he carried its law with him. They are, however, really based on practical convenience. Without them, though not necessarily in their most extreme form, it would be impossible for the diplomatic agent to perform his functions satisfactorily. Diplomatic agents were thus placed outside the criminal and civil law of the land. They could not be arrested on a criminal charge or sued for debt in a civil court.

During the 16th and 17th centuries these immunities were firmly established by numerous precedents. With a few exceptions they were very generally observed in all civilized communities. Perhaps the one most challenged was exemption from prosecution for refusal to pay debts, which was more than once successfully contested. But the immunities were extended to the diplomatic agent's wife and suite and even to his menial servants, since otherwise his freedom of action would be limited by consideration for those who depended on him and on whom he depended for the exercise of his functions. This privilege was in many countries, especially in the orient, often abused in earlier centuries; and even in the 19th century it was sometimes a source of profit to the diplomatic agent. Since a diplomatic agent's house is inviolable, the right of asylum for political refugees was at one time of importance, especially in Latin America, but it was always regarded with jealousy and not held to be good in the case of ordinary criminals, who could be taken by force if not surrendered. He and his suite are exempted from taxation and customs duties. He has naturally also the right of free communication with his own country unless he allows himself to be shut up in a besieged town. On this analogy the diplomatic body in Great Britain was prevented from using cipher dispatches or couriers during the period before the invasion of the European continent in 1944.

In return for these privileges the diplomatic agent had the duty of never creating a breach of the peace or civil disturbance. He was, indeed, expected to avoid all interference in the internal affairs of the host country. If he failed to do so the only remedy was expulsion. It became more usual, however, to ask that the diplomatic agent be recalled by his own government. Such action should not be taken without sufficient cause, though it has been maintained that it is simply sufficient to declare an agent to be *persona non grata* as justification for desiring his removal. But if this is done unreasonably, reprisals may follow and a rupture of diplomatic relations take place. (*See* EXTERRITORIALITY; FOREIGN SERVICE.)

Early 20th Century.—During the 19th century diplomacy became a highly organized profession, and its practitioners were for the most part chosen for their technical proficiency. In democratic countries the foreign minister was nearly always a politician who might have had no experience at all in diplomacy; he was also a member of a cabinet or under a president who decided policy, subject to certain legislative controls. In the more autocratic countries the foreign minister was often himself a professional diplomat. The old aristocracy still played a notable part in the profession in many countries; and in Great Britain there was an income qualification for the diplomatic service, and its members tended to be chosen exclusively from the upper class. Moreover, of the foreign ministers of Great Britain between 1815 and 1914 all except two (George Canning and Sir Edward Grey) were either peers or the sons of peers. Parliamentary control was also limited by ignorance of many important facts. "It is in the cabinet alone that questions of foreign policy are settled," Lord Palmerston told Richard Cobden. "We never consult parliament until after they are settled." Diplomacy still remained highly secret and, to the man in the street, mysterious. The treaties which bound the states of Europe together in the period before World War I were nearly all unknown to the peoples whose actions they pledged. Even Great Britain had secret discussions with France which, though they left the former free to determine its own course of action, yet were a moral obligation which could not be disregarded. During the war secret treaties were made which became known only when revealed by the Bolsheviks after the Russian Revolution.

The press, it is true, took an increasing interest in foreign affairs. In return, the foreign ministers and diplomats generally took an increasing interest in the press and tried to control it either by bribery or by more subtle methods. Its use became part of the technique of diplomacy. Some journals were controlled by powerful financial and commercial interests, which thus obtained an influence on foreign affairs. Papers such as the *Times* (London), the *Frankfurter Zeitung* or the *Neue Freie Presse* (Vienna) exerted a real effect on public opinion and consequently on legislatures and cabinets. Governments had to defend themselves by publishing correspondence showing the manner in which diplomatic transactions had taken place. But it still remained true that many things, and often the most important, were kept secret. It was natural, therefore, that there should have arisen during World War I an insistent demand in many countries that secret treaties should be abolished and that much more information should be given to the public about foreign affairs. In addition, two other developments in international affairs began after that war to exercise an important effect on diplomatic methods: for the first time in history a world-wide permanent international organization had been set up in the League of Nations, which brought together diplomats from many different countries; and new technological developments, including those which affected communications, made the use of expert knowledge on many different subjects a necessity to the diplomatic profession.

In the western world and in the democracies generally the period between World Wars I and II was marked above all by the growth of popular control over the processes of diplomacy. In the United States, where this control had always been most extensive, all treaties had to be sanctioned by a two-thirds majority of the senate before they could be ratified. This system had resulted in the rejection of many treaties, including the most famous of all, the treaty of Versailles, signed by Pres. Woodrow Wilson in 1919. In Great Britain the executive had the power to ratify treaties, but it was recognized increasingly that it could only do so in important cases if parliament had previously indicated approval. Another step in the direction of democratic control was to make the diplomatic profession more easily accessible to candidates from every class. In Great Britain the income qualification for the diplomatic service was abolished and new methods of appointment and examination introduced—although it took some time for such measures to have any great effect.

As the power of an only partly instructed public opinion over foreign affairs became greater, governments began to use new methods to influence it, not only in their own country but in others. Departments of propaganda were organized which appealed to peoples over the heads of their governments. This practice, first begun by the Soviet government at the end of World War I, was adopted by other authoritarian regimes that appeared elsewhere, the development of radio communication providing them with a new instrument for their purpose.

After the Creation of the United Nations.—With the emergence after World War II of many "new" nations; with the increase in the power of the Soviet Union and the challenge which this presented to the United States and, indeed, to the western world; and with the constitution of the United Nations, a world organization more extensive in scope and in potential importance than the League of Nations, the character of international diplomacy changed. Thus the game of chess which for centuries had been played by the "great powers" of Europe, together with (toward the end of the 19th century) the United States and to some extent Japan, was complicated by the appearance among them on the international stage of such emergent nations as India, Pakistan, China and Indonesia and movements such as Arab and African nationalism.

Similarly the development of the technique of appeal by one nation to another over the heads of established governments by

radio and other mass media, which had begun in the 1920s and 1930s, became more violent in the circumstances of the "cold war," as the rivalry between the United States and the Soviet Union came to be called. A new technique of subversion, sometimes known as indirect aggression, came into being. The object of this new form of diplomacy, if such it could be called, was to gain control of a given country by intrigue conducted from within and fostered from without.

Along with these tendencies was a rather happier development, inevitable with the continued progress in transport and communications, namely diplomacy by conference. As noted above, this device had been initiated in the early 19th century and was employed at intervals up to World War I. It received a great impetus with the foundation of the League of Nations, but it really came into its own with the creation of the United Nations in 1945. That organization was established as a "centre for harmonizing the action of nations in the attainment of (their) common ends" and it was a feature of the whole charter that major international problems could be solved only if the five permanent members of the Security council were in substantial agreement. Unfortunately, the very structure of the Soviet state, together with the westward extension of its power, prevented such harmony save on rare occasions. But the presence of a world organization in which the intermediate and smaller states could play the valuable role of "ball bearings" which could lessen and direct the shock caused by the inevitable rivalries of the great powers seemed right in theory. It is quite true that up till the beginning of the 1960s at least the world forum was often used as a sort of platform in which the ends of the opposing blocs were sought by means of propaganda. It seemed that, in the view of the Soviet Union at any rate, conferences (including, of course, meetings of the Security council and the general assembly of the United Nations) were chiefly desirable as means for dividing its adversaries. When the Soviet Union found it desirable to make a deal the fact was usually made known privately (as happened in 1949 in the case of the Berlin blockade) or action was taken independently and without publicity. But in order to reach this point it might well be necessary to have gone through the processes of diplomacy by propaganda, and to that extent the latter might have served a useful purpose.

The technique of diplomacy by conference has been more profitably employed in the non-Communist world for practical political, economic and social purposes. There advances have been made in the direction of international co-operation. Typical of this kind of co-operation are, for example, the Atlantic council, the Organization of American States and, in eastern Europe, the Council for Mutual Economic Aid, and such United Nations bodies as the Food and Agriculture organization and the World Health organization, where the participating states are represented by their ministers or by career officials in more or less permanent session. It is, as it always was, for the governments to make the decisions and to lay down the policies, but it must be clear that in doing so they are largely dependent on the trained services they employ. "The Prince" has changed in character since diplomacy began with the European Renaissance but the "negotiator" remains much as he was.

Even the invention of television and its application to diplomacy by conference did not invalidate these conclusions. It is, of course, clear that it is not actual negotiation which is televised. What is televised is the sort of speech which was made in very ancient times when diplomatists were sometimes known as "orators." It is arguable that the "formulator" is better at this kind of thing than the "negotiator," who is more profitably employed behind the scenes; but the experienced negotiator should be capable of making an effective speech and suiting his manner to the occasion.

Finally, it is evident that, apart from diplomacy by conference, there must still be machinery for conducting bilateral relations between nations. In modern conditions such relations are becoming increasingly complicated even if, from the point of view of war and peace, they may be becoming less important. It must also be admitted that the debasing of the coinage as regards embassies (by the early 1960s there were practically no legations left) and the bureaucratic inflation in the centre has resulted in a diminution of the role of the conventional diplomat. For all this, he still has a role to play, together with the consular corps. Into this field comes the increasing work of the press attachés, of the scientific and labour attachés and of national "cultural" agencies such as the U.S. Information agency and the British council. With the unification of the world in the realm of manners and ideas that is taking place rapidly in spite of political differences, it is evident that this type of diplomacy serves a real need. Though the qualities required are not necessarily the same as those required for a negotiator, they do for the most part demand *expertise* and are therefore best left in the hands of professionals.

Qualities of a Diplomat.—No better description of the qualities with which the representatives of independent states ought to be endowed is ever likely to appear than that contained in the work of François de Callières (one of the chief diplomatic advisers of King Louis XIV of France) entitled *The Art of Negotiating With Sovereign Princes*. It is also true that the qualities are of such a high order that they could hardly ever be embodied in a single person.

To start with, the negotiator must be an excellent, indeed, an exceptional linguist. Next, he must above all be aware of the state of mind, the weak points and the strong points of those with whom he is negotiating. "His aim should be to arouse the minds of his hearers by a sympathetic touch . . . He should therefore at the outset think rather of what is in their minds than of immediately expressing what is in his own . . . The words that I have just used are the beginning and end of all diplomacy." (This point is reinforced by Francesco Guicciardini who, Sir Victor Wellesley informs us, "went so far as to say that an ambassador is at his best when he appears to be so anxious to meet the views of his opponent that he might be suspected of being a traitor to his country.")

He must further possess "an observant mind, a spirit of application which refuses to be distracted by pleasures or frivolous amusements and sound judgment which takes the measure of things as they are and goes straight to its goal by the shortest and most natural paths without wandering into useless refinements and subtleties which as a rule only succeed in repelling those with whom one is dealing." This in its turn implies "an address always open, genial, civil, agreeable, with easy and ingratiating manners." Above all he must always act in complete good faith. "It is a capital error, which prevails widely, that a clever negotiator must be a master of the art of deceit. No doubt the art of lying has been practised with success in diplomacy; but . . . a lie always leaves a drop of poison behind," and this may have terrible consequences. (In this respect De Callières differs from the earlier exponents of the art of diplomacy who based themselves on what was to some extent a misunderstanding of the principles of the great Italian master, Macchiavelli.) Finally, the negotiator must be "a man of peace."

"Neither the soldier nor the courtier can hope to discharge the duties of the diplomatist with success, unless they have taken the pains to instruct themselves." Neither, for that matter, can a lawyer, as a rule. "It is true that sometimes a lawyer diplomatist has made a great success of negotiation, especially in countries where the final responsibility for public policy lay with public assemblies, which could be moved by adroit speech; but in general the training of a lawyer breeds habits of mind which are not favourable to the practice of diplomacy." In any case, incompetence is "the parent of disaster." "It is a crime against the public safety not to uproot incapacity whenever it is discovered." The competent diplomatist, on the other hand, must write candid and crystal-clear reports (which demands long training); and De Callières reveals an ancient secret of the craft, which is that the diplomatist would do well to insist on the improbability of success "even when he is virtually sure in his own mind that he will succeed."

It is perhaps superfluous to add, after all this, that "the prince should remember that it is within his power to equip the able man with all the necessary means, but that it is not in his power to

endow with intelligence one who does not possess it." As a general conclusion we are rightly told that "the most perfect ambassador is valueless unless his advice carries weight with his own sovereign or minister and unless they in their turn disclose to him the full nature of their policies and desires."

Has such a paragon any relevance to the modern age? It is true that circumstances have greatly changed since De Callières laid down the qualifications of the ideal diplomat. Some maintain that modern conditions have reduced the diplomat to the rank of a sort of glorified clerk; whenever anything important is to be transacted in the international field the foreign minister or another minister, occasionally even the head of the government himself, arrives by air to transact it. The "negotiator" is not therefore (so it is often alleged) the person who actually negotiates. Even the considered telegram often arrives too late; the really important point is usually decided on the open telephone. All this is true. But it is also true that, if the minister arrives, the man on the spot has a welcome opportunity to explain his own views to the fountain of authority. If he is telephoned to he can also telephone back. Even if the considered telegram arrives too late his reports can at least create the climate in which the crucial decision is eventually taken.

Sir Harold Nicolson in his *Diplomacy* observes that "most ambassadors during the period of slow communications were so terrified of exceeding their instructions . . . that they adopted a purely passive attitude, missed opportunity after opportunity, and spent their time writing brilliant reports on situations which had entirely altered by the time their despatches arrived." He concludes: "I do not agree therefore that improvements in means of communication have essentially disinvested the responsibility of an ambassador or to any important extent altered the nature of his functions." The probability indeed is that the modern ambassador (in which term is included all representatives of their country abroad, whether accredited to nations or to any form of international organization) still has considerable influence if he is efficient, little or none if he is indifferent or bad.

Though the one occasionally assumes the functions of the other, a clear distinction should be drawn between the diplomat and the politician. The latter is, inevitably, directly concerned with the great game of power. Whatever the form of the state in which he operates the politician must consider primarily those factors that are likely to preserve him in office or, alternatively, to result in his dismissal or disgrace. If necessary, it is he who must ride the whirlwind. In any case it is he who must assess the risks. The diplomat—the negotiator—is thus necessarily, from the political point of view, a secondary figure. It is for him to offer advice on the best means of attaining the "prince's" ends; it is for him to say frankly whether these ends are attainable, or, alternatively, doomed to frustration. But when his government has finally established the policy there is nothing for it but for him to apply it loyally, whatever his personal doubts may be. Only one exception to this rule is allowed by De Callières, namely, when the negotiator is ordered by his chief to do something "against the laws of God and Justice"; *e.g.*, assassination. This rule clearly holds good even today when there is much less common agreement on what exactly the laws of God and justice are. Should the diplomat feel that he is being instructed to do something that violates his conscience (if he has one) there is certainly no option for him but to resign.

In conclusion, a word may perhaps be said on the confraternity of diplomats. This is not, as is sometimes thought, a sort of social snobbery, a feeling of belonging to a special and privileged class. Class, indeed, is increasingly irrelevant in the modern world. But there is no doubt that long experience of working with negotiators of other countries tends to create among the more intelligent diplomats a sort of freemasonry which sometimes results in a mysterious improvement in an otherwise apparently hopeless situation. People who have known each other for many years and who have constantly worked together, whether in some international organization or in some particular capital (and this naturally includes not only conventional diplomats but international officials as well), are at least predisposed to see each other's point of view and may even get to the point of showing each other, in confidence, their respective instructions. It is just as likely, perhaps, that the foundations of a lasting peace will be built up on this kind of foundation as on speeches delivered primarily for political purposes. Only one thing can interfere with such a beneficent process. Ideological warfare similar to that of the 17th century in Europe or to that of the intensive "cold war" of the era after World War II permits of no diplomacy at all. For, when everything that the one side does is suspect and condemned a priori by the other, international relations are outside the realm of all possible compromise and are continually menaced by total war. In its place is needed a reversion, for negotiating purposes, to the 18th-century assumption of an ideal republic transcending warring nationalities—no longer a "republic of Europe" but a republic of the world.

See also references under "Diplomacy" in the Index volume.

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DIPLOMATIC is the science which has as its object the critical study of the formal sources of history; *i.e.*, of the "records" or archive documents (charters, mandates, deeds of all kinds, judgments, etc.) as opposed to the informal or literary sources such as chronicles. The term "diplomatic" (for which German scholars have substituted the more appropriate one of *Urkundenlehre*) is ill chosen, as the word "diploma," from which it is derived, was never used to designate more than one of the many types of documents which come within the compass of the diplomatic science. Modern terminology, which dates back to the Renaissance, restricts the use of "diploma" in this context to the most solemn acts of kings and princes. The name "diplomatic" was in fact simply taken directly from the title of the first textbook on the subject, *De re diplomatica,* published in 1681 by Jean Mabillon, a Benedictine monk of St. Germain-des-Prés.

History.—Mabillon's book was called forth by the publication in 1675 of the "Propylaeum antiquarium circa veri ac falsi discrimen in vetustis membranis," a prefatory dissertation by the Bollandist Daniel van Papenbroeck to the second volume for "April" of the *Acta Sanctorum* (*see* BOLLANDISTS). In this work the author argued against the authenticity of the majority of Merovingian diplomas and other ancient charters which he had come across in monastic archives such as those of the Benedictine abbey of St. Denis, near Paris. Mabillon's refutation of Papenbroeck's criticisms was complete and was accepted by Papenbroeck himself. The *De re diplomatica* established the science on a secure basis; and though its immediate result was a flood of controversy between the Benedictines and the Jesuits, it has been the foundation of all subsequent works on the subject.

Mabillon's lead was soon followed with varying success by other scholars all over Europe. In England, the *Formulare Anglicanum* of Thomas Madox was published in 1702, followed in 1705 by the *Linguarum veterum septentrionalium thesaurus* . . . of George Hickes. Similar works, endorsing the principles laid down by Mabillon, also appeared in Germany, Italy and Spain.

France, however, the cradle of the science, continued to be the home of its development. Mabillon had not taken cognizance of documents later than the 13th century, and a more comprehensive work, the *Nouveau Traité de diplomatique,* 6 vol. (1750–65), was compiled by two later Benedictines, René Prosper Tassin and Charles François Toustain. Like all the other early treatises on diplomatic, the *Nouveau Traité* is an extensive encyclopaedia on the criticism of documents, including such matters as paleography (*q.v.*) and sigillography (the science of seals), which now fall outside the scope of diplomatic.

As a result of the Revolution, the medieval records of France

lost their legal value as title deeds, but this rather tended to enhance their historical importance. The taste for historical literature revived, fostered by the Académie des Inscriptions. The École des Chartes in Paris, founded in 1821, soon became an active centre for the teaching and encouragement of the study of diplomatic. The same end was achieved in German-speaking countries by the Institut für Oesterreichische Geschichtsforschung, set up in Vienna in 1854–56, with Theodor Sickel as its first director. Great series of critical editions of records were launched both in Germany and in France; *e.g.*, the *Monumenta Germaniae Historica* (1826–) and *Chartes et diplômes relatifs à l'histoire de France* (1908–). By the end of the 19th century enough groundwork had been done in those countries to make it possible to write new treatises on diplomatic. The first part of Harry Bresslau's great work, *Handbuch der Urkundenlehre für Deutschland und Italien*, was published in 1889 (later completed and revised) and Arthur Giry's *Manuel de diplomatique* in 1894. In England the wealth of record material was such that public and private institutions devoted all their energy to the publication of facsimiles and texts; in the field of public records, this work was undertaken first by the Record commission in 1800 and later taken over by the Public Record office (established in 1838).

Since Mabillon's time diplomatic has made great strides. The method used remains virtually the same: it is still a study of the forms as opposed to the contents of the documents. The objectives of the science, however, are steadily widening: it aims not only at testing the authenticity of records but also at ascertaining their date, their methods of production and the purposes to which particular forms were applied. In many ways the field covered by modern diplomatic borders on administrative history.

Classification of Documents.—Records may be classified according to their provenance: royal documents, issued by kings or on their behalf; and private documents, emanating from private individuals or corporations, ecclesiastical or lay. Each category may again be subdivided according to its formulas, purpose and methods of sealing. In the 13th century, for example, the English royal chancery issued three main types of documents: charters (normally used for grants of land and liberties in perpetuity); letters patent (letters sent "open," used for grants of limited duration, commissions, etc.), in which the seal validated the document without closing it; and letters close (used for news letters, administrative orders, etc.), in which the seal authenticated and closed the document. Some documents are still preserved in the original, others are found only in copies. Of the latter the most important are the contemporary copies made by the authorities who issued the documents; among them the patent, close and charter rolls of the English royal chancery (kept in the Public Record office in London) and the registers of the papal chancery (in the Vatican) are particularly worthy of notice. The copies preserved in monastic and lay cartularies, although not contemporary and compiled by the recipients of the documents, are also valuable, since the originals may no longer exist.

The practice followed by the different chanceries of medieval Europe varied so much that it is impossible to give even a brief account of all of them here. Only some of the results achieved in this field of research can be given.

Papal Chancery.—First and foremost stands the papal chancery, the evolution of which can be traced without interruption from the fall of the Western Roman empire to the present day. At first the papal chancery was organized on the model of the imperial chancery. It grew around the *scrinium* (a word originally meaning "box" and extended first to the records kept in the box and finally to the record office), the centre of the papal archives and secretariat. For the study of papal documents four periods have been defined, each being distinguished by some particular development of forms and procedure.

First Period.—The first period is reckoned from the earliest times to the accession of Leo IX (1049). Down to 788 no original has survived, and it is necessary to rely on copies, sometimes incomplete and untrustworthy, found in transcripts of registers and canonical collections. The earliest original is a fragment of a letter of Adrian I, of 788, written on papyrus. This material was used exclusively until the beginning of the 11th century, when it was gradually replaced by parchment; there is no evidence that papyrus was used after 1057 in the papal chancery. The vast majority of papal documents are in the form of letters, the only notable exceptions being the acts (*decreta* or *constituta*) of the synods presided over by the pope. There is no clear distinction between the various papal letters until the 10th century, when the privilege, a more solemn type of document used for grants of lasting value, began to be differentiated from the other letters by some special features such as the papal subscription *Bene Valete* ("Fare well") and a fuller date. All papal documents were authenticated by a leaden impression of the pope's seal, called *bulla*.

To cope with his huge correspondence, the pope had a secretariat, which until the 10th century was staffed by Roman regional notaries styled *notarii sedis apostolicae* and also sometimes *scriniarii;* at their head was the *primicerius,* who supervised their work and saw to the dating and probably to the sealing of the documents. Gradually, in the 10th century, the Roman notaries residing in Rome were replaced by papal notaries attached to the pope's person, and the functions of the *primicerius* were taken over by the papal librarian, who finally added to his title of *bibliothecarius* that of *cancellarius* (chancellor).

Second Period.—The second period, 1049–1198, extends from the accession of Leo IX to that of Innocent III. At the beginning of the period formulas tended to take more definite shape and to become fixed. The distinction between documents of lasting and those of transitory value became more exactly defined, the former class being known as *privilegia* or *bullae majores* (the term *bulla* or "bull" being extended from the seal to the document in the 13th century), the latter as *litterae* or *bullae minores*. Among other characteristics distinguishing the privileges were the subscriptions of the pope and cardinals (in the form: *Ego* . . . . *s[ubscrip]s[i]*) and the two special features called the "rota" and the "monogram"; the rota was a seallike design drawn in ink, and the monogram was made up of the letters of the words *Bene Valete*, the papal subscription of the earlier period. By the time of the pontificate of Innocent II (1130–43), the subscriptions of cardinals were arranged according to rank, those of the cardinal bishops being placed in the centre under the papal subscription, those of priests on the left and those of deacons on the right.

By degrees the use of ordinary letters increased, superseding the privilege, even for grants of lasting value.

Third Period.—The third period in the history of papal documents, 1198–1417, extends from Innocent III's accession to that of Martin V. The pontificate of Innocent III was a most important epoch in the history of the development of the papal chancery. Formulas became more exactly defined, definitions more precise, the observation of rules and precedents more constant. The staff of the chancery became more specialized and more numerous, and the titular head of the chancery was known, from 1216, as *vicecancellarius*. It is also with Innocent III that the uninterrupted series of registers of papal documents really begins.

The growing use of ordinary letters for the business of the papal court led to a further development in the 13th century. They were now divided into two classes, letters of grace (*litterae gratiosae*, or *tituli*) and letters of justice (*litterae executoriae*, or *litterae de justitia* or *mandamenta*); the former were used for granting favours and generally for decisions of lasting value, the latter for issuing orders, commissions, etc. The letters of grace were written in a more elaborate fashion and sealed on silk cords, like the privileges; the letters of justice were written with less care and sealed on hemp cords, like the letters close which the pope used to convey personal and confidential messages. Letters of grace and letters of justice were sent open; in the case of letters close, the *bulla* was used not only to validate the document but also to close it.

Fourth Period.—In the fourth period, extending from 1417 to the present time, the letters of grace and letters of justice have continued to be used, but other kinds also have arisen. Such are the briefs (*brevia*), sealed not with a leaden *bulla* but with a wax impression of the pope's signet ring, the Fisherman's ring (so-called because it represents St. Peter fishing). This type of docu-

ment, which took its origin from some secret letters of the 13th century, came into general use during the pontificate of Martin V or thereabouts. It is written on thin parchment, in the humanistic script, and the name of the pope with his style as *papa* (in the abridged form *PP*) and his number is written at the head of the sheet: for example EUGENIUS PP III. The address is in the vocative (for example, *Dilecte fili*, "Beloved son") instead of in the dative ("To our beloved son"). Briefs were first used for political and administrative business and were at first always sent close, but from the middle of the 15th century their use became more general. They were then employed even in matters of grace and for the publication of important decisions, such as the promulgation of the *Index librorum prohibitorum* in 1564. In cases of this sort, the brief was sent patent.

Merovingian Chancery.—Of the acts issued by the chancery of the Merovingian kings of France 38 originals have survived: 13 of them, the earliest (625–673), are written on papyrus, the remaining 25 (from 677) on parchment. All these acts, loosely described as diplomas, are technically letters; they are authenticated by the autograph subscriptions of the king (sometimes replaced by a nonautograph monogram when the king was unable to write) and of one of the *referendarii* (lay chancery officials of the higher rank) and also by the royal seal applied to the face of the diploma toward the bottom right-hand corner. These diplomas fall into several categories: (1) the capitularies (*see* CAPITULARY) or legislative documents; (2) the precepts or grants in perpetuity to individuals or communities; (3) the mandates or executive documents; (4) the judgments of the royal court. The royal seal was a full-face representation of the king's head.

Carolingian Chancery.—The diplomas of the early Carolingian sovereigns of western Europe differed little from those of their predecessors. The royal subscription was in the form of a sign manual or mark, but Charlemagne elaborated this into a monogram of the letters of his name built up on a cross. Most of his diplomas were authenticated by the subscription of the chancellor and impression of the seal. A novelty in the form of dating was also introduced, two words, *datum* (for time) and *actum* (for place), being then employed. The character of the writing of the diplomas, founded on the Roman cursive hand, which had become intricate under the Merovingians, improved under their successors, yet the reform which was introduced into the literary script hardly affected the cursive writing of diplomas until the latter part of Charlemagne's reign. The archaic style was particularly maintained in judgments, which were issued by the private chancery of the palace, a department more conservative in its methods than the imperial chancery. It was in the reign of Louis I the Pious (emperor from 814 to 840) that the Carolingian diploma took its final shape. A variation then appears in the monogram, which is built up not on a cross as previously but on the letter H, the initial of the name Hludovicus (Louis, Ludwig). This served as the pattern for successive monarchs of the name of Louis.

In the Carolingian chancery the staff was exclusively ecclesiastical; at its head was the chancellor, whose title goes back to the *cancellarius* of imperial Rome. His subscription, as keeper of the royal archives, was indispensable for royal acts. The diplomas were drawn up by the notaries, an important body on whom devolved the duty of maintaining the formulas and traditions of the office. In the 9th century the documents were drawn carefully, but in the 10th there was confusion and want of uniformity in diplomas. It was not until 1108, in the reign of the Capetian Louis VI of France, that the formulas were again reduced to rules.

English Royal Chancery.—For the Anglo-Saxon period (up to 1066), English royal documents can be divided into two main types, the diploma and the writ. The diploma, used by Anglo-Saxon kings to convey grants of lands in perpetuity, can be described as a solemn statement, in the king's name, that a grant is made: for example, *Ego . . . concedo* . . . ("I . . . grant . . ."). The document usually begins with a verbal invocation (such as *In Dei nomine, amen*) or a chrismon (often Christ's monogram formed from the letters XP), followed by a more or less lengthy harangue quoting a sacred passage on the virtue of charity or similar pious themes. Then come in turn the recital of the grant, the date and a detailed description of the lands granted (the boundary clause). The diploma ends with the subscriptions of the king and of ecclesiastical and lay dignitaries, each of them being often preceded by a cross. The language used in the main part of the document is usually Latin, sometimes Old English, but the boundary clause is always in the vernacular. The subscriptions and crosses were never autograph, nor was any seal ever attached to the document for validation.

The earliest genuine diploma known to have survived in the original belongs to 679, and no trustworthy copy exists of such documents earlier than 670, the year following Archbishop Theodore's arrival in Canterbury. This fact, combined with the appearance in these early documents of features characteristic of the late Roman private deed, led Wilhelm Levison, in his *England and the Continent in the 8th Century* (1946), to the conclusion that the royal Anglo-Saxon diploma had an Italian origin. The Anglo-Saxon diploma was still in use in 1066 and some examples are alleged, perhaps rightly, to have been issued even after the Norman Conquest. In the latest examples, the boundary clause is always written in a smaller script than the rest of the document. Although it has been argued that, for part of the period, the diplomas were drafted and written in a royal secretariat, it seems that this task was more often than not left to the care of the beneficiary. This would explain the extreme variety of titles given to the same king in the charters attributed to him. From the second quarter of the 11th century, the diploma decreases in importance as the sealed writ begins to appear.

The Anglo-Saxon writ, unlike the diploma, is always written in the vernacular and in letter form. It begins with the king's style (*e.g.*, "Edward king"), followed by an address to the bishop, earl and thegns of the shire concerned in the text of the grant, and by a greeting. A short statement of the grant often concludes the writ, the whole of the document taking no more than a few lines. The writ is always authenticated with the royal great seal. This type of document may have had administrative antecedents dating back to the reign of King Alfred, but it is doubtful whether it was used for grants of land before King Canute, who is also credited with having imported the royal double-sided great seal into England. The earliest genuine originals of Anglo-Saxon writs and seals to have survived belong to Edward the Confessor's reign.

Before 1066 the writ was unknown to the dukes of Normandy, and there is every reason to believe that they had neither a seal nor a regular secretariat. They conveyed their grants of lands by means of diplomas which were often validated by autograph crosses. After the conquest of England, William the Conqueror had a great seal made, which represented him on one side as king of England, sitting on a throne, and on the other as duke of Normandy, on horseback. During the first years of his reign he continued to issue writs in Anglo-Saxon for his English subjects, just as Edward the Confessor had done; but from *c.* 1070 the writs began to be couched in Latin. From that time onward royal writs in the vernacular are rare. Gradually the Conqueror and his Anglo-Norman successors improved on the structure of the writ by adding to it some new features which increased its administrative value and gave it a better guarantee of authenticity. At some time between 1070 and 1072, a clause mentioning one or several witnesses began to be inserted at the end of the document. Late in the reign of the Conqueror, this clause was sometimes followed by the mention of the place of issue. Such additional features are not found regularly, however, until the reign of Henry I (1100–35). Exceptionally a date of issue is also given, either by reference to a religious festivity (*e.g.*, after Michaelmas) or even by an indication of the year of the incarnation.

For grants to Norman and other continental beneficiaries and also for grants in England, the diploma of Norman type was still used after the Conquest, but it was now sometimes authenticated with the royal seal. By the time of Henry II's accession (1154) it can be safely said that the diploma was dead, being totally replaced by the writ of Anglo-Saxon origin.

When King John succeeded to the throne (1199), the evolution of the writ had been completed. It had developed into three main

types of document easily distinguishable from one another. The most solemn of these was the charter (*carta*), used for grants of lands and liberties in perpetuity. It begins with the king's titles, followed by an address to "all archbishops, bishops, [etc.]." It has two final clauses, a witness clause mentioning a number of ecclesiastical and lay witnesses, and a dating clause introduced by the words "Given by the hand of *X*, chancellor" and giving a full date by reference to the day of the month and to the king's regnal year. Charters are as a rule authenticated with the great seal in green wax, appended on silk cords.

Next in importance come the letters patent (*littere patentes*), used for acts of transitory value such as grants for a period and commissions to royal officials. They begin with the king's titles, followed by an address to "all those to whom the present letters shall come." There are two final clauses, one indicating that the letters were sent patent; the other reads: "Witness myself at [place of issue] on [day, month and regnal year]." Letters patent are sealed with the great seal in white wax, appended either on a tag (double-queue) or on a tongue (simple-queue).

Letters close (*littere clause*) differ from the other two types of documents in that the seal is used to close the document. They were used to convey information or orders to a single person or to a definite group of people; for that reason, they have a special address. The final clauses are reduced to one, the dating clause, introduced by "Witness myself at . . ." or "Dated at . . . ." Letters close were authenticated and closed by the great seal in white wax, appended on a tongue.

The three types of documents which have been described remained virtually unchanged for the whole of the medieval period. The dating clause of charters was slightly adjusted early in the reign of Henry III to become "Given by our hand . . . ." Also, from the 13th century, Latin was sometimes replaced by French in letters patent and letters close.

The styles used by the English kings from the Conquest to the present time varied much according to fashion and to the political events in which they were involved. It is well known, for example, that Henry III dropped the titles of duke of Normandy and count of Anjou after concluding the treaty of Paris of 1259 with Louis IX of France. Similarly, Edward III assumed or dropped the title of king of France according to circumstances.

The existence of the title of chancellor (*q.v.*) for the head of the royal secretariat can be traced back to the reign of William the Conqueror. He was in charge of the custody of the great seal and also of all the work done in the chancery, although most of the actual work was discharged by less important clerks and scribes whose number increased as time went on.

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DIPLOPIA, seeing a single object as double, occurs whenever one of the two eyes leaves the correct position of fixation, *i.e.*, when one eye can not focus on an object simultaneously with the other eye. An object clearly seen by the normal eye gives rise to an image in the deviated eye to one side of the macula and is referred by the mind to a position different from that which it really occupies. Thus, there seem to be two objects, one clearly seen with the normal eye and one indistinctly seen by the deviated eye. Causes of deviation of one eye are (1) disturbances in the motor apparatus of the eye, (2) tumour or abscess in the orbit, (3) limitation of motion of the eyeball from without. Paralysis, or weakness of one or more of the eye muscles, is by far the commonest cause of ocular deviation, and it is in those cases which come on suddenly that diplopia is a striking feature. *See* also EYE, HUMAN; VISION.

DIPNOI (DIPNEUSTI), the true lungfishes, an early order of primitive fleshy-finned fishes having functional lungs. They include forms from Africa, Australia and South America. *See* LUNGFISH; FISHES.

DIPOENUS AND SCYLLIS, early Greek sculptors, who worked together, and are said to have been pupils of Daedalus. Pliny assigns to them the date 580 B.C., and says that they worked at Sicyon, which from their time onward became the site of one of the great schools of sculpture. They also made statues for Cleonae and Argos.

DIPOLE MOMENTS. In common chemical parlance this term refers to an electrical characteristic of a molecule which gives valuable information about the structure thereof. This article will give a simple account of the principles of measurement, and of the main conclusions that have emerged. There is a related magnetic property, commonly called the paramagnetic moment, which also gives valuable information, though of a different kind.

Physical Principles.—A dipole is a system composed of two poles, in the present case electric point charges, of equal magnitude (e) but of opposite sign ($+e$, $-e$), fixed a distance l apart. The product el is commonly denoted μ. Placed in a uniform electric field of strength F, such a system is subject to a twist, or turning moment, which varies from a maximum value of μF when the dipole axis is athwart the field (fig. 1[A]) to a minimum of zero when it is parallel thereto (fig. 1[B]). A field, therefore, tries to align a set of dipoles parallel to each other, and this results in a separation of electric charges in the assembly dipoles which in turn produces surface charges thereon, as shown in fig. 2. This process is called polarization.

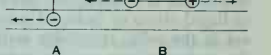

FIG. 1.—DIPOLE SYSTEMS EXHIBITING MAXIMUM (A) AND MINIMUM (B) VALUES OF TURNING MOMENTS

If the original field is produced by opposite electric charges on two parallel conducting plates (an arrangement called a condenser), the effect of introducing a slab of dipole-containing material between these is partly to neutralize it and, therefore, to reduce the electric potential between the two plates although the charges on them remain unaltered (fig. 3). Alternatively, if the potential between the plates is maintained, *e.g.*, by a battery, the charges on them will be correspondingly increased when the slab is inserted.

Such a drop of potential or increase of charge can actually be measured. The ratio, for a given material relative to a vacuum between the plates, is called the dielectric constant of that material, and is written ϵ.

There are other processes of polarization, in addition to that of dipole alignment or orientation, arising from distortion of the molecules by the field which induces dipoles in them; and in order to measure the permanent dipole moment it is necessary to separate the two types of process. Because a field tends to align the dipoles, it tends to produce a higher degree of order in the material than that which obtains in its absence. Thermal agitation of the molecules always tends to produce disorder: it opposes the ordering tendency of the field; and this is more marked as the temperature is higher. Hence, dipole orientation is a temperature-sensitive process; but dipole induction, being a matter of the internal rather than of the external

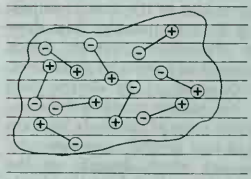

FIG. 2.—POLARIZED DIPOLES. POSITIVE (+) CHARGES TEND TO BE TOWARD THE RIGHT, AND NEGATIVE (−) CHARGES ON THE LEFT

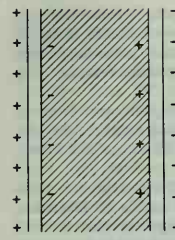

FIG. 3.—A DIPOLE SLAB BETWEEN TWO OPPOSITELY CHARGED PLATES

relations of a molecule, is not.

This relation is shown by the Debye equation:

$$\frac{\epsilon-1}{\epsilon+2}\cdot\frac{M}{d}=\frac{4\pi N}{3}\left(\alpha_E+\alpha_A+\frac{\mu^2}{3kT}\right)$$

where M is the molecular weight, d is the density, N the Avogadro number, α_E and α_A are the induction polarizabilities of a molecule due respectively to (1) distortion of electron distributions relative to nuclei and (2) distortion of one partly charged atom relative to another, k is the Boltzmann constant and T the absolute temperature. From studies of dielectric constant as a function of temperature, therefore, the electric dipole moment, μ, of the molecules comprising the material can be evaluated.

There is an alternative method. The measurements of ϵ are taken in an alternating field, for practical reasons. Now, while at low field frequencies the dipoles can keep in step with the oscillations, at very high ones they cannot, owing to their inertia or to their friction with each other. Therefore, orientation eventually ceases as field frequency is increased; and the polarization due to it can be derived from the resulting change of ϵ, if measurements are done over a wide enough frequency range.

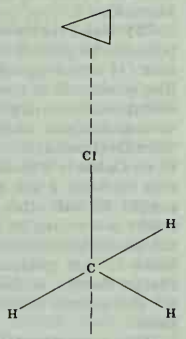

FIG. 4.—METHYL CHLORIDE (CH_3Cl) MOLECULE SHOWING DIPOLE MOMENT ALONG VERTICAL AXIS OF SYMMETRY

In order to measure electric dipole moments, it is therefore necessary to study the variation of ϵ with temperature (T) or with field frequency (ν). This must be done upon a state of matter in which dipole orientation is possible, *i.e.*, in the gaseous or liquid states or in liquid solutions, but not in the solid, crystalline state wherein the molecules are usually locked rigidly and so cannot orient freely. Measurements in the gas phase are better, because in liquids or in solutions the close approach of molecules causes complications; but measurements in solution are easier. Well over 2,000 substances have been examined in one way or other.

An entirely different method of measurement was developed which depends essentially upon the behaviour of single molecules.

Save at low temperatures, the molecules in a gas rotate about various axes of the molecular framework. If they are dipolar, they can absorb electromagnetic radiation, by virtue of their rotation, at certain wave lengths which depend upon the shape and the size of each molecule and on the masses of the atoms composing it; consequently, they show an absorption spectrum which consists of a series of sharp lines. Application of an electric field to the vapour modifies the spectrum: some of the single lines are split into several components by amount which depends on the field strength and on the dipole moment of the molecule. This is called the Stark effect. Therefore, if the spectrum be observed with no field and then with a field of known strength, the dipole moment can in principle be calculated.

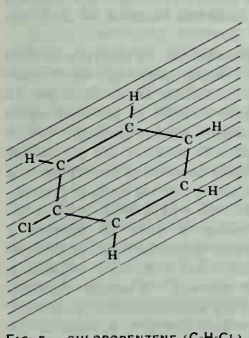

FIG. 5.—CHLOROBENZENE (C_6H_5Cl) MOLECULE SHOWING DIPOLE MOMENT ALONG PLANE OF SYMMETRY

This possibility has been realized in the study of so-called microwave spectra because many rotational spectra fall in the microwave range of wave length of about 0.3—3 cm.; and the development of radar apparatus has led to intensive investigation. Analysis of the Stark effect is an elaborate matter, and as yet not many determinations have been thus made; but comparisons between results from this method and from dielectric constant studies on vapours can be made for about 12 substances. The agreement is gratifyingly good, the average difference being only about 0.02 D (standing for a Debye unit, *see* below).

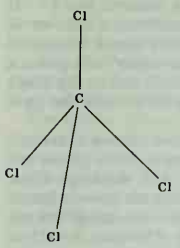

FIG. 6.—NONPOLAR ARRANGEMENT OF CARBON TETRACHLORIDE (CCl_4)

Several other methods of determination exist. The most important of these depends upon the deflections produced in a beam of dipolar molecules by a nonuniform electric field. This is the molecular beam method. (*See* below.)

Applications.—The electric dipole moment is of chemical interest for two reasons. It depends upon the symmetry of the molecule, and also upon the degree of electrical asymmetry within the component parts.

An atom is believed to consist of a very small nucleus, bearing a positive electric charge, around which is a relatively disperse cloud of negative electric charge which is produced by the average distribution of the electrons which neutralize the nuclear charge. It can be shown that this cloud has spherical symmetry about the nucleus, in the absence of an externally imposed electric field; so, in atoms, the centres of action (or centroids) of the positive and of the negative charges coincide, that is to say the distance of separation is zero, and they have no permanent electric dipole moment.

When, however, two atoms combine to form a molecule, there is a profound disturbance of the electron clouds. One or more electrons are redistributed so as to cement the atomic nuclei together. Unless this process results in a symmetrical sharing of electrons between them, there is a permanent preponderance of electrons toward one end or the other of the molecule; the positive and negative centroids no longer coincide; and the system has a permanent dipole moment. In general therefore, unless the two nuclei are identical, as they are in the hydrogen, nitrogen, oxygen or halogen molecules, the molecule should be (di)polar.

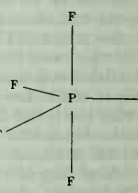

FIG. 7.—NONPOLAR ARRANGEMENT OF PHOSPHORUS PENTAFLUORIDE (PF_5)

This expectation has been verified experimentally. The possible order of magnitude of the dipole moment can be estimated by supposing that an electronic charge is completely transferred from one end of a chemical bond to the other end. These bonds are roughly $1-3\times10^{-8}$ cm. long; so the moment thus created would be $4.8-14.4\times10^{-18}$ e.s.u. (electrostatic units), commonly written 4.8—14.4 D. Actual values are zero for H_2, N_2, O_2, Cl_2, Br_2 and I_2, but 1.18 D for HCl, 0.10 D for CO and 0.16 D for NO. It is therefore clear that when the atoms are unlike, a relatively small but noticeable displacement of charge occurs.

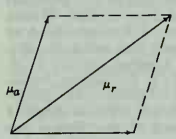

FIG. 8.—ANGLE BETWEEN TWO DIPOLE MOMENTS CALCULATED BY PARALLELOGRAM METHOD USING EQUAL COMPONENT MOMENTS (μ_a AND μ_b) AND RESULTANT MOMENT (μ_r)

In a polyatomic molecule it is generally to be expected that the component bonds will all be polar. Now, a dipole being the product of a charge and of a length, is a vector quantity, which means that, like a force, it has a direction as well as a magnitude, its direction being that of the dipole axis. If in a triatomic molecule, AB_2, the two A-B bonds are antiparallel, B-A-B, then the two

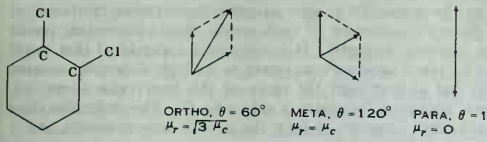

FIG. 9.—THEORETICAL MOMENTS OF CHLOROBENZENE COMPOUNDS

bond dipoles will neutralize each other and the molecule as a whole will be nonpolar; whereas if they are not, *i.e.*, if AB_2 is bent, , the molecule is polar. It is in fact found that triatomic molecules fall into two such classes. For example, CO_2, CS_2, are nonpolar and therefore straight, while H_2O, H_2S, SO_2, NO_2 and O_3 have moments of 1.84 *D*, 0.93 *D*, 1.61 *D*, 0.3 *D* and 0.5 *D* respectively, and are therefore bent. Similarly, it can be seen that because BCl_3 is nonpolar it must be flat, whereas NH_3, NF_3 and PCl_3 having moments of 1.46 *D*, 0.21 *D* and 0.9 *D* respectively must be pyramidal.

More generally, it is reasonably obvious that if a molecule has an axis of symmetry in terms of its atoms, as has methyl chloride, CH_3Cl (fig. 4), with a three-fold axis about the C-Cl bond, then the dipole moment of the whole molecule must lie along this axis. Also, if a molecule has a plane of symmetry, as chlorobenzene, C_6H_5Cl, has (fig. 5); then the moment must lie in this plane.

It follows that a molecule which has more than one axis of symmetry must be nonpolar, as must also one which has an axis of symmetry perpendicular to a plane of symmetry. (*See* STEREOCHEMISTRY: *General Discussion of Stereoisomerism.*) Carbon tetrachloride is nonpolar, which supports the hypothesis that the four chlorine atoms are at the corners of a regular tetrahedron with the carbon at the centre, for this arrangement has four three-fold axes, and three two-fold axes (fig. 6).

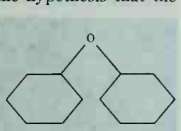

FIG. 10.—ANGLE BETWEEN TWO ARMS OF DIPHENYL ETHER

Phosphorus pentafluoride is also nonpolar, which agrees with the structure shown in fig. 7, for this has one three-fold axis and a plane of symmetry perpendicular to it, and three two-fold ones.

Just as two forces may be compounded by the parallelogram of forces to give a single resultant which depends upon their magnitudes and upon their mutual direction, so may two dipoles be compounded.

Therefore, if the two component moments are equal, if their magnitude is known, and if their resultant is known, the angle between them may readily be calculated (fig. 8).

(*See* MECHANICS: *Kinematics.*)

It was therefore hoped that by measuring the moments of chlorobenzene, orthodichlorobenzene, metadichlorobenzene and paradichlorobenzene, the suggested hexagonal structure for the benzene ring could be tested, because the three angles between the C-Cl bonds should be found as 60°, 120° and 180° respectively (fig. 9). The moment of the para compound is certainly zero as expected, that of the meta compound gives $\theta = 121°$, but that of the ortho one gives $\theta = 101°$. It was soon realized, however, that this simple test is not valid, because the permanent dipoles, due to their unequal sharing in the C-Cl bonds, can each affect the other C-Cl bond; *i.e.*, each dipole, by virtue of its electric field, can modify the other dipole by polarizing it. The modifications thus to be expected could produce the observed anomalies; and more precise calculation shows that these could be accounted for satisfactorily. Because of the additional information required in these calculations, and because of the difficulty of getting it with sufficient accuracy, such secondary, induced moments remain a serious difficulty in the quantitative application of this method when the dipoles are close together; *i.e.*, their centres are only 2—3 Å apart (1 Å = 10^{-8} cm.).

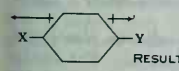

FIG. 11.—BONDS OF A CARBON COMPOUND IN WHICH THE MOMENT IS NEARER TO THE DIFFERENCE OF THE COMPONENTS THAN TO THE SUM

The method can be applied with more confidence when the centres are further apart, and has been used, for example, to measure the angle between the two arms of diphenyl ether (fig. 10) by successive para-substitution in the two rings. By such means, qualitative or roughly quantitative information has been obtained about many substances, particularly organic ones (*e.g.*, cis and trans isomers can often be readily distinguished; ethylene dichloride has been shown not to be rigidly fixed in a trans configuration) and information about the complicated, but important cyclohexane derivatives has been obtained.

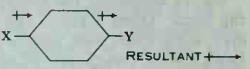

FIG. 12.—BONDS OF A CARBON COMPOUND IN WHICH THE MOMENT IS NEARER TO THE SUM OF THE COMPONENTS THAN TO THE DIFFERENCE

The Magnitudes of Dipole Moments.—The main applications of this quantity to solving chemical problems, aside from those already discussed, comes from the information which it gives about the degree of electrical asymmetry in a molecule. Already it has been shown how, in the case of H_2, Cl_2 and HCl certain simple theoretical predictions have been verified. A more quantitative consideration of magnitudes should indicate general features of electron distribution in chemical bonds.

It is immediately obvious that, in order to begin, we must have a means of finding out whether in A-B the negative pole is toward B or toward A, that is to say the sense of the dipole relative to the two atoms joined by the bond. There is no general, simple way of doing this, but at least the relations between bonds can be shown if one of the atoms is carbon, by taking a compound in which the two bonds (*e.g.*, C-X and C-Y) are in the para position on a benzene ring. Obviously, if the negative pole of C-X is toward X and that of C-Y toward Y, the moment of this compound is nearer to the difference of the magnitudes of the moments of C_6H_5X and C_6H_5Y than to the sum: whereas if in one of the bonds the negative pole is toward the carbon atom and in the other the positive pole is toward the carbon atom, the moment of the disubstituted compound will be nearer to the sum of the components than to the difference (figs. 11 and 12).

The distinction is easily made. Because of the common occurrence of chlorine as a negative ion in compounds, this element is deemed to be highly electronegative, or electron-seeking, and to be more so than carbon. In the C-Cl bond, therefore, the negative pole is expected to be toward the chlorine end. Assuming this, it may be shown that the same is true for bonds to fluorine, bromine, iodine, oxygen, sulfur, nitrogen and phosphorus.

The emphasis has hitherto been on bonds which are formed by the not-very-unequal sharing of electrons; these are the so-called covalent bonds in which each atom contributes nearly equally to the electrons which form it. In ionic bonds, however, transference of one or more whole electrons from one atom to another is expected, and the moment in such cases should be large. The values for several alkali halides have been measured (by the molecular beam method [*see* above]); and although they are large (KCl, 6.3 *D*; KI, 6.8 *D*; and NaI, 4.9 *D*) they would be respectively 12.8 *D*, 15.5 *D* and 13.9 *D* if complete electron transfer occurred. The discrepancies show that this does not happen; the field of the cation may be deemed to polarize the anion, and so to reduce the effective degree of transfer (fig. 13). That this would happen had been anticipated, but the actual degree had not been accurately predicted.

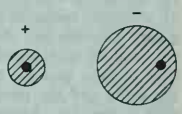

FIG. 13.—REDUCTION OF ELECTRON TRANSFER

A third type of bond, in which electron transfer is followed by electron sharing (*i.e.*, in which one atom provides both of the electrons which form the bond) the so-called dative bond, should also be highly polar. Such a bond should be formed between nitrogen and oxygen when trimethylamine $(CH_3)_3N$, is oxidized to trimethylamine oxide $(CH_3)_3NO$.

The difference of moment between these two compounds is

4·37 *D*, which is 63% of the value for complete transference followed by symmetrical electron pair sharing. The conclusion is that the nitrogen has the larger share of the electron pair, as would indeed be expected because of the positive charge which it acquires, and the negative one which the oxygen acquires, due to the initial electron transfer.

Fig. 14 represents the hypothetical stages in the formation of this bond. Other bonds of this type also are highly polar. However, some which were supposed to be highly polar, according to Lewis's octet theory, proved on careful consideration, not to be sufficiently polar; they are better described as double covalent bonds. Of this type are the PO bonds in phosphorous oxychloride Cl_3PO, and the SO bonds in thionyl chloride (Cl_2SO) and in sulfuryl chloride (Cl_2SO_2).

Attempts have been made to calculate dipole moments of simple molecules purely by theory; but the difficulties have been such that no accurate results have been obtained. The dipole moment is now known to be a complicated function; and a specially important conclusion is that unshared electrons (*e.g.*, those electrons which in water are not used for bonding between the hydrogen atoms and the oxygen atom but which reside on the latter) may be affected by the electron redistribution due to bond formation and may themselves make a large, even a dominant contribution to the total moment of the molecule.

A further application of this quantity with close bearing on quite recent theoretical developments is to show that in some substances, the classical formulation, by one single structure based on the Lewis-Langmuir concepts of covalent, ionic or dative bonds, cannot represent the facts. Nitrous oxide may be represented as $\overset{-}{N}::\overset{+}{N}:O$ or $N:::\overset{+}{N}:\overset{-}{O}$, the plus and minus signs showing the formal charges (which may be somewhat modified) arising from dative bond formation. Either structure would be highly polar: yet in fact nitrous oxide is almost nonpolar ($\mu = 0.17$ *D*). The organic azides present a similar problem, since they might be formulated: $R:\overset{-}{N}::\overset{+}{N}::N$ or $R:N:::\overset{+}{N}:\overset{-}{N}$ yet phenyl azide has a

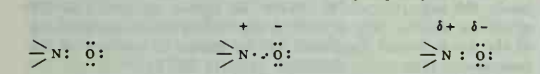

FIG. 14.—HYPOTHETICAL STAGES IN THE FORMATION OF A DATIVE BOND

moment of only 1.55 *D* instead of the 4–5 *D* to be expected for either formulation. A mixture of the two forms would be just as polar as either, because the effect of a dipole on dielectric properties is a function of its square. The only conclusion is that neither formulation is correct and that if "mixing" occurs it must do so in much less time than is required for a dipole to orient in a field, and for a gas such as nitrous oxide this is less than 10^{-11}—10^{-12} sec.

According to current theory, when two such representations, differing only in electron distribution, are possible, neither alone can be correct: the simple Lewis-Langmuir formulation is inadequate. This concept, which is variously called "resonance," "mesomerism" or "electron de-localization," is now known to be of wide occurrence and of great importance for explaining not merely the formal representation but the important properties of many compounds, both inorganic and organic. One further example may be quoted. The moments of aliphatic and of aromatic compounds with the same substituent group (*e.g.*, methyl chloride and chlorobenzene) are usually somewhat different; and by considering the direction of the differences it is possible to show that the groups which direct further substitution to the ortho and the para positions in the benzene ring produce a drift of electron charge into the ring, whereas those which direct to the meta position produce a drift out of the ring. In this way dipole moment measurements confirm a theory which has been based on a careful analysis of organic reactions.

Other Phenomena.—When dipoles are crowded together, as they are in a pure dipolar substance such as liquid nitrobenzene, their fields interact in a very complicated way; so that, as yet, it has not been possible to give an exact, quantitative treatment of the dielectric behaviour of such states. Some interesting points have, however, emerged. It is commonly appreciated that water owes its remarkable solvent power to its high dielectric constant (81); but at first sight the cause of this high value is not apparent, because μ for water is only 1.84 *D*. The molecules cling to each other, however, to form chains with large moments, and it is thus that the liquid is so polar.

It was stated earlier that if the field frequency is raised sufficiently, dipoles fail to follow it because of their friction with each other. Friction generates heat, and in fact a dielectric can become hot from this cause. The electrical energy which should be stored in the dielectric is in part lost as heat, so this phenomenon is called dielectric loss. It happens in noncrystalline, plastic solids, for although dipoles are not entirely free in these, they usually are not entirely rigid either. Dielectric loss can be useful, as a means of heating a material very uniformly, as is necessary in making certain plastics, but it can be a serious problem, especially in radio and radar equipment, by causing energy loss and, sometimes, overheating of the electrical insulation. "Polythene" (polyethylene) has a low dielectric loss because the molecules in it are virtually nonpolar, so too has "Fluon" (polytetrafluoroethylene). Appreciation of the fundamental theory has been important in improving and controlling the properties of electrical insulators.

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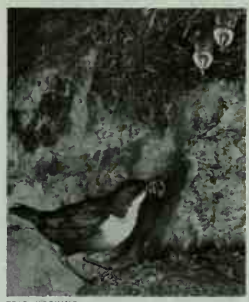
(L. E. SN.)

DIPPER (WATER-OUSEL), a bird about the size of a thrush, squatly built and of an active disposition. The dipper (*Cinclus cinclus*) haunts the swift hill streams of Europe and north Asia. It belongs to a small family of its own, the Cinclidae, and feeds upon small fresh-water mollusks, crustaceans and insects, which it captures under the water, walking along the bottom of the stream and aiding its progress with its wings. The dipper can also swim on the surface of the water, despite the fact that its feet are not webbed. The plumage is thick and oily, being almost impervious to the icy waters of snow-fed streams. The upper parts are dark and the throat and breast white; the belly has a chestnut band. Its ringing song may be heard even in winter. The white eggs, four to seven in number, are laid in a cup-shaped nest of grass, lined with dead leaves and completely encased and domed with moss, except for a small hole to admit the bird. There are five species in the family, found in the northern hemisphere.



ERIC HOSKING

DIPPER (CINCLUS CINCLUS) BRINGING FOOD TO YOUNG IN NEST

In North America this genus is represented by *C. mexicanus* in the mountains of the west. The American dipper lacks the white throat of the European bird, which it otherwise resembles. The Costa Rican dipper (*C. ardesiacus*) of the highlands of Costa Rica and western Panamá is similar, with the general colour a lighter gray.

DIPSACACEAE, a family of dicotyledonous plants, the best-known member of which is the teasel (*q.v.*). The family includes 9–10 genera and about 160 species. Several ornamentals also belong to this group; among them are the scabiouses or pincushions (*see* SCABIOSA).

DIPSOMANIA, a term formerly applied to the attacks of delirium caused by acute alcoholism and sometimes loosely used as equivalent to chronic alcoholism. *See* ALCOHOLISM.

DIPTERA, the scientific name, derived from the Greek, for the order of insects that includes all two-winged flies. Most

winged insects possess four wings, but the hind pair in Diptera are reduced to slender stalks bearing apical, knoblike structures termed halteres or balancing organs. A few insects besides the Diptera (*e.g.*, certain small May flies and Homoptera) also have only one pair of wings, but they have no halteres. Several parasitic and a few free-living kinds of flies, rarely seen, are wingless but may be recognized by the presence of halteres.

Diptera are one of the largest and most widespread orders of insects, including approximately 100,000 known species, which vary greatly in size, form and coloration. They abound almost everywhere that insects occur, from subpolar regions to the tropics.

The order has been variously subdivided: one system, based on antennal structure, separates flies having elongate, slender antennae (Nematocera) from those having shortened antennae with fewer segments (Brachycera). Commonly encountered Nematocera include mosquitoes, long-legged crane flies, midges and black flies. Deer flies and horseflies; colourful, wasplike hover flies; the common housefly; bristly blowflies and tachinid flies; and small fruit flies are representative Brachycera.

See FLY; separate articles on various dipterans; *see* also references under "Diptera" in the Index volume. (G. W. Bs.)

DIPTEROCARPACEAE, an economically important family of old world tropical trees; the fruits of most genera are characteristically two to five winged, so as to give them a spiral motion in falling. All of the species are important timber trees, and many of them yield valuable resins. The timber of various Philippine representatives of the genus *Shorea* has been extensively imported into the United States under the trade name Philippine mahogany. Twenty genera are usually recognized, with about 400 known species. The family is a characteristic one of the tropics of the eastern hemisphere; there are two aberrant genera in Africa. The large genera are *Dipterocarpus, Anisoptera, Hopea, Shorea,* and *Vatica.* Sal is an important timber tree in India (*Shorea robusta*). Several species of *Shorea* are producers of dammar resin (*see* DAMMAR). (E. D. ML.; X.)

DIPTYCH, two writing tablets hinged or strung together, used in the Roman empire for letters and documents.

Ornamental diptychs of wood, ivory or metal were made for various ceremonial purposes, and especially as tokens of entry upon state offices. Consular diptychs, presented to friends and to persons of importance by a new consul in the later empire, were usually of ivory carved in relief work with portraits and historical or symbolic scenes; surviving examples provide the student of Byzantine art with a useful series of accurately datable objects from 406 to 541. In the middle ages painted or carved diptychs, like similar triptychs and polyptychs, were used as altarpieces or for private devotional purposes.

In the early church the names of persons to be prayed for were inscribed on diptychs and read out during the liturgy. These "diptychs of the living and the dead" included the names of outstanding Christians, especially bishops, of the local church who had died in the faith. With time the lists grew longer and contained not only local names. Only those of blameless orthodoxy were put on the diptychs, so the removal of a name implied an accusation of heresy. Commemoration of certain early saints is still made in the canon of the Mass; the similar list in Orthodox liturgies is still called the diptychs.

See F. Cabrol and H. Leclercq, *Dictionnaire d'archéologie chrétienne et de liturgie,* vol. iv, col. 1045–1170 (1921); T. Klauser (ed.), *Reallexikon für Antike und Christentum,* vol. iii, col. 1138–49 (1955).

DIR, a state included in the Malakand agency of West Pakistan, is named after its capital which lies on the Dir stream, an affluent of the Panjkora. Area (1951) 2,040 sq.mi. Pop. (1961) 385,183. It comprises the country drained by the Panjkora and its affluents down to its junction with the Bajaur Rud. The valley of the Dir is also known as Kashkar. The valleys are fertile and produce fruit in abundance. The forests on the mountainsides yield timber in large quantities, the main source of income. After the accession of the state to Pakistan, developments there included a metaled road linking Dir with Malakand and numerous village schools of a religious character.

The rulers of Dir are the Akhund Khel section of the Painda Khel, a sept of the Malizai branch of the Yusufzai Pathans. The founder of the town was Mulla Ilias, known as Akhund Baba, a holy man of the 17th century whose grandson, Ghulam Khan, seems to have acquired temporal power. Mohammed Sharif Khan, the first chief to make treaty agreement with the government of India, succeeded his father Rahmatullah Khan in 1884. The subsequent history of the state was one of rebellion and strife but there was greater peace after accession to Pakistan. Khan Bahadur Sir Mohammed Shah Jehan Khan, the nawab of Dir from 1925, was deposed on Oct. 8, 1960, and was succeeded by his third son, Prince Mohammed Shah Khusro. (K. S. Ab.)

DIRAC, PAUL ADRIEN MAURICE (1902–), British mathematical physicist in the field of atomic structure, was born in Bristol. He started as an engineering student at Bristol university, but soon shifted to physics and received his Ph.D. from Cambridge university. His pioneer work in the quantum mechanics of the atom won him the Nobel prize (jointly with Erwin Schrödinger) in 1933, at the age of 31. He was awarded the royal medal of the Royal society in 1939. In 1925, when the true quantum mechanics was first being developed by Werner Heisenberg, Louis Victor de Broglie and Schrödinger, he independently developed an equivalent mathematical form, which involved essentially a noncommutative algebra for calculating atomic properties.

In his book *The Principles of Quantum Mechanics,* Dirac developed the so-called transformation theory of quantum mechanics which furnished a machinery for calculating the statistical distribution of certain variables when others are specified. He was co-discoverer of the Fermi-Dirac statistics and pioneered in developing the quantum theory of radiation. In his *Quantum Theory of the Electron* he replaced the conventional single second-order Schrödinger wave equation by four simultaneous first-order equations. When these equations are solved, various properties of the electron, such as its spin and anomalous magnetic moment, make their appearance in an almost miraculous fashion.

For a while, a rather mystifying property of the solutions of these equations was the existence of states of negative energy, which at first did not seem to correspond to physical reality, and hence had to be excluded arbitrarily. However, in a later paper, Dirac suggested that a deficiency of an electron in one of these states would be equivalent to a positively charged particle, of transient life because the state might later become occupied. This concept was confirmed in Carl David Anderson's discovery of the positron.

See also QUANTUM MECHANICS: *The Dirac Electron.*

(J. H. V. V.)

DIRECTOIRE STYLE, a loose term designating, in architecture, furniture, etc., the transitional work between the restrained classicism of the Louis XVI style (*see* LOUIS STYLES) and the Roman heaviness of the Empire style (*q.v.*); so called from the French Directory which was in power 1795–99. The style is characterized by a gradual loss of the delicacy and grace of Louis XVI forms and a growing enthusiasm for purely Roman motives.

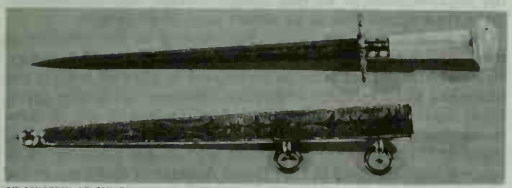
DIRE DAWA, a town of Ethiopia in the northern part of Harar province, lies in the Great Rift valley on either side of the Dachatu river at a height of under 4,000 ft. in a hot, dry region. Pop. (1956 est.) 30,400. It is on the railway from Addis Ababa (296 mi.) to Djibouti, French Somaliland (194 mi.), and from 1904 until the railway reached Addis Ababa in 1917 it was the rail terminus and exercised the commercial functions of Harar town, on the plateau to the south, to which it is now connected by a motor road. It was known for several years after its establishment as Addis ("new") Harar. Because of the railway, the road linking it with Addis Ababa was not maintained. There is little cultivation in the dry environs of Dire Dawa, which means "empty plain," and grain and other produce for rail transit come from the highland area to the south. The town has railway workshops, an important cotton-goods factory, and the only cement factory in Ethiopia, which utilizes the exposures of Jurassic limestone at the base of the nearby fault scarp. Near the town are some caves decorated with prehistoric paintings, of undeter-

mined age, showing herdsmen, cattle and wild animals.
(G. C. L.)

DIRICHLET, PETER GUSTAV LEJEUNE (1805–1859), German mathematician, who made valuable contributions in number theory, analysis and mechanics, was born at Düren on Feb. 13, 1805. Educated at Cologne and Paris, he held professorships at Breslau and Berlin. In 1855 he became the successor of Carl Friederich Gauss at Göttingen. Dirichlet worked in many fields of mathematics and in all of them he made notable contributions still associated with his name. (*See* NUMBERS, THEORY OF: *Topics in Analytic Number Theory.*) In number theory he proved the existence of an infinite number of primes in any arithmetic series $ax + b$ (a and b relatively prime); he developed the general theory of units in algebraic number field. His *Vorlesungen über Zahlentheorie* appeared in 1863, edited by R. Dedekind; it has since seen many editions. In analysis Dirichlet gave general conditions for a function to the expressible by a trigonometric series; he studied the so-called Dirichlet series and definite integrals. In mechanics he investigated the equilibrium of systems and potential theory that led him to the Dirichlet problem concerning harmonic functions with prescribed boundary values. He died at Göttingen on May 5, 1859. His *Gesammelte Werke* was published in two volumes (1889, 1897). (O. OE.)

DIRIGIBLE: *see* AIRSHIP.

DIRK, a combination dagger and all-purpose knife that rose to popularity in the 17th and 18th centuries, chiefly among working-class people. It had largely disappeared except for ceremonial purposes by 1850. The best known of all the dirk forms were those carried by the Scottish Highlanders and those worn by naval officers and midshipmen with their undress uniforms. The Scottish dirk seems to have derived from the kidney dagger (*see* DAGGER). It normally had a straight tapering blade and a short wooden hilt carved with interwoven traceries. As time passed the hilts tended to become longer and after 1800 cairngorms or other



BY COURTESY OF TRUSTEES OF NATIONAL MARITIME MUSEUM

DIRK AND GUARD FORMERLY WORN BY MIDSHIPMEN IN THE ROYAL NAVY

stones were often set in them. The dirk is still worn as part of ceremonial Highland costume.

In almost all European navies dirks have been worn at various times. In the British and U.S. navies the practice seems to have developed late in the 18th century, though dirks were not mentioned in regulations until somewhat later. In 1869 the U.S. navy confined the wearing of dirks to midshipmen, and shortly after 1879 the dirk was abandoned completely. At the close of World War II, dirks were still listed in regulations for British midshipmen. Most naval dirks had straight blades, but for a short period, from about 1805 to 1830, sharply curved blades were popular in both Great Britain and the United States.

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DISARMAMENT. The word disarmament is used to cover four distinct conceptions: (1) the penal destruction or reduction of the armament of a country defeated in war; (2) bilateral disarmament agreements applying to specific geographic areas; (3) the complete abolition of all armaments; and (4) the reduction and limitation of national armament by general international agreement. Disarmament in the first sense is by no means new. It was enforced in ancient times and as recently as World Wars I and II. Disarmament in the second sense is well represented by the Rush-Bagot agreement between the United States and Great Britain which, since 1817, has kept the Great Lakes and the U.S.-Canadian border disarmed. Disarmament in the third sense has been advocated by utopian thinkers and occasionally by governments. In the fourth sense, disarmament did not come before an international assembly until the Hague conferences (*q.v.*) of 1899 and 1907, which ended in failure.

After the explosion of the first atomic bombs in 1945 and the rapid development of nuclear weapons of mass destruction, such as intercontinental missiles, the problem of disarmament became at once more urgent and more complicated. In consequence, there was talk at many levels of the need for general disarmament. The arguments commonly used in favour of disarmament had always ranged from complete pacifism to economic expediency. After 1945 there was a change: the contention that armaments races inevitably led to war was replaced by the argument that the use of nuclear weapons in quantity threatened civilization itself. Despite this realization, a solution to the problem of disarmament continued to depend on mutual confidence. Before disarmament could relax world tensions, world tensions had to be relaxed to provide a propitious setting for disarmament.

Disarmament and the 1919 Settlement.—It was partly as a reaction against the arms race in Europe that disarmament was stressed in making the Versailles settlement. The fourth of Pres. Woodrow Wilson's fourteen points demanded that national armaments be reduced to the "lowest point consistent with domestic safety." Art. 8 of the covenant of the League of Nations changed the word "domestic" to "national" and added to the point of "national safety" the further phrase, "and the enforcement by common action of international obligations." In this way the disarmament problem was linked more directly with the problem of security. The Versailles settlement began by applying the principle of disarmament to the defeated countries, Germany and its allies. Germany was required to reduce its army to 100,000 men, and its munitions in proportion. Its naval power was also kept at a minimum, and maintenance of a military air force was prohibited.

(*See* GERMANY: *Defense;* STRAITS QUESTION; VERSAILLES, TREATY OF.)

Disarmament and the League of Nations.—The attempt to secure agreement on general disarmament through the League of Nations (*q.v.*) passed through three phases. The first period of committee work lasted from 1920 to 1925. The second period, from 1925 to 1932, was marked by the slow progress of the Preparatory commission for the disarmament conference. The third period, from 1932 to 1934, was that of the disarmament conference itself, which was never formally brought to a close.

At the beginning of the first period a nongovernmental Temporary Mixed commission was set up and, after long deliberations, proceeded in 1923 to draw up a draft treaty of mutual assistance. When this failed to secure adoption, it was replaced by the Geneva protocol of 1924, which set out to offer a threefold guarantee of security—a common definition of aggression, a general system of arbitration and a clarification of the enforcement measures to be taken against aggression—as a necessary preliminary to the calling of a disarmament conference, which, it was suggested, should meet in July 1925. The protocol was warmly welcomed by the assembly in 1924, but failed to secure support from Great Britain to bring it into operation.

In Dec. 1925 the council set up a Preparatory commission for the disarmament conference, which met for the first time in May 1926. Germany and the United States became members at once, and the U.S.S.R. followed a year later. Progress was slow, but in Dec. 1930 qualified agreement was reached on six main points: budgetary limitation of armament expenditure; limitation of the period of service; the establishment of a Permanent Disarmament commission; the limitation of land, sea and air forces; the naval limitations embodied in the London Naval agreement of 1930; and the renunciation of chemical and bacteriological warfare. But these six points were so subject to reservations that they provided little satisfaction. In Jan. 1931 the council agreed that the disarmament conference should open on Feb. 2, 1932, and in May it appointed Arthur Henderson, then British foreign secretary, as president-elect.

The conference was attended by representatives of 59 states, but there was little unity of purpose. The French emphasis was on international control; on the building of a powerful force to assist the League in its work. The British emphasis was on qualitative limitation; the reduction of armament not by numbers but by categories, offensive armament being distinguished from defensive. It proved impossible to secure a universally accepted distinction between the two types; but more than this, the solution of the problem of disarmament clearly could be found only in the building of an effective international organization.

The most important stages in the history of the conference were the acceptance in July 1932 of a limited agreement (1) that air attack against civilian populations should be absolutely prohibited and the number of aircraft and civil aviation regulated; (2) that heavy artillery and tanks should in principle be limited in size; (3) that chemical warfare should be prohibited. Germany, along with the U.S.S.R., voted against this agreement and, insisting on equality of status as a condition of continued support, did not attend the second session of the conference, which began in October.

Although Germany was brought back it was difficult to reconcile French demands for security with German demands for equality. In March 1933 the British prime minister tried a new approach with the so-called MacDonald plan, a five-year draft convention, which for the first time set out disarmament figures for most European countries. The plan was received with cordiality, but the conference adjourned again in June 1933 without having reached any new understanding.

A French plan, prepared during the recess of 1933, suggested that armament should be stabilized at the existing level for a four- or five-year period. It was accepted by Great Britain and Italy but was strongly opposed by Germany, now under the control of Adolf Hitler. On Oct. 14, 1933, Germany finally left the disarmament conference and the League of Nations.

The conference now came to a standstill for six months, and diplomatic negotiations about disarmament produced no results. The publication of German military estimates in March 1934 diverted attention to the problem of rearmament; and although the conference reassembled in May 1934, it was in an atmosphere of unreality. From 1934 onward there was a return to power politics, the prelude to World War II. In March 1935 it was announced openly that a German air force was once more in existence, and a few days later compulsory military service was reintroduced. From this date rearmament rather than disarmament became a leading political issue in all European countries.

Naval Disarmament.—Attempts were made between 1919 and 1930, largely on the initiative of the United States, to secure limited naval disarmament. At the Washington conference (*q.v.*) of Nov. 1921, a five-power treaty was signed, fixing an arithmetical ratio for large battleships (Great Britain 5, United States 5, Japan 3). It was easier to secure quantitative disarmament in capital ships than in other types of vessels or land armaments (*see* WASHINGTON, TREATIES OF).

In June 1927 Pres. Calvin Coolidge called a conference at Geneva, Switz., to consider the limitation of ships not included in the Washington ratios. France and Italy refused to attend, and the United States and Great Britain soon disagreed. The British delegates insisted that mathematical parity with the United States was not equivalent to practical parity, since British lines of trade and communication were longer, and absolute requirements, particularly in small cruisers, were greater. The conference broke down in August.

The London Naval conference of Jan. 1930 was more successful. The United States, Great Britain and Japan drew up an agreed tonnage table, and together with France and Italy accepted a five-year holiday in the construction of capital ships and a limitation of submarines and aircraft carriers. The international situation after 1931 did not permit any extensive discussion of general naval disarmament. Indeed, the Anglo-German Naval agreement of June 1935 recognized Germany's right to ignore the naval restrictions and prohibitions imposed upon it in 1919. In the meantime, Japan had built up a large navy which, taken in conjunction with its greatly increased army, posed a threat to general peace in the far east.

Disarmament and the United Nations.—The experience of the breakdown of the disarmament negotiations of the interwar years and the parallel breakdown of collective security led to a more realistic approach to disarmament problems during and after World War II. They did not, however, point to a solution, which was made more urgent by the invention of atomic weapons, including the hydrogen (fusion) bomb, the atomic submarine and the launching of the first earth satellite in 1957. The eighth point of the Atlantic Charter drawn up by Winston Churchill and Pres. Franklin Delano Roosevelt in 1941 was in line with League of Nations declarations; it stated that all nations "for realistic as well as spiritual reasons" must abandon force and demanded as a first step toward a general system of security the disarmament of aggressor countries. The Moscow declaration of 1943 followed the same lines. The charter of the United Nations reflected the increased emphasis on security. So too did the peace treaties signed on Feb. 10, 1947, with Bulgaria, Finland, Hungary, Italy and Rumania. They all contained stipulations aimed at unilateral disarmament of the defeated countries. Although peace treaties were not signed immediately with Germany, Austria and Japan, each of these countries was occupied and disarmed; in the case of Japan the new postwar constitution (*see* JAPAN) outlawed war and prohibited the formation of an army or navy. All these arrangements for maintaining security presupposed continued collaboration between the Allies of World War II. There were hopes of creating new institutions to maintain security. Thus by art. 11 the general assembly of the United Nations was empowered to consider and make recommendations concerning "the general principles . . . of international peace and security, including the principles governing disarmament and the regulation of armaments," and the Security council by art. 26 was made responsible for drawing up specific plans with the assistance of the Military Staff committee, created by art. 47. A further step was taken in Jan. 1946, when as part of a new approach the Atomic Energy commission was set up and given full powers to make plans for controlling not only atomic weapons but also "all other major weapons adaptable to mass destruction."

Despite these provisions, however, the record of achievement in disarmament after 1945 was not impressive. The main differences of opinion between the Soviet bloc and the rest of the powers centred on the problem of international control, but they reflected a general lack of mutual confidence and a fear of the supremacy of the U.S.S.R. in "conventional weapons." In Dec. 1946 a resolution was passed unanimously by the general assembly recognizing the necessity of "an early general regulation of armaments." A Commission for Conventional Armaments was set up by the Security council in Feb. 1947, but there was early deadlock. In the UN Atomic Energy commission the so-called Baruch proposals, first put forward in June 1946 by the U.S. representative, Bernard Baruch, for setting up an international atomic authority with power to control and inspect were turned down by the Soviet Union, which demanded an immediate banning of atomic weapons. When the project of an international atomic agency, with a system of control, was placed before the general assembly in Nov. 1948 and Nov. 1949, the Soviet Union voted against it on the ground that it failed to prohibit atomic weapons and was an infringement of national sovereignty. In Jan. 1950 the Soviet Union withdrew from the Atomic Energy commission.

Meanwhile, proposals for an arms census were vetoed by the Soviet Union in the Security council in Oct. 1949, and a statement was issued in the same month by Canada, China, France, the United States and the United Kingdom claiming that there was a "fundamental difference not only in methods but also on aims" between the Soviet bloc and the rest.

In the meantime, divisions among the wartime Allies were so substantial that the immediate postwar aim of forcing unilateral disarmament on the defeated countries was abandoned. Fear of Russian expansion in Europe led to the signing of the Brussels treaty of March 1948 and ultimately to the establishment of the North Atlantic Treaty organization (NATO) in April 1949. Soon

afterward the question of a "German contribution" to European defense was mooted. Eventually, after complicated discussions, west Germany became a member of NATO in Oct. 1954. In the far east, Japan was permitted and even encouraged to rearm after the outbreak of the Korean War in June 1950. The Russians, too, were arming most of the countries within their sphere of influence, and by the early 1950s only the unilateral disarmament clauses of 1947 concerning Finland were still in force.

At the 1950 session of the general assembly—after the start of the Korean War—there was an attempt to break the deadlock, and Pres. Harry S. Truman suggested that the Atomic Energy and the Conventional Armaments commissions should be merged. A committee of 12 (the Security council members plus Canada) was formed to report on the proposal. While it considered procedural implications, the French, U.S. and U.K. governments studied matters of substance and in Nov. 1951 tabled a draft resolution in the general assembly proposing a merger and the creation of a new Disarmament commission. After long discussions the U.S.S.R. agreed to the proposal, and the commission was set up in Jan. 1952, but there was an open conflict between Soviet and other views. The U.S.S.R. continued to demand an atomic weapons ban and a one-third arms cut before mutual disclosure of information and the introduction of an inspection system. Most of the other powers asked for (1) a sharing of information; (2) an agreement on inspection methods; (3) an international atomic authority; and (4) a system of safeguards "to ensure observance and detect violations" in that order of priority.

The new commission began its work in March 1952 through two committees—the first on reduction and control of armaments, the second on means of verification. The first was handicapped by the Soviet refusal to discuss details before principles and by Soviet rejection of a U.S. statement of "essential principles" in April. The second was the scene of bitter controversy. When in May 1952 the French, U.S. and U.K. representatives submitted detailed proposals for the determination of numerical limitations on existing forces, the Russians replied that the recommendations were merely designed to reduce the Soviet army while increasing the air and naval power of the United States. They rejected the tripartite proposals in August, accused the United States of employing bacteriological methods of warfare in Korea and refused to agree to a proposed impartial commission to inquire into these accusations. So sharp was the disagreement that the commission held only one meeting in 1953.

Increased awareness of the dangers of hydrogen bomb warfare, the knowledge that "both sides" possessed the bomb and the first large-scale production of tactical atomic weapons were more important than strictly political factors in the subsequent period of discussion which began with a speech of Pres. Dwight D. Eisenhower in Dec. 1953. "Elementary prudence" was given as a new reason for disarmament. Eisenhower suggested an international atomic agency to develop peaceful uses of atomic energy and secret diplomatic discussions between the United States and the U.S.S.R.

There was still no real progress, however, and proposals made by both sides were either shelved or rejected at the five meetings of the Disarmament commission between May 1954 and Sept. 1957. In April 1954 the Disarmament commission established a subcommittee of five (Canada, France, Great Britain, the U.S. and the U.S.S.R.). In June 1954 an Anglo-French memorandum was endorsed by all members of the subcommittee except the U.S.S.R. It suggested the preparation of a draft treaty to embody the following points: (1) the total prohibition of the use and manufacture of nuclear weapons and weapons of mass destruction of every type, together with the conversion of existing stocks of nuclear weapons for peaceful purposes; (2) major reductions in all armed forces and conventional armaments; and (3) the establishment of a control organ with rights, powers and functions adequate to guarantee the effective observance of the agreed prohibitions and reductions. In Dec. 1954 the U.S.S.R. representative at last accepted the memorandum as the basis of the commission's future work, and there was a further moment of hope in May 1955 when the U.S.S.R. went on to announce in a draft declaration, supplemented by draft resolutions for the UN general assembly, that it would accept limitation and control, as the western powers had suggested, in the interest of "peaceful coexistence." On paper this was a notable change of policy, but it did not lead to positive results, for the western powers, placing increasing emphasis on a reliable system of inspection, insisted that the subcommittee should adjourn until Aug. 1955.

In the meantime, at the Geneva "summit" conference of July 1955, President Eisenhower made a new proposal for an exchange of air reconnaissance—the "open-skies plan"—and after Geneva the earlier disarmament proposals of the western powers were withdrawn. The reasons given were twofold: first, that any progress in the reduction of armaments must be dependent on the settlement of outstanding political disputes; and second, that no progress could be made in the most urgently needed form of disarmament, nuclear disarmament, without the inauguration of scientific inspection. The U.S.S.R. restated its proposals of May 1955 and urged that the drafting of a disarmament treaty should begin. There was thus renewed deadlock in 1956, with papers and proposals being produced by both sides.

In March 1956 Britain and France drew up a revised version of their earlier plan of June 1954, while the U.S.S.R. suggested an immediate plan for conventional disarmament only. For the first time, no proposals were made concerning nuclear weapons, except an immediate ban on tests. A month later the United States made suggestions for a first phase of disarmament. Armed forces would be reduced, information about nuclear materials and weapons would be exchanged, and there would be a limitation and monitoring of nuclear tests under international control. The practical position was stated clearly, however, by the French representative, who remarked that "a limited agreement seems to me today to be as difficult to reach as a general agreement."

In Aug. 1957 the United States, Britain and France prepared a package plan for partial disarmament as a reply to Soviet proposals made in March 1957 for a general "reduction of armaments and armed forces and the prohibition of atomic and hydrogen weapons." Both sets of proposals included a reduction of service manpower by stages and a reduction of conventional armaments under the supervision of an international control organization. While the Russians proposed the total prohibition of the use and manufacture of nuclear weapons and the total abolition under international control of all missiles for warlike purposes, the western governments pressed for a cutoff of new nuclear weapons to begin one month after the international control organization had certified that an effective inspection system had been installed. No detailed proposals were made about the dates or quantities involved in the subsequent transfer of nuclear materials to peaceful purposes. As far as missiles were concerned, the western powers suggested that three months after a disarmament treaty had come into operation a technical committee should be set up to study "the design of an inspection system which would make it possible to assure that the sending of objects through outer space will be exclusively for peaceful and scientific purposes."

The package plan was rejected without hesitation by the U.S.S.R., which continued to stand by its more comprehensive proposals at the UN general assembly which considered the question in the autumn of 1957. The assembly passed by 56 votes to 9 a resolution urging the Disarmament commission to give priority to reaching a disarmament agreement, which would achieve six of the partial measures, but the U.S.S.R. and other Communist countries were in the minority and refused to give their support to the enlargement of the Disarmament commission to include 14 new members, among which were Czechoslovakia, India, Egypt and Yugoslavia. The U.S.S.R. announced that it would take no further part in the work of the new commission or of the "bankrupt" subcommittee.

In 1958 the U.S.S.R. continued to advocate the total abolition of nuclear weapons and a comprehensive scheme of disarmament. A movement to press for the former objective gained strength in several western countries. No progress was made at the international level, however, until July 1958 when a conference of scientists from eight countries, including the U.S. and the U.S.S.R., met at Geneva "to study the possibility of detecting violations of a

possible agreement on suspension of nuclear tests." In Aug. 1958 it was announced that agreement had been reached that within limits it is possible to detect and identify nuclear explosions. This important statement on the possibility of technical control was followed almost at once by an Anglo-U.S. proposal to suspend nuclear tests for a year by international agreement as a prelude to "measures of real disarmament." No more tests had taken place when Nikita Khrushchev on his visit to the United States in Sept. 1959 appealed to the general assembly to achieve "total disarmament" over a period of four years.

On Nov. 20, 1959, the general assembly unanimously approved a resolution recommending "complete and universal disarmament" and called upon the new 10-nation Disarmament committee to make a "thorough examination" of the whole problem. The committee—composed of the representatives of Canada, France, Great Britain, Italy and the United States on one side and of Bulgaria, Czechoslovakia, Poland, Rumania and the U.S.S.R. on the other—met in Geneva in March 1960 but made no progress. The main points of difference concerned the time schedule for disarmament and provisions for inspection. International tension mounted meanwhile, culminating in the sudden breakup of the summit conference at Geneva during the summer. (A. Bri.)

In 1958 the United States, the U.S.S.R. and Great Britain had each stopped conducting nuclear tests and hopes had risen that a permanent and comprehensive ban on such tests might be agreed upon. France meanwhile became a nuclear power, conducting atomic weapons tests in the Sahara desert. Late in Aug. 1961, at the height of the international tension over Berlin, the U.S.S.R. announced that it would resume testing of nuclear weapons and immediately set off a series of nuclear explosions in the atmosphere. Before it broke the moratorium on tests the U.S.S.R. had obviously been secretly planning to do so for many months. The U.S. government responded by declaring that, in the interests of its own defense, it would also resume testing. It exploded several small nuclear devices underground during September and October. On April 25, 1962, it set off the first in a series of nuclear test explosions in the atmosphere near Christmas Island in the Pacific ocean.

During July 1963 special representatives of the U.S., British and Soviet governments met in Moscow to discuss proposals for discontinuing nuclear tests. They soon agreed upon a treaty by which each government pledged itself to conduct no more nuclear weapons tests in the atmosphere, under water or in outer space. The only tests not covered by the treaty were those underground. After being signed in Moscow early in August, the treaty was ratified by the three major powers concerned and, because it was left open to all states, was also signed by more than 100 other governments. The documents of ratification by the U.S., Great Britain and the U.S.S.R. were formally exchanged on Oct. 10 and the treaty then went into effect. Proponents of the treaty hoped that it would not only prevent further contamination of the atmosphere by radioactive fallout but would lessen international tension and advance the cause of disarmament. A new dimension was added to the problems of disarmament in Oct. 1964 when the People's Republic of China detonated its first nuclear device.

See also references under "Disarmament" in the Index. (X.)

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DISASTER RELIEF refers to assistance to persons who are deprived of the essential needs of life because of natural disasters resulting from flood, fire, earthquake, hurricane or similar catastrophe. The term also applies to assistance to communities and people suffering from the effects of war or from political oppression or mass prejudice causing physical or economic deprivation. (*See* also Refugees.) Disaster relief generally is not circumscribed by the laws and regulations that apply to assistance to persons deprived of the means of support through loss of income or illness and old age and known as poor relief or public assistance (*see* Social Welfare).

Programs.—Before 1900 disaster relief consisted largely of emergency grants of food, clothing and medical care and the provision of mass shelter through hastily organized local committees, often with the aid of voluntary contributions of money or supplies from other communities or countries. In the 20th century disaster relief became one of the chief activities of the International Red Cross, which originally had been organized in the 1860s to aid the victims of war. The American Red Cross, under its revised charter (1905), was given responsibility for establishing a system of disaster relief in the United States. This system included nationwide expansion of disaster preparedness in Red Cross chapters, including the training of volunteers to serve in emergencies and the development of plans and programs to be used in case of either natural disaster or enemy attack. Other voluntary organizations that have been especially active in providing supplies and services for relief in cases of natural disasters have been the Cooperative for American Remittances to Everywhere (CARE), the Salvation Army and church groups.

Modern weapons of war, including chemical, biological and nuclear devices, have aroused nations and communities to establish organizations to plan for prevention and protection against the effects of these weapons. During World War II, a nationwide civil defense program in Great Britain prevented the loss of many lives and helped to reduce some of the suffering following bomb attacks. (*See* Civil Defense.) Plans for similar programs were developed in the United States and many other countries to provide for relief in event of catastrophe whether resulting from war or natural causes.

After World War II the Office of Civil and Defense Mobilization, which operates under the executive office of the president, became the official national agency in the United States concerned with disaster relief. This agency prepares plans for mobilization and recommends the adoption of suitable warning devices, protective measures and first-aid facilities. Most cities and states have established some civil defense activities and have prepared inventories of resources available in case of an emergency and of individuals with knowledge of the location of such resources. Locally, the mayor or some designated official is usually the top authority for directing the services when needed. In most instances the major city department involved is the fire department. (This more or less follows the pattern established in Great Britain during World War II.) Other officials generally represented on a disaster relief authority include the commissioners of police and health departments, officials of public and private welfare agencies, hospital authorities, representatives of the local medical society and transportation authorities. In many communities the Red Cross, the Salvation Army and public services are organized to determine the need for food, clothing and shelter in the event, for example, of a large fire. In case of a disaster affecting a large area, transportation facilities—public or commercial—are drawn into service. Emergency medical services and hospital care are important elements in relief after serious fires, floods and windstorms.

Fund Raising.—Many natural disasters occur throughout the world, and aid for the suffering has a special concern for people with ethnic or nationalistic ties. This results in the development of many temporary, short-time services and emergency drives for funds or food and clothing.

With the development of world-wide communication, the knowledge of distress from disasters of all kinds is public information within hours of the occurrence; organizations such as the Red Cross (international and national) quickly provide reliable information on the extent and type of need. CARE, the Red Cross, churches and other groups have trained volunteers who help to interpret the need and assume responsibility for orderly and informed appeals to people who wish to contribute funds or supplies. Within some groups, plans and specific instructions for disaster fund raising are published as guides.

Scores of natural disasters occur annually. Added to these are the periods of distress and suffering imposed on people from political upheavals and minor wars. All of these are given world-wide attention, and appeals for help, usually in funds, are issued. The lack of responsible fund-raising organization has sometimes deterred prospective contributors. As a result, in the United States a few communities offer information and guidance to contributors through such organizations as a local chamber of commerce or a council of social agencies.

Incidence.—The natural disasters that occur in any one year result in the need for local, national and, often, international disaster relief efforts. In 1960, for example, disaster relief operations were required in at least nine countries: the United States as a result of hurricane "Donna" which caused serious damage in eight states along the eastern coast from Florida to Maine; south central Chile which suffered a series of severe earthquakes, tidal waves and landslides; Iran and Turkey which experienced serious earthquakes; Korea and India which suffered storm damage that required emergency action; northern Italy which was hit by floods resulting in property loss and death; England which also experienced flood damage; and East Pakistan as a result of high winds and a tremendous tidal wave resulting in more than 3,000 deaths and the destruction of 30,000 homes. In the case of East Pakistan, it was a week after the storm before the news of the tragedy reached the rest of the world, but immediately on receipt of information voluntary aid was forthcoming.

War Relief.—During and following World War I and World War II the people of many countries responded to the need for war relief. The World War I relief program administered by Herbert Hoover (*q.v.*) provided funds for the assistance and rehabilitation of people and communities who were in serious need of help. Funds from the United States were also made available to rehabilitate buildings which had been seriously damaged.

After the invasion of north Africa by the Allied armed forces in World War II, the U.S. state department created the office of foreign relief and rehabilitation under the direction of Herbert Lehman, former governor of New York state. Food and other supplies were shipped to north Africa, together with a small staff responsible for proper distribution of clothing, food and medical supplies.

In 1943 the Allied nations created the United Nations Relief and Rehabilitation administration (*q.v.*; UNRRA), first under the direction of Governor Lehman and later under former New York city Mayor Fiorello La Guardia. Forty-eight nations provided supplies and personnel to countries where the war resulted in personal and community losses. Greece, Belgium, France, Poland and other areas were given food, medical supplies and machinery to be used for relief and rehabilitation.

The displaced persons division of UNRRA, assisted by funds from participating countries and personnel assigned by many of the same countries, carried on services for the people who had been in concentration camps and forced labour groups. The major task, in which the Allied forces and UNRRA participated, was the repatriation of 8,000,000 displaced or homeless persons, and the provision of medical and other needs while the camp residents were being processed for return to their homes or other suitable areas. Approximately 800,000 displaced persons remained in UNRRA's care pending their repatriation or resettlement.

Support for this service, as in north Africa, came in part from voluntary groups and religious organizations—the Roman Catholic Church, the Friends Service committee (Quakers), Jewish organizations, and a host of other nongovernmental groups from the United States and the United Kingdom, including the Red Cross and similar welfare services. Most of the funds and supplies came from the governments associated with UNRRA.

Similar mass operations were undertaken in China, Korea and other countries that were seriously affected by the disaster of war and the confusion that followed it. In the 1960s CARE engaged in self-help projects for refugees in a German camp clearance project through a special grant, as well as similar programs among Tibetan refugees, supplying food and other commodities. CARE also provided self-help programs in addition to relief supplies for refugees in Hong Kong and the Gaza Strip, which involved disaster situations largely of the political type.

Fifteen years after the end of hostilities in World War II refugees throughout the world were still considered a remnant of the disaster resulting from the war. The United Nations designated June 1959 through June 1960 as World Refugee year and committees raised funds to assist in the resettlement of thousands of refugees still in camps. This appeal had only moderate public response, but governments provided official funds to help in the enterprise. *See* also Red Cross; Salvation Army; Earthquake; Flood; Fire Protection; Hurricane; Tornado; Tropical Storm. (F. K. Ho.)

DISCIPLES OF CHRIST (Christians), a Protestant denomination characterized by a special concern for Christian unity, found chiefly in the central and western United States. Originating as an informal movement including persons of many denominations, the Disciples of Christ have developed into a typical American denomination of liberal character. By the 1960s there were about 1,800,000 members in the U.S. in about 8,000 congregations; world membership was about 2,000,000.

The principal founders of the denomination were Thomas Campbell, his son Alexander Campbell (*q.v.*) and Barton W. Stone. Stone had been a Presbyterian minister prominent in the Kentucky revival of 1801, but, with others, signed "The Last Will and Testament of the Springfield Presbytery" (1804), giving up that name in order to be called "Christians." Stone advocated as a basis for Christian unity the adoption of New Testament faith and practice without any admixture of human opinions. A similar view was put forward by T. Campbell, a Presbyterian minister of western Pennsylvania, in a "Declaration and Address" (1809), and in the later writings of A. Campbell. The new American nation was looked upon as providing a God-given challenge to a new start in religious organization, and the democratic spirit of the frontier led to a renewed emphasis on the place of the laity in the ministries of the church. The followers of the Campbells, known as Reformers or Disciples, were soon out of favour with Presbyterianism. Because they adopted immersion of adult believers as the only form of baptism, they joined the Baptists in 1813, but, differing with the Calvinism of the Baptists, left them to unite with the Christians in 1832. The latter had already been strongly influenced by the teachings of Alexander Campbell, who now emerged as the leader of the new denomination. It grew most rapidly in the states bordering the Ohio river and from there westward. Moving with the frontier, the Disciples of Christ increased most rapidly in the midwest and southwest and on the west coast.

The Disciples did not suffer schism during the Civil War, but the following years saw controversy over many practical issues. Continuing opposition to instrumental music in worship characterizes a group known as Churches of Christ, first separately listed in the U.S. census in 1906. (*See* Christ, Churches of.) A minority opposed agencies for intercongregational co-operation as unscriptural, but the majority support of co-operation led the Disciples to take membership in interdenominational local, state, national and world councils of churches.

During the 19th century many periodicals were launched, and leadership in the denomination was exercised primarily by its

great editors: from 1823 to 1860 by A. Campbell through the *Christian Baptist* and the *Millennial Harbinger;* from 1866 to 1888 by Isaac Errett through the *Christian Standard;* from 1888 to 1912 by J. H. Garrison through the *Christian Evangelist* (this periodical, renamed the *Christian* in 1960, is an official publication of the denomination). In the early 20th century a Disciples' periodical, the *Christian Century*, emerged as a leading interdenominational journal under the editorship of Charles Clayton Morrison.

Like most U.S. denominations in the 19th century the Disciples founded many colleges, the first successful one being Bethany college, established by A. Campbell at Bethany, W.Va. Most of the surviving schools hold membership in the Board of Higher Education of Disciples of Christ; they include 16 liberal arts colleges and universities, 7 undergraduate Bible colleges and chairs and 11 seminaries or centres of graduate studies. Graduate study for the Disciples' ministry was first established in 1894 through the Disciples Divinity House of The University of Chicago.

Missionary work was initiated by several different organizations, which joined in 1920 to form the United Christian Missionary society, now carrying on missionary work in the major Asian nations, Africa, the Philippines and Central and South America.

The polity of the Disciples of Christ is basically congregational. However, state associations for evangelism began to appear in the 1830s, and a national missionary society and convention was established in 1849. Subsequently, many organizations for missionary work, education, publishing, pensions, benevolence, preservation of history, cultivation of scholarship, etc., have been established. The original convention developed into the International Convention of Christian Churches (Disciples of Christ), serving the U.S. and Canada; to this most of the agencies report and from it they receive advice. After 1950 a Council of Agencies provided general program planning and co-ordinating for all of the agencies of the denomination. A World convention, organized in 1930, includes units from Great Britain, Australasia, South Africa and other nations, some of which originated independently but associate in convention because of similarities of doctrine and practice.

A distinguishing feature of Disciple worship is the celebration of communion every Sunday morning as part of the main service of the day. Disciples believe their service, and its interpretation as a memorial of the life of Jesus Christ, accords with New Testament worship. While an ordained minister usually leads in worship and preaches, the communion normally is administered by elders and deacons appointed by the congregation. Following prayers by the elders and scripture verses, the deacons distribute the bread and wine to the congregation in the pews. Since an ordained minister is not necessary to the service, Disciple congregations maintain their practice of weekly communion even when without a minister.

The Disciples maintain a simple creedal position, accepting faith in Jesus as "the Christ, the Son of the Living God" as an adequate confession for church membership. Infant baptism is opposed, and believer's immersion is usually preached as the adequate form. The New Testament is emphasized as supplanting the covenants of the Old Testament. Though not Unitarian, the Disciples urge the use of a simple New Testament phraseology as to the Godhead. The denomination is rationalistic in temperament, influenced originally by the philosophy of John Locke and "common sense" Scottish philosophy, but its tradition includes a warm evangelical preaching first developed by Walter Scott during his evangelization of the Western Reserve in the late 1820s. At times a minority has placed a legalistic emphasis upon the restoration of New Testament practices as the way to achieve Christian unity; the majority, recognizing the inadequacy of the restorationist idea, have entered fully into the discussions of the 20th-century ecumenical movement.

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DISCOUNT. In general business usage, a discount is a deduction from the price of an article offered to the buyer for paying cash, for buying in large quantities or for some other reason. In banking the word denotes the sum of money deducted from a loan to pay the interest in advance. A bank loan of $1,000 discounted at 6% interest for one year, for example, actually yields only $940 ($1.000 less 6%). The rate of interest is thus referred to as the discount rate. In the money market, discount means the rate allowed to the buyer who pays cash for a bill of exchange due at some future date. Discount house is the name applied in the British money market to firms that specialize in the business of buying and selling bills of exchange. *See* MONEY MARKET.

DISCOUNT HOUSE, a term that has different meanings in retail trade and in banking. According to the first meaning, most common in the United States, a discount house is a retail store, or a division thereof, that sells nationally advertised products at prices lower than the prices asked by other stores. Some discount houses sell products specifically labeled for them at what may appear to be very low prices. In banking usage a discount house is a part of the money market (*q.v.*) where bills of exchange and short-term government obligations are bought and sold.

Some U.S. discount houses feature wide assortments of durable and semidurable consumers' goods; others specialize in jewelry, phonograph records, radios or electrical appliances. Attempts also have been made to operate food stores on the discount principle. Widely varying practices exist as to the use of membership fees and cards. Some houses offer the barest minimum of services; others offer a wide range. These establishments originated in the United States after the turn of the 20th century mainly in such cities as Chicago and New York. The depression of the 1930s gave them a sharp stimulus because so many manufacturers and wholesale middlemen had to liquidate their inventories under the pressure of declining sales.

The post-World War II market furnished the real growth for discount houses. Many reasons can be given for this development: (1) the large pent-up demand for many durable goods that had not been available during the war; (2) increased consumers' incomes; (3) rising luxury and leisure standards; (4) increased emphasis by manufacturers of resale price maintenance (*see* FAIR TRADE LAWS). Successful ventures of book clubs and mail-order record firms spread quickly to other products. The somewhat apathetic views of existing retailers toward discount retailing strengthened the position of discount houses. Finally, the growth of discount houses was stimulated by the abandonment of resale price maintenance by many of its supporters. By the early 1960s discount houses had become an established part of the retail structure. Depending on what types of goods were included, they accounted for 2% to 5 % of the total volume of retail sales. The practice of selling at reduced prices in special shops also grew in Great Britain, particularly after enactment of the Restrictive Trade Practices act of 1956, but the use of the word "discount" was not so common as in the U.S. (D. A. R.)

DISCUS THROWING, the art of throwing an implement known as a discus (weighing 4 lb. 6.4 oz.) from a circle 8 ft. 2½ in. in diameter to the greatest distance, so that it falls within a 90° sector marked on the ground. The sport was common in the days of Homer, who mentions it repeatedly. It formed part of the pentathlon, or quintuple games, in the ancient Olympic games and is fully described by Statius. Judging by specimens found by excavators, the ancient discus was a circular plate of stone, later of metal, about 8 in. or 9 in. in diameter, and weighed from 4 lb. to 5 lb., although one of bronze, probably a trophy, preserved in the British museum weighs more than 8 lb.

Throwing the discus was introduced as an event in modern athletics at the revived Olympic games first held at Athens in 1896, and in the same year was instituted as a Swedish championship. The first Swedish champion was Helgesson, 97 ft. 5½ in. Thereafter throwing the discus became a recognized event in the athletic championship meetings of all nations. The United States adopted the event in 1897, champion C. H. Henneman, 118 ft. 9 in., and England in 1911, champion W. E. B. Henderson, 106 ft. 11 in. In this era the discus was thrown from a circle 7 ft. in diameter. Martin Sheridan, U.S., improved upon Henneman's record seven times, establishing a mark of 141 ft. 4⅜ in. in 1911. Thereafter the

circle was increased to 8 ft. $2\frac{1}{2}$ in. and James Duncan, U.S., in 1912 threw 156 ft. $1\frac{3}{8}$ in. Less than 20 ft. was added to Duncan's effort in 36 years. After World War II, however, improved techniques led to new achievements. An Olympic games record was established by Alfred Oerter, U.S., when he triumphed in 1960; his mark was 59.18 m. (194 ft. $1\frac{3}{8}$ in.). Oerter became the first man to throw more than 200 ft., establishing a world record of 200 ft. $5\frac{1}{2}$ in. at Los Angeles in 1962.

A great deal of discussion has taken place as to the method of throwing the discus employed by the ancient Greeks. Theories have been based upon the description of the sport as given by Statius and upon a reconstruction of Myron's statue of a discus thrower, "Discobolos," which may be seen in the British museum. This statue portrays the thrower in the act of hurling the missile. F. A. M. Webster contends the reconstruction is substantially correct and the discus thrower correctly posed. (F. A. M. Webster, *Athletics of To-Day*, Frederick Warne & Co., Inc., 1929.) Norman Gardiner, however, holds that a wrong attitude has been adopted by the restorer. R. Tait McKenzie calls the "Greek style," insisted upon at the first modern Olympic games, "absurd and ridiculous," and says it "could never have been in use among the ancient Greeks." (Robert Tait McKenzie, *Exercise in Education and Medicine*, W. B. Saunders Company, 1923.) Dean B. Cromwell claims the event "was never standardized" in ancient days and that the Myron statue "seems to have been responsible more than anything else" for having "misled us on the interest of the ancient Greeks in the event." (Dean B. Cromwell and A. F. Wesson, *Championship Technique in Track and Field*, Olympic Games edition, McGraw-Hill Book Co., Inc., 1949, p. 276.)

The so-called Greek style of discus throwing was included at the Athenian celebration, 1906 (Jaervinen, Fin., 115 ft. 4 in.), and at the London Olympiad, 1908 (Sheridan, U.S., 124 ft. $7\frac{11}{16}$ in.), but without any great success, so that the event was abandoned. In the Greek style the thrower stands upon an inclined pedestal, stretches the arms above the head with the discus held between the hands. He then turns the trunk to the right, bends the body at the waist, allows the right hand holding the discus to swing up behind and places the left hand on the right knee, as in Myron's "Discobolos." From this position the thrower straightens out his body, hurls the discus forward and leaves the pedestal in the instant of making the throw.

The modern style, which has entirely superseded the Greek style, provides a more graceful and a more natural series of movements. The essence of this style is that the discus must be slung out and not really thrown at all; the athlete's difficulty lies in controlling an implement which can be retained under and against the hand and wrist only by centrifugal force and such slight pressure as the tips of the fingers are able to exert.

The discus, as used in modern competitions, is composed of a smooth metal rim, permanently attached to a wood body, brass plates set flush into the sides of the wood body, and, in the exact centre of the discus, a means for securing the correct weight, which must be not less than 4 lb. 6.4 oz. The brass plates, circular in form, may not be less than 2 in. nor more than $2\frac{1}{2}$ in. in diameter. The sides taper in a straight line from the beginning of the curve of the rim to a line at a distance of 1 in. from the centre of the discus. The largest dimension comprises a circle not less than $8\frac{5}{8}$ in., the thickness through the centre is not less than $1\frac{3}{4}$ in., and $\frac{1}{4}$ in. from the edge, not less than $\frac{1}{2}$ in.

The discus throw was included when women's track and field was added to the Olympic program in 1928. A slightly smaller although substantially lighter (2 lb. $3\frac{1}{4}$ oz.) implement is thrown. In 1963 at Moscow, Tamara Press, U.S.S.R., created a world record of 59.29 m. (194 ft. $6\frac{1}{4}$ in.). *See* Olympic Games.

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(F. A. M. W.; Sy. S.)

DISEASE in human beings can be classified in various ways. One method arranges diseases on the basis of the causative organisms. Articles following this method include Bacterial and Infectious Diseases; Fungus Infections; Parasitology; Rickettsiae; Viruses. Noninfectious diseases are considered according to their causes in such articles as Allergy and Anaphylaxis; Malnutrition; Metabolism, Diseases of.

Classification may be based on the anatomical part or system affected. Examples of articles using this method include Blood, Disorders of; Eye, Human: *Diseases of the Eye;* Nervous System, Diseases of; Urinary System: *Diseases and Their Medical Treatment.*

Another method of classification is founded on the age or activity of the patient. Articles following this system include Children, Diseases of; Gerontology and Geriatrics; Industrial Medicine; Space Exploration: *Problems of Man in Space.*

Articles relating to the propagation and control of communicable disease include Carrier; Epidemiology; Immunity and Immunization. Organ and tissue damage wrought by disease is discussed in Pathology. For general information about disease prevention and treatment *see* Therapeutics. Further suggestions for readings on subjects relating to human disease are offered in Medicine and Surgery (Articles on).

For diseases of animals *see* the separate articles on these diseases, such as Anthrax; Distemper, Canine; Foot-and-Mouth Disease; Swine Fever; etc. *See* also sections on disease in the articles on various animals, such as Cattle and Sheep.

For a general discussion of the diseases of plants *see* Plant Diseases. This subject is covered in detail in articles on specific plants, such as Apple; Wheat. *See* also Agriculture (Articles on). *See* also references under "Disease" in the Index.

DISINFECTANTS: *see* Antiseptics.

DISMAL SWAMP, sometimes called Great Dismal swamp, is a marshy region located on the Coastal plain of southeast Virginia and northeast North Carolina between Norfolk, Va., and Elizabeth City, N.C. It covers parts of Norfolk and Nansemond counties in Virginia, and parts of Currituck, Camden, Pasquotank and Gates counties in North Carolina. The swamp is densely forested and contains scattered natural clearings with elevations of 10 to 20 ft. above sea level. Along the western margin the Pamlico formation, sometimes known locally as the Dismal swamp terrace, rises to 25 ft. and more, forming a natural boundary. In 1763 George Washington, as a member of a surveying and engineering company, surveyed the area with a view to draining and reclaiming the swamp. At that time the swamp was about 40 mi. long and covered about 2,000 sq.mi. In the late 18th century 40,000 ac. were drained. The swamp is now about 37 mi. long north to south, and covers an area of approximately 750 sq.mi. The swamp has been lumbered over and much timber has been destroyed by fires set to peat bogs in it. Despite this, the area is still heavily wooded with cypress, black gum, juniper and water ash, and a tangle of honeysuckle and woodbine. The swamp is populated with many rare birds, including the ivory-billed woodpecker. Water moccasins and other poisonous snakes are numerous. It is noted for fishing and hunting; deer, bear, raccoons and opossum are plentiful, especially in the nearly inaccessible Coldwater ditch area. From 1790 to 1828 the Dismal Swamp canal, sometimes called the Lake Drummond canal, was built. It is a 22 mi.-long north-south intracoastal waterway connecting Chesapeake bay, by way of Deep creek and the southern branch of the Elizabeth river, with Albermarle sound in North Carolina through the Pasquotank river. The canal, which has aided in lumbering and in some clearing for truck farming, forms a link in the 1,700 mi. Atlantic Intracoastal waterway (*q.v.*). In the midst of the swamp is Lake Drummond, a fresh-water lake connected with the canal by the 3-mi.-long Feeder ditch, and is about 3 mi. in diameter. This lake is the basis of the poem "The Lake of the Dismal Swamp," by the Irish poet Thomas Moore.

(M. C. P.)

DISNEY, WALT (Walter Elias Disney) (1901–), U.S. motion-picture and television producer of animated cartoons and other features, the creator of Mickey Mouse and Donald Duck, was born on Dec. 5, 1901, in Chicago, Ill. After driving an ambulance for the Red Cross in France during World War I, he worked as a commercial artist (1919–20) and then as a cartoonist for the Kansas City *Film Advertising* (1920–22). Experimenting

with animated cartoons in Hollywood, Calif., he produced the *Alice* comedies with live and animated characters (1923–26) and also created and produced the *Oswald the Rabbit* cartoons (1926–28). Disney produced his first successful sound picture, *Steamboat Willie*, in 1928. His animated cartoon characters, notably Mickey Mouse and Donald Duck, soon became popular throughout the world, and his short *Silly Symphony* cartoons, in colour, also became one of the most popular screen series. *Snow White and the Seven Dwarfs* (1938), the first full-length animated cartoon feature, was followed by other children's classics such as *Pinocchio*, *Bambi* and *Dumbo*.

During World War II Disney produced *Victory Through Air Power* (1943), based on the book by Alexander de Seversky, to illustrate the significance of the airplane in modern warfare. He also produced a series of U.S. government films used for training men in the armed forces and in defense plants.

Disney's productions after World War II included *Cinderella* (1950), *Alice in Wonderland* (1951) and *Sleeping Beauty* (1959). Frequently he combined cartoons and live action. He also produced True Adventure Nature films and the live features *20,000 Leagues Under the Sea* (1954), *Davy Crockett* (1955) and *The Littlest Outlaw* (1956). He won many awards. In 1955 he opened Disneyland, a large amusement park at Anaheim, Calif. *See* also MOTION PICTURES: *Animated Cartoons*. (M. S. BY.)

DIS PATER, Roman god of the infernal regions, the precise equivalent of the Greek Pluto (*see* HADES). Dis ("rich") is a Latin translation of Pluto; Pater is usually added to designate his position as sovereign of the lower world, a rich kingdom in that it is ever increasing and never diminishing. Like Pluto he was never very popular and there is little mythology about him. Proserpina (a Roman corruption of Persephone; *q.v.*) is his wife, although in the late empire she is at times replaced by Aera Cura, of whom little but the name is known. There was an altar of Dis and Proserpina in Rome. *See* also ORCUS.

See G. Wissowa, *Religion und Kultus der Römer* pp. 309 ff. (1912). (R. B. LD.)

DISPENSATION is the term applied to the action of a competent authority in granting relief from the strict application of a law. It may be anticipatory or retrospective. In Greek *oiconomia* means the management of a household or family, and in Latin *dispensatio* ("stewardship") meant much the same. When, therefore, in Greek, *oiconomia* was used with reference to the management of the household or family of the church, it was naturally translated into Latin by *dispensatio*. The special use of *oiconomia* as a suspension of the strict canon law in cases of urgency in accordance with the dictates of wise stewardship was equally naturally translated into Latin by *dispensatio*. Hence in English the words economy and dispensation are, in this special use, interchangeable.

In Ecclesiastical Law.—Economy is the term normally used in the Eastern Church. The supreme example of economy in its wider sense is the divine economy exhibited in the incarnation whereby in his wisdom God made possible man's salvation. In continuation of the Saviour's work the church strives for the salvation of souls and, when this is more likely to be achieved by a relaxation of a rule rather than by a strict adherence to it, economy permits the relaxation. With typical Orthodox elasticity no canon defines the limits or use of economy, though certain broad principles are discernible. Thus, to run counter to fundamental dogma is an abuse of economy. But the waiving of subsidiary regulations is permissible where this is conducive to the greater good of the church and the salvation of souls. On this principle baptisms and ordinations by heretics may be recognized, and unfermented grape juice may be used in the Eucharist when wine cannot be had.

Lack of precision is also found with regard to the persons who may exercise economy. The most obvious person is the bishop, and all bishops exercise it in their own right and not by delegation; but they should have regard to the views of episcopal synods, which themselves exercise economy, though only after consultation with the bishop of the district within which it is to be exercised. Above both the bishop and the synod is the general council, which can exercise economy of its own mere motion and can reverse the decisions of synods and bishops and is, in fact, supreme. Below the bishop is the priest who exercises economy in day-to-day matters, such as the relaxation of the rules of fasting and the celebration of the Eucharist in cases of necessity in uncanonical places and at uncanonical times; but, in so acting, the priest is exercising an authority expressly or by implication delegated to him by the bishop.

The Western Church has evolved rules with regard to dispensation with far greater precision and, in the Roman Catholic Church, in some detail. At first it was held that only the common good of the church as a whole justified the granting of a dispensation. It was also generally held that the power to dispense was an adjunct of legislative authority, and that only the person or body which made the laws, whether pope, synod or bishop, could dispense from them. With the development of canon law and the growth of the power of the papacy, however, it came to be accepted, at any rate in practice, that the ultimate dispensing power resided in the pope, though it could be delegated by him to subordinate persons and bodies. The field over which dispensation could operate was significantly widened, for, whereas formerly the divine law and the natural law were outside the scope of the dispensing power, the view was gradually reached that the apostolic jurisdiction of the pope, while unable to abrogate the divine or the natural law, could nevertheless dispense from the obligations imposed by them and from their effects in particular cases, though only where the remote and ultimate object of such laws was not thereby thwarted.

Gradually, moveover, but with increasing frequency, dispensations were granted solely for the benefit of individuals regardless of whether or not the whole church could be said to benefit thereby, and the belief that such dispensations were granted too frequently and for financial gain was a factor contributing to the movement which led to the Reformation. Indeed, the Council of Trent (1545–63) was clearly uneasy about what had been happening and tried to guard against abuses. But it left intact the papal authority, and the Roman Catholic system today is essentially the same as that which had developed by the end of the middle ages. While the authority which has the power to legislate in any case may dispense from its own legislation, so also may its superior; and the subordinate authority's power may be limited by superior authority. The ultimate authority resides in the pope which extends over even the divine and the natural law, though, as has been stated, it is conceded that in such extreme cases the dispensation must not be such as to thwart the ultimate divine intention.

In England the Reformation, inspired at least in part by the pope's refusal to grant Henry VIII a dispensation from his marriage to Catherine of Aragon, put an end to the papal authority in this and all other spheres of its previous jurisdiction. The need for a dispensing authority was, however, recognized, and the statute (1534) 25 Hen. 8 c. 21, while saving to the archbishop of York and the other bishops the power to dispense "in all cases in which they were wont to dispense by the common law or custom of this realm before the making of this Act," conferred upon the archbishop of Canterbury the power of dispensing formerly exercised by the pope, subject in the more important cases to royal confirmation and "for causes not being contrary or repugnant to the Holy Scriptures and laws of God." These provisions, however, have remained largely a dead letter save for the grant by the archbishop of Canterbury of licences to hold benefices in plurality and in the case of marriages for the grant of special licences by the archbishop of Canterbury, or of common licences by the bishop (both in practice granted under the authority of their respective ecclesiastical judges). The lack of any ordered, practical system of dispensation in the Church of England led to the appointment in 1935 by the archbishop of Canterbury, Cosmo Lang, of a commission which in 1944 produced a report entitled *Dispensation in Practice and Theory*, containing a valuable review of the whole subject.

In English Constitutional Law.—In the realm of constitutional law the problem of dispensation has been important and in England the attempts of James II to dispense with laws con-

tributed largely to his downfall. Though the Bill of Rights (1688 old style; new style, 1689) declared his "pretended power" to be illegal, it is by no means certain that this is a true statement of the law before that date. The 17th century was a period when much of English constitutional law took shape; but its form was hammered out in battle, and though the side which ultimately won set the pattern for the future, it does not follow that in points of controversy the losers were always wrong with regard to what the law then was. The courts had had great difficulty in deciding the limits of the royal power to dispense; but that they had not doubted that in some form it existed is clear from the judgments in *Thomas* v. *Sorrell* (1674) and *Godden* v. *Hales* (1686). Indeed, no one doubts the power of the supreme legislative authority to dispense from its own laws. The struggles of the 17th century have shown that, since then, the crown in parliament is the supreme legislative authority and not the crown alone, and its dispensing powers are exercised, like all its other powers, by acts of parliament. Even so, the crown still possesses powers which, if not strictly powers of dispensation, are very closely allied thereto. The crown, through the attorney general, can enter a *nolle prosequi* in any proceedings on indictment after the indictment has been signed, and this has the effect of staying the proceedings *sine die*. The crown also possesses the prerogative of mercy by which it may modify the sentence of a court and, as part of the prerogative it may grant a free pardon under the great seal, entirely exonerating an accused person, either before or after conviction. It is possible to distinguish the power of dispensation both from the entering of a *nolle prosequi* and from the exercise of the prerogative of mercy. Dispensation makes lawful that which would otherwise be unlawful. The *nolle prosequi* and the free pardon relieve from the consequences of an illegality, though, in the case of the free pardon, the circumstances in which it is employed are usually those where subsequently a conviction is shown to have been mistaken and it is thus granted for the very purpose of giving relief from the consequences and (because its purpose is well understood) of clearing the name of the convicted person. But, for practical purposes, the *nolle prosequi* and the prerogative of mercy in fact in large measure preserve the objects of dispensation. The substantial effect of the constitutional struggles of the 17th century has been to transfer power from the crown alone to the crown in parliament. *See* also PARDON.

See W. J. Sparrow Simpson, *Dispensations* (1933). (E. G. Mo.)

DISPLAY DESIGN. Display is the art of presenting merchandise attractively for sale.

History.—As regular market gatherings became established in the middle ages, a need was felt for shops (rather than mere spaces or stands) that provided for storage and protection of merchandise when the market was not active. Such shops required display. Their fronts were more or less open to reveal stock inside; counters and tables often were placed at or before the shop front, or were built into it, and these became natural locations for attractive displays. Entire shop fronts sometimes were garlanded or otherwise decked with samples of wares for sale. Under roof, as in bazaars, the tendency was to duplicate the less formal displays of the open market place; sometimes they were no more than an attractive ordering and contrasting of the merchandise at hand, without fixtures, lighting or signs of any kind. In later times galleries, glass-roofed shopping areas similar to the ancient bazaars, became known; in these the tendency was to imitate a shopping street rather than a transient market. The arcaded street, with covered walks on one or both sides, represents a transition between street and gallery.

When glass became available in the later middle ages, shop-front display entered a new phase. The small pieces of glass then in use were assembled into display windows, and wares seen through the mullions acquired new attraction. As technological developments made possible the production of larger sheets of glass, the structural framing was reduced in size, and shop windows more and more became transparent treasure chests, tempting the passer-by to stop, look and investigate.

Comparable changes inside the shop had to await the growth of trade, wealth and population. Until comparatively modern times, most shops were small and had to store a considerable stock; display of stock inside the shop generally was handled as a special event for an important client and commonly was arranged in a back or upstairs room. Such special display had been arranged since time immemorial in the homes of the wealthy by itinerant hucksters. The idea that important customers might visit a shop was a late development, unusual until the 18th century, the period during which shops began to grow in size and complexity. On large premises, merchandise could be attractively grouped rather than merely shelved; thus interior displays, so important to modern trade, developed.

Display—whether temporary, as at a market stall, or semipermanent, as in a shop, whether in a window or inside the shop on a display stand—is of two main types: (1) assortment display, which shows the quantity and variety of wares for sale, a visual inventory of the stock; and (2) token display, which dramatizes a few selected articles as representative of a larger choice actually available. Generally, assortment displays are associated with inexpensive and nonfragile merchandise, token displays with goods intended for a sophisticated public that is not interested in bargains.

As shops became big stores in the mid-19th century, and as the western standard of living improved, display began to be a recognized asset to trade and a specialty for which training was required. The great mercantile cities of Europe and America exhibited window and interior displays that, toward the turn of the century, under the influence of repeated international world's fairs became more and more elaborate, some of them, indeed, such self-conscious constructions that they made the public more aware of the display designer's art than of the goods exhibited.

After World War I a new style of display was developed that avoided such excesses and that reflected the *avant-garde* fine arts of the time, particularly Cubism. Cubistic display fixtures and even Cubistic arrangements of goods became common. Feature displays for holidays or other special events also became particularly elaborate. At Christmas time, for instance, mechanized troupes of puppets would be set up in show windows portraying fairy tales in motion. The show window as a substitute for popular entertainment was destroyed by the motion picture, by urban traffic and by a competitive commercial system that could not long afford such expensive (in comparison with the return) display. The other aspect of display in the 1920s and '30s (its sense of artistry and its emphasis on up-to-date fixtures and on dummy figures for clothes) has become part of the standard apparatus of modern merchandizing.

Display staffs of large stores came to be organized into departments, with a chief of display in charge, responsible for as many as 80 frequently changed show windows. The increasing importance of lighting as a factor emphasized the resemblance between display design and stage design (*see* STAGE DESIGN). In important shops window display developed into such expert productions that audiences gathered to see the new effects when a hank of windows was changed, as at a first night at the theatre. This flourishing state of display appeared first in Germany, Switzerland and France, but it soon spread to all major cities of Europe and America.

While this growth of dramatic effectiveness was taking place, the cost of display was rising sharply, and commercial managements began to analyze display in a variety of ways. By investigating the behaviour of the purchasing public it was learned that, on the average, people pass a show window in eight seconds; hence it became important to spread display through windows in series. The importance of impulse buying and its correlation with interior displays was demonstrated. Such analyses tended to counterbalance the urge for novelty and for prestige-creating effects, and thus display was turned into something of a science as well as an art.

Contemporary State.—Display is a profession whose efficiently trained members work in every sizable community. Training in art is basic and experience in merchandising and styling indispensable to the display designer. The idea or theme around which a display is developed springs from the merchandise itself—

its use, colour, construction or news value. Properties and background are used to develop the theme, but these, though they may be unusual or striking, rarely are more conspicuous than the merchandise itself. Several types of displays have evolved according to the peculiarities of the goods to be shown; each has its technical problems of support, lighting and presentation. A whole field of related industries has sprung up, supplying mannequins, properties, materials and lighting devices. These display materials are shown at gatherings of designers and manufacturers, which serve as centres for new ideas as well as for new fixtures; salesmen from display supply houses also travel with samples of their wares. There are, in addition, periodicals devoted to the needs of the display world. (T. B. L.)

DISRAELI, BENJAMIN: *see* BEACONSFIELD, BENJAMIN DISRAELI, EARL OF.

D'ISRAELI, ISAAC (1766–1848), English man of letters and literary critic, pioneer of literary research, and also the father of Benjamin Disraeli, 1st earl of Beaconsfield, was born at Enfield, Middlesex, in May 1766. His father, Benjamin D'Israeli, a scion of a Jewish family expelled from Spain by the Inquisition, had migrated to England from Venice in 1748 and made a fortune in commerce. Hopes that his only son would succeed him in his affairs were shattered when, at the age of 14, the boy produced a poem. Sent to Amsterdam to study, Isaac returned four years later a disciple of Rousseau. He then spent a further period in Paris where he moved in literary circles, and on his return he published, in 1789, a poem addressed to Thomas Warton, called "On the Abuse of Satire," attacking the satirist John Wolcot, whose pseudonym was "Peter Pindar." This poem gained him the friendship of the poet H. J. Pye, and in 1790 he dedicated his verse *Defence of Poetry* to Pye, then poet laureate. The following year D'Israeli published anonymously a collection of *Anecdotes, Characters, Sketches, and Observations, Literary, Critical and Historical,* which became the first volume of *Curiosities of Literature.* A second volume appeared in 1793, and with some reluctance he abandoned his ambition to be a poet and occupied himself with scholarship. Further volumes of *Curiosities* appeared in 1817, 1823 and 1834, and similar works were *Miscellanies* (1796), *Calamities of Authors* (1812) and *Quarrels of Authors* (1814). His *Essay on the Manners and Genius of the Literary Character* (1795) was named by his son "the most perfect of his compositions." These were all intended as chapters of a connected history of English literature; but although in 1841 he published three volumes called *The Amenities of Literature,* he was never able to complete the project. This failure was partly because of the continued success of *Curiosities of Literature,* which was originally a tentative effort "to discover whether a taste for literature could be infused into the multitude." Continued demand suggested a positive answer, and D'Israeli felt obliged to meet it conscientiously with further volumes. At first the work was intended only as a collection of excursions into the byways of literature and history, but later volumes contained more criticism, some of which, particularly that concerned with recent writers such as Thomas Gray, showed considerable acumen. However, D'Israeli was accused of exaggerating the importance of the "secret histories," as he called the fruits of his research.

D'Israeli also published some short novels or romances, *Vaurien* (1797), *Mejnoun and Leila,* an oriental tale (1797), *Flim Flams* (1805) and *Despotism, or the Fall of the Jesuits* (1814), but these were not very successful. Purely historical works were *Inquiry Into the Literary and Political Character of James I* (1816), *The Life and Reign of Charles I* (1828–31) and *The Genius of Judaism* (1833).

He married in 1802, and Benjamin Disraeli, later earl of Beaconsfield, was the second of five children. Isaac D'Israeli died at Bradenham, Buckinghamshire, on Jan. 19, 1848.

A memoir by his son was prefaced to the 1849 edition of *Curiosities of Literature. See* also W. F. Moneypenny and G. E. Buckle, *The Life of Benjamin Disraeli,* vol. i, rev. ed. (1929). (P. M. Y.)

DISSOCIATION, a separation or dispersal, the opposite of association but of wider application (*see* ASSOCIATION, CHEMICAL). In chemistry the term is given to chemical reactions in which a substance decomposes reversibly in such a way that, from a single molecule of the original substance, two or more smaller molecules are formed. Often these smaller molecules are of different kinds but sometimes they are of the same kind. Thus the reactions $NH_4Cl \rightleftarrows NH_3 + HCl$ and $PCl_5 \rightleftarrows PCl_3 + Cl_2$ are instances of the first type; $N_2O_4 \rightleftarrows 2NO_2$ of the second. When this breakdown is effected by heating, the process is termed thermal dissociation. Electrolytic or, as it is termed, ionic dissociation is the separation of a substance in solution into ions. (*See* ACIDS AND BASES: *The "Hydrogen-Ion" Theory of Acids;* SOLUTIONS: *Solutions of Nonelectrolytes and Electrolytes: Electrolytic Dissociation and Ionic Association.*)

In psychology dissociation is an abnormal condition of the mind wherein the usual connection between various mental elements is lost. Ordinary lapses of memory represent dissociations, in normal minds, between the idea or object which cannot be called to mind and the clue or stimulus idea which formerly sufficed to recall the thing desired. Abrupt changes of mood or change of interest from one subject to another in normal people may represent emotional dissociation. When large, combined groups of ideas and emotions (complexes) become dissociated from other similar groups the resulting condition is known as dissociation of personality.

See also references under "Dissociation" in the Index volume.

DISTEMPER, CANINE, is an acute, highly contagious disease of dogs caused by a virus. Wolves, foxes, mink, raccoons and ferrets are also susceptible, but other common laboratory and farm animals cannot be infected, even by inoculation. The disease is world-wide in distribution, occurring wherever dogs exist. In most areas canine distemper is so ubiquitous that dogs older than six months are often presumed to have been exposed to the disease in some degree and to have developed an immunity. This is more true in urban areas than in rural areas. Although a few cases are mild, and recovery is rapid and complete even without medical treatment, by far the greater number are fatal if treatment is delayed or ignored.

The Virus.—The virus of distemper in dogs is known as the virus of Carré or, more properly, the virus of Laidlaw and Dunkin to distinguish it from other disease-producing organisms of dogs that have complicated the understanding of distemper. H. Carré in France, in 1905, first described a virus from sick dogs. Not until the work of P. P. Laidlaw and G. W. Dunkin (under the auspices of the Field Distemper Research committee in England), who published their first paper on the disease in 1926, did the true picture of distemper uncomplicated by other conditions become known. Important contributions to knowledge of the diseases associated with distemper were added by R. G. Green and his coworkers at the University of Wisconsin, Madison, and by S. Rubarth in Sweden during the second quarter of the 20th century. J. A. Baker and his co-workers at the Cornell Research Laboratory for Diseases of Dogs, who started their work midway in the 20th century, also contributed greatly to understanding of the disease.

The virus that causes distemper in dogs is ultramicroscopic. It is destroyed in a few minutes by heating to 56° C., but may remain infective under ordinary temperatures for days. If dried in a frozen state it may remain viable for years. Excreta from affected animals, especially from the nostrils, during the first few days of symptoms, are highly infective. The organism is spread by feeding and drinking utensils, cleaning brushes, and by contact with contaminated clothing and boots from animal attendants. Also, droplets containing the virus may be distributed through the air on particulate matter and still be infective.

Symptoms and Course of the Disease.—The course of the uncomplicated disease was first described by Laidlaw and Dunkin. After an incubation period of three to five days there is an acute fever (105° to 106° F.) for a few days. After an interval another febrile attack of a few days often takes place. The dog becomes dull and apathetic and refuses food and water, with attendant loss of weight and dehydration. In unusually mild cases the appetite may return after the fever subsides. The uncomplicated disease usually lasts four to eight weeks. For 10 to 15 days after inoculation there is an acute catarrh. The sclera and conjunctiva of the eyes become infected. The entire respiratory tract may be-

come involved in varying degree from simple cough to severe difficulty in breathing (dyspnea), with excessive watery discharge from the nostrils and the eyes. The entire gastrointestinal tract may become involved, with varying degrees of nausea and diarrhea. The slimy diarrhea that usually is a concomitant of distemper has a characteristic disagreeable odour. A thickening of the pads of the feet is common. (The concept of a separate disease entity, "hard pad disease," that prevailed for a few years after 1945 was shown to be untenable.)

Symptoms involving the nervous system occur in about one-fourth of the cases. These may range from mild involuntary twitchings of a group of muscles (chorea) to posterior paralysis or convulsive seizures.

Clinical cases may often be complicated by the existence of concomitant and superimposed infections such as canine viral hepatitis and toxoplasmosis. Too, bacteria that are usually present in healthy animals, such as *Bordetella bronchiseptica*, have been incriminated as pathogens in the distemper-weakened dogs, as are organisms of the pleuropneumonia (PPLO) group.

The virus of Laidlaw and Dunkin has a predilection for epithelial cells, those cells that act as the covering or lining of the body, such as the skin, the mucous lining of the mouth, gullet, stomach and intestines, the lining of the ducts of the liver and other glands, the glandular cells themselves, the lining of the genital and urinary tracts and the lining of the entire respiratory tract.

The disease process (pathogenesis) depends upon which of the epithelial cells are attacked most markedly. Congestion and edema of the lungs is present in almost every case that is examined after death (necropsy). Any part of the gastrointestinal tract, including the bile ducts, may show a varying degree of damage (pathological change). The same can be said of the urinary tract. The skin may be involved, especially on the underside of the body.

In the early stages of the disease there is a remarkable depletion of lymphocytes, one of the white cells of the blood. However, at about the fifth week the lymphocyte-forming tissue begins to regenerate cells. The nervous system, too, is affected. Almost all natural cases at necropsy show some inflammation of the brain.

Intracellular particles called inclusion bodies are found in the affected epithelial cells, although they may be difficult to find in the earlier stages of the disease. They are found in that portion of the cell termed the cytoplasm. When found in the epithelial cells of the urinary bladder they are considered to be pathognomonic (diagnostic) of distemper.

Treatment.—Treatment of distemper is a time-consuming procedure requiring patience and sympathy. Free use of serum or the globulin fraction of the serum, if given early enough, is effective. The use of antibiotics to ward off secondary invaders is good therapeutic practice. Nursing should be aimed at restoring appetite. Keeping the nostrils clear is fundamental so that the dog may smell his food and be encouraged to eat. It may be necessary to replenish lost body water and salts with parenteral solutions.

Control.—Laidlaw and Dunkin first formulated a method whereby dogs could be immunized against distemper. They obtained tissues from infected animals, treated the tissue with formalin and gave repeated injections of the treated tissue to young healthy pups to confer an immunity on those pups. The result was a more lasting immunity.

Green, by repeated passage of the Laidlaw-Dunkin virus through ferrets, developed a modified live virus that produced an active immunity in dogs. The dogs had to be healthy, however. If they had worms, or were otherwise debilitated, serious reactions took place. Mid-point in the 20th century an egg-propagated vaccine was developed.

Passive immunity can be conferred by inoculating dogs with serum from other dogs in which an immunity has been developed. Such immunity is effective for about 10 days. Passive immunity can also be transferred from the mother to her pups through the early milk (colostrum), if the mother is immune; this immunity may vary in duration from a few days to a few months.

Active immunity will take place if the dog has recovered from the disease, or if live attenuated virus (vaccine) is inoculated. The effectiveness of the vaccine (duration of protection) is diminished by the presence of immune bodies in the dog. J. A. Baker and his co-workers have shown that the amount of passive immunity transferred by a mother to her pups may be measured, and that the date the vaccine can be given with the assurance that it will become lasting can be calculated.

Active immunity, although more lasting, is variable. It may last eight months or it may last several years. To insure a continuous state of immunity a dog should (1) have its serum tested for immunity each year, and, if the serum is low in immune response, be vaccinated again, or (2) be vaccinated each year without testing.

See also HEPATITIS, CANINE VIRAL.

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(NA. BR.)

DISTEMPER, WHITEWASH AND CALCIMINE are inexpensive water paints that provide little protection and are used mainly for decorative purposes. All three are composed basically of whiting (calcium carbonate), glue (size) and water. In thick paste or jelly form the paint may be called distemper or whitewash; in dry form it may be called calcimine. The glue acts as a vehicle for suspending the pigment during application and also bonds the pigment to the painted surface. Usually a distemper type of paint contains just enough binder to prevent it from rubbing off a surface, but not enough to make it washable. Consequently, if a coating is to remain durable it must be kept dry. Distemper paints may be improved by adding a little oil or varnish to provide additional bonding, add limited waterproofing and enhance durability. Distemper and similar types of paint cover well and can be applied quickly and easily with large brushes. They are used mainly on ceilings and other interior surfaces when economy is important and washability is not.

Paints made with naturally occurring glues such as water-soluble gums have been known throughout recorded history. Early precursors provided the media for the mud daubings of the cavemen, the distemper wall paintings of the Egyptians, the frescoes of the ancient Romans and medieval Italians, the milk and curd paints of the Hebrews and the whitewash of colonial United States.

A simple distemper can be made as follows: Let 14 lb. of whiting stand overnight in water. Pour off the excess water and thoroughly knead the residue. Disperse 5 lb. of hot jelly size into the slurry of whiting. Strain and use. The jelly size is made by dissolving 1 lb. of animal glue into 1 gal. of hot water. To improve the whiteness, add a small amount of ultramarine blue to the whiting. Because size is likely to decompose on standing, with consequent loss of binding power, a small amount of preservative is required. In the above example, about 1 oz. of alum, borax, phenol, salicylic acid or other preservative should suffice. Other proteins (such as gelatin, albumin or casein) or carbohydrates (such as starch, dextrin or vegetable glue) may be used instead of or in conjunction with the conventional animal glue. In recent years water-soluble synthetics such as methyl cellulose, sodium carboxymethylcellulose, polyvinyl alcohol and polyvinyl acetate latices have found favour because they resist mildew and bacterial attack.

Casein distempers, instead of being made with glue, are made with a binder of casein, the insoluble white protein derived from skim milk. Casein must be treated with an alkali such as ammonia, sodium carbonate or borax to make it water soluble. Because casein forms insoluble salts with calcium, casein-based distempers are preferred where limited washability and weather resistance are desired. Immediately after it is applied, a casein distemper film is as sensitive to water as conventional distemper but it hardens with age and develops better water resistance; it

never approaches, however, the durability of oil paints.

A large variety of shades may be obtained by adding coloured pigments to white distemper. Since distemper is usually used on cement and plaster walls that contain free lime and alkali, the tinting pigments must be fast to light and must resist lime and alkali. Ultramarine blue, the various iron oxides, Hansa yellow, carbon black and titanium dioxide are a few of the many pigments that can be used to colour distemper.

Calcimine, or dry distemper, is usually a mixture of whiting with dry slaked lime and finely powdered glue or casein binder. It is manufactured by intimately blending the ingredients in special grinding and sifting machinery. Care must be taken to keep the powders dry at every stage for even a small amount of water could cause the calcimine to cake and become insoluble. Preservatives are also needed. Two formulas for calcimine are as follows: (1) whiting 100 lb., fine-powdered size 8 lb., powdered alum 2 oz.; (2) whiting 100 lb., dry slaked lime 5 lb., sodium carbonate 2 lb., casein 5 lb. Calcimine also may be tinted to any desired shade by using alkali-fast colours.

For many years the term "water paint" referred to the better type of distemper, which, in addition to the usual ingredients, contained a little oil or varnish as well as opaque white pigments such as titanium dioxide, lithopone and zinc oxide. But with the advent of synthetic rubber technology and subsequent development of latex-based water paints, distemper fell into disfavour and the term "water paint" came to be used in reference to latex paints.

(P. He.)

DISTILLATION, an operation involving the conversion of a substance into vapour which is subsequently condensed to the liquid form. It may also be thought of as a process for separating liquid mixtures which depends on the difference in composition between a liquid and its vapour. The process is exemplified at its simplest when steam from a kettle plays upon a cold surface, producing drops of distilled water. The natural cycle by which the water of the oceans passes into the air and later condenses and falls as rain is an example of distillation. The term, which was originally applied to the separation of alcoholic liquors from fermented materials, now has a far wider application, and distillation is an integral part of many chemical manufacturing processes. It has for its object the separation of liquids from nonvolatile solids, as pure water from the salt in sea water, or the separation of two or more liquids, as gasoline, fuel oil and lubricating oil from crude petroleum.

Simple Distillation.—This term is used to distinguish the simplest distillation operations, as illustrated in fig. 1, from the many possible modifications and elaborations. The basic apparatus consists of three parts: the still or retort in which the liquid is heated; the condenser, to cool the vapours; and the receiver to collect the distillate. On distilling a mixture of substances, the most volatile or lowest boiling distills over first, and the others subsequently or not at all. The simple apparatus described is entirely satisfactory for the purification of a liquid containing nonvolatile material, and reasonably satisfactory for separating liquids of widely divergent boiling points. For laboratory use, the apparatus is commonly made of glass and connected with corks or rubber bungs or ground-glass joints. Simple distillation is also used frequently in technology, and for such purposes larger equipment of metal or ceramic ware is used. (See *Distillation in Industry,* below.)

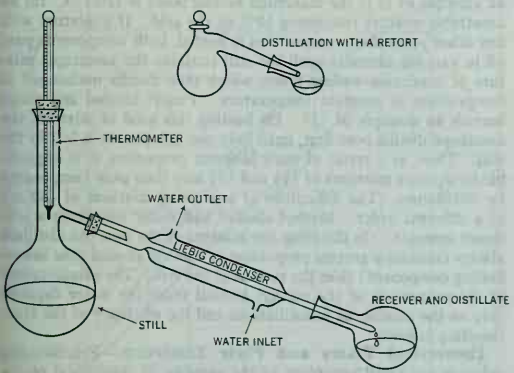


FIG. 1.—TYPICAL LABORATORY DISTILLATION APPARATUS OF SIMPLEST TYPE. THE VAPOUR PASSES FROM THE STILL TO THE LIEBIG CONDENSER, WHERE IT IS CONDENSED BY COLD-WATER CIRCULATION IN THE WATER JACKET. THE DISTILLATE IS COLLECTED IN THE RECEIVER. RETORTS ARE NOW SELDOM USED

A laboratory distilling flask may be heated by direct gas flame or indirectly through a sand tray or wire gauze, or by electrical means. A thermometer is often used to indicate the progress of a distillation. Its bulb is placed just below the side arm where the vapour leaves the still, so that the thermometer reading approximates the temperature of the vapour. Exact boiling points are best determined in a special apparatus.

An air-cooled elongated side tube is adequate as a condenser with substances boiling above 170° C. For lower-boiling substances a Liebig single-surface condenser (fig. 1) is used. Many varieties of glass condensers are available, but the chief differences between them are in the ingenuity with which the internal members are designed to give maximum cooling effect.

Historical Note.—Distillation appears to have been used by the earliest experimentalists. Aristotle (384–322 B.C.) mentioned that pure water is made by the evaporation of sea water. Pliny the Elder (A.D. 23–79) described a primitive method of condensation in which the oil obtained by heating rosin is collected on wool placed in the upper part of the still. The Alexandrians added a head or cover to the still and prepared oil of turpentine by distilling pine resin.

The Arabians improved the apparatus by cooling the tube leading from the head, or alembic, with water. They discovered a number of essential oils by distilling plants and plant juices.

The alchemists used such apparatus to prepare hydrochloric, nitric and sulfuric acids in a relatively pure state.

Early in the 1800s, large-scale continuous stills for the recovery of alcoholic liquors were devised by J. B. Cellier-Blumenthal and Louis Charles Derosne in France, and by Aeneas Coffey in Great Britain. Their bubble plate towers are basically identical with many modern industrial stills. Laboratory practice owed much to the introduction, about 1850, of the condenser named (incorrectly) after Justus von Liebig (fig. 1).

In the early 1920s the theory of distillation developed earlier by Ernst Sorel was reduced to engineering terms. This stimulated a series of theoretical and practical investigations resulting in such improvement in the efficiency of both industrial and laboratory distillation that separations formerly considered impractical became commonplace. This made distillation one of the most widely used operations in laboratory research, analysis and chemical engineering.

Fractional Distillation and Rectification.—Fractional distillation was developed because simple distillation is not efficient in the separation of liquids whose boiling points lie close to one another. Originally the term meant the collection of the distillate in successive fractions or cuts. It was also applied to the systematic recombination and redistillation of such cuts in order to improve separation.

In modern usage, fractional distillation represents the whole of any process or method whereby the fractions from a distillation are made as different in properties as possible. Especially important in this connection are still heads, columns and condensers (fig. 2) that permit the return of some of the condensed vapours toward the still. The whole aim is to achieve the closest possible contact between rising vapour and descending liquid, and so to allow only the most volatile vapour to proceed to the receiver while returning the less volatile material as liquid toward the still. The purification of the more volatile component by contact between such countercurrent streams of vapour and liquid is referred to as enrichment or rectification. The descending liquid is known as reflux.

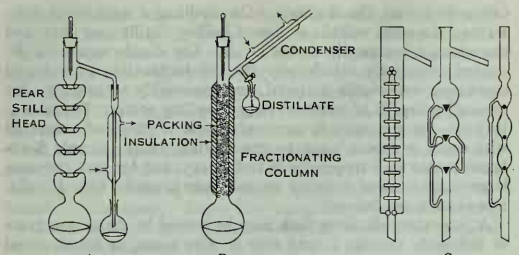
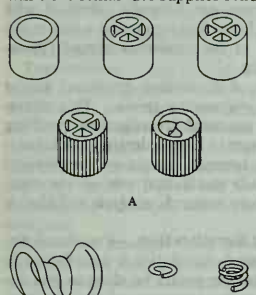


FIG. 2.—FRACTIONAL DISTILLATION, STILL HEADS AND FRACTIONATING COLUMNS. (A) FRACTIONAL DISTILLATION WITH PEAR STILL HEAD; (B) FRACTIONAL DISTILLATION WITH INSULATED COLUMN AND TOTAL CONDENSER; (C) TYPICAL STILL HEADS

In modern apparatus reflux is produced by a condenser at the top of a column (fig. 2) which is preferably insulated or otherwise made nearly adiabatic and filled with packing or plates (fig. 9) or some other device for achieving good contact between vapour and liquid. The most common packings (fig. 3[A] and [B]) are glass beads, metal chain, Lessing and Raschig rings, Berl saddles, Stedman screens and single- and multiple-turn helices of thin wire or glass. A choice among these depends on the diameter of the column and on a balance between cost and efficiency. The Bruun column is an example of a superior laboratory bubble plate column, but this type reached its greatest development in large-scale technological distillation operations. Other devices involve passage of the countercurrent liquid and vapour streams through the narrow annular space between a tube and a rotating cylinder within the tube.

Either partial or total condensers may be used to produce reflux. In the former, which is also called a dephlegmator, the temperature of the condenser is controlled so that only part of the vapour is liquefied and used as reflux, while the remainder passes on to a second condenser and is collected as product. In total condensers, all the vapour is liquefied. Some of the condensate is removed through a side tube just below the condenser (fig. 2) while the remainder supplies reflux. The greater the ratio of reflux liquid to final product (reflux ratio), the better the separation of the various components, but at a corresponding increase in the time and cost of the distillation. Infinite reflux, or total reflux operation, involves no withdrawal of product, and return of all condensate down the column as reflux liquid. Since no distillate is produced, this type of operation is of interest only for testing and for theoretical purposes.



FROM PHOTOS BY COURTESY OF MAURICE KNIGHT CO.

FIG. 3.—COLUMN PACKING MATERIALS: (A) RASCHIG RING, PARTITION RINGS, SPIRAL RING; (B) BERL SADDLE, SINGLE- AND MULTIPLE-TURN WIRE HELICES

Theory of Distillation.—Every liquid or liquid mixture will evaporate into a closed space until the pressure of the resulting vapour reaches a characteristic or equilibrium value. This vapour pressure is a measure of the volatility of the liquid. It has a fixed value for any one liquid at a particular temperature, but always increases with rising temperature. At any particular pressure, a sample of pure liquid will distill completely at a fixed temperature, but constancy of boiling point does not prove that the material being distilled is a pure substance. Most liquid mixtures distill over a range of temperatures, but certain compositions of particular mixtures (azeotropes) pass over without change in composition or boiling point. These relations are summarized by the boiling-point curves of fig. 4, in which the boiling point of the distillate is plotted against the percentage of the charge that has been distilled. The mixture of liquids with widely divergent boiling points gives a curve with a break at the point where most of the lower-boiling component has distilled over. The sharpness of the break in the distillation curve is determined chiefly by the difference in volatility of the materials being distilled, by the inherent separating power of the column or still head and by the reflux ratio.

The general theory of distillation is quite complex. For the sake of simplicity the succeeding discussion will be confined to mixtures of two components. Three situations can be distinguished according as the components are: (1) quite insoluble in each other—completely immiscible mixtures; (2) soluble only within limits—partly miscible mixtures; (3) soluble in all proportions—completely miscible mixtures.

The first case is illustrated by benzaldehyde and water as discussed under *Steam Distillation*, below. Both components distill together at a temperature below the normal boiling point of either, and in constant proportion until one disappears, after which the other distills alone at its normal boiling point. Partly miscible

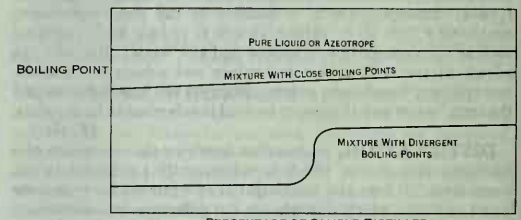


FIG. 4

Boiling-point curves for typical liquids. If pressure is constant, the boiling point rises as the distillation progresses, except when pure liquids or azeotropes are being distilled. If the pressure is increased or decreased, all the boiling points are respectively raised or lowered, and the azeotrope distilling at the new constant temperature will be of different composition

systems behave similarly as long as two immiscible layers are present; but when one disappears, they behave like a completely miscible mixture.

Three varieties of completely miscible mixtures occur. They are (*see* fig. 5): (1) systems in which an azeotrope has a boiling point greater than that of either pure component—maximum boiling-point mixtures; (2) systems in which an azeotrope has a boiling point less than that of either pure component—minimum boiling-point mixtures; (3) systems in which all boiling points are intermediate between those of the pure components. Nitric acid (boiling point [b.p.] 86° C.) and water (b.p. 100° C.) provide an example of (1); the maximum boiling point is 120.5° C. for an azeotropic mixture containing 68% of the acid. If a mixture with any other percentage composition is heated, both components pass off in varying amounts until the still contains the azeotropic mixture of maximum boiling point, which then distills unchanged in composition at constant temperature. Propyl alcohol and water furnish an example of (2). On heating this kind of mixture, the azeotrope distills over first, until only one component is left in the still. Thus, as a result of their inherent properties, it is impossible to separate mixtures of (1) and (2) into their pure components by distillation. The difficulties of separating mixtures of (3) are of a different order. Methyl alcohol and water constitute a pertinent example. On distilling any mixture of the two, the distillate always contains a greater proportion of methyl alcohol (the lower-boiling component) than the residue in the still. The completeness of the separation of the methyl alcohol from the water depends only on the number of redistillations and the efficiency of the fractionating column.

Theoretical Plates and Plate Efficiency.—Fractionating columns are rated according to the number of theoretical plates, and, in the case of plate columns, also according to plate efficiency. A theoretical plate may be defined as one that produces the same difference in composition as exists at equilibrium between a liquid mixture and its vapour. Thus, for example, any portion of a

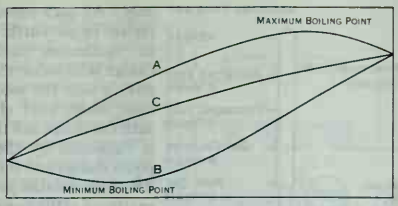


FIG. 5.—THE THREE VARIETIES OF COMPLETELY MISCIBLE BINARY MIXTURES: (A) MAXIMUM BOILING-POINT MIXTURES; (B) MINIMUM BOILING-POINT MIXTURES; (C) MIXTURES IN WHICH ALL COMPOSITIONS HAVE BOILING POINTS INTERMEDIATE BETWEEN THOSE OF THE PURE COMPONENTS

column that produces an improvement in composition from *a* to *b* or *b* to *c*, etc. (*see* fig. 6), is a theoretical plate. On simple distillation of a liquid of composition *a*, the first drop of distillate should have composition *b*. This would be a theoretical or perfect simple distillation. These terms are used since this operation is difficult to achieve in practice because of condensation on the upper walls and neck of the distillation flask. Specially designed apparatus is used to obtain the data for constructing vapour liquid equilibrium curves such as that of fig. 6.

The number of theoretical plates is determined from the compositions obtained experimentally at the bottom and top of a column or a section of column. A common example involves operation at total reflux and use of a vapour liquid equilibrium curve, as may be illustrated by reference to fig. 6. Stepwise construction is commenced at the point *a* corresponding to the composition at the still or bottom of the column and continued (along *h*, *i*, *j*, *k*, *l*, *m*, *n*, *o*, *p*, *q*) to the top or distillate composition (*g*). The number of steps required in this construction (four and a fraction in this example) is the number of theoretical plates in the column. The height of the column divided by the number of theoretical plates is called the H.E.T.P. or height equivalent to a theoretical plate. The more fundamental H.T.U. (height of a transfer unit) is determined in a somewhat similar fashion. Practical applications often involve use of more complex graphical procedures and formulas in order to estimate the type and height of column needed to secure a desired separation or purification.

Plate efficiency may be defined as the ratio (in per cent) of theoretical plates to actual plates. Plate efficiencies vary from 10% to more than 100% but with common mixtures having normal viscosities the value is usually between 50% and 75%.

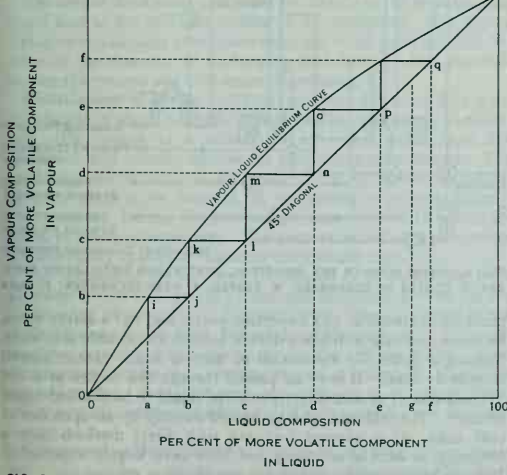
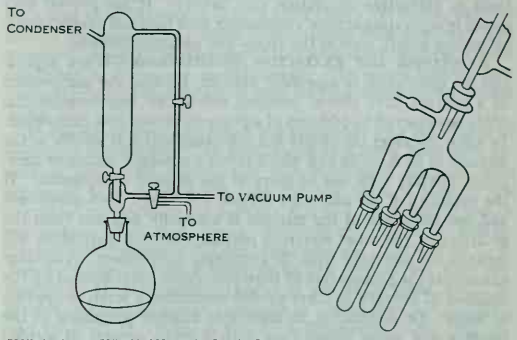


FIG. 6.—VAPOUR LIQUID EQUILIBRIUM DIAGRAM AND THEORETICAL PLATES

Reduced Pressure or Vacuum Distillation.—Distillation under reduced pressure is adopted when dealing with substances that normally boil at inconveniently high temperatures or that decompose when boiling under atmospheric pressure. Vacuum distillation is also sometimes used because it is more economical. The apparatus differs little from that already described except that the distillate receiver must be connected to a vacuum pump and preferably also to a gauge and automatic pressure regulator.

The collection of fractions under reduced pressure is best managed by an arrangement of stopcocks and connecting tubes or by a specially designed multiple receiver which permits removal of one fraction after another without interrupting the distillation or breaking the vacuum (fig. 7).

The volume of vapour from a given volume of liquid is 760 times as great at one millimetre pressure as at standard atmospheric pressure (Boyle's law). Hence vacuum distillation is



FROM A. A. MORTON, "LABORATORY TECHNIQUE IN ORGANIC CHEMISTRY," MCGRAW-HILL BOOK CO., INC. (1938)

FIG. 7.—DEVICES FOR COLLECTING FRACTIONS IN VACUUM DISTILLATION

subject to the disadvantage that reduction of the pressure to ten millimetres or less greatly reduces the distilling capacity because of the resistance offered by ordinary apparatus to the easy flow of the very great volumes of vapour. Distillation at pressures below one millimetre is usually carried out in molecular stills (see *Molecular Distillation*, below).

Steam Distillation.—This is an alternative method of achieving distillation at temperatures lower than the normal boiling point. It is applicable when the material to be distilled is immiscible and chemically nonreactive with water. The usual procedure is to pass steam into the liquid in the still to supply heat and cause evaporation of the liquid. The steam will condense at the start and form a layer of water. In fact, steam distillation is sometimes carried out by simply adding liquid water to the charge and supplying heat in the usual way. For instance, impure benzaldehyde (oil of bitter almonds) may be purified either by adding water and heating, or by passing in steam. As the mixture becomes warm, each liquid vaporizes as if the other were not present. The total pressure of the two vapours is the sum of the individual pressures of the water and benzaldehyde (Dalton's law of partial pressures), as indicated in the accompanying table.

Temperature (°C.)	Vapour pressure (10 mm.)			Remarks
	Benzaldehyde	Water	Total	
50	5	92	97	
80	28	355	383	
90	40	526	566	
95	50	634	684	
98	56	707	763	Mixture boils
100	61	760	820	Boiling point of water
140	263			
170	614			
180	790			Approximate boiling point of benzaldehyde

Since any liquid boils when its vapour pressure equals or slightly exceeds the atmospheric pressure (760 mm.), the mixture of water and benzaldehyde will boil slightly below the boiling point of pure

water and far below that of pure benzaldehyde. The volumes of the two vapours in the vapour mixture will be in the proportion of the vapour pressures; *i.e.*, about 56 of benzaldehyde to 707 of water. The relative weights may be found by multiplying the relative volumes by the corresponding molecular weight. Thus, for benzaldehyde, $56 \times 106 = 5{,}936$, and for water, $707 \times 18 = 12{,}726$; it follows, therefore, that benzaldehyde will distill with about two times its weight of water.

Distillation with steam is merely a special instance of the distillation of immiscible liquids, as described under *Theory of Distillation*, above. Accordingly, liquids other than water can be used in analogous operations. Thus impure indigo can be distilled with kerosene to produce a good yield of pure indigo, without loss caused by overheating and decomposition during the distillation.

Steam distillation of mixtures that are partly soluble in water involves entirely different and more complex principles similar to those of extractive distillation (*see* below). It has proved very useful in separating organic compounds with high and nearly identical boiling points, such as the ortho- and paranitrophenols.

Azeotropic and Extractive Distillations.—When separation by distillation is especially difficult, because the components of a mixture have almost identical volatilities, improvement can often be achieved by addition of a properly chosen new component. In some instances the choice is a substance which is soluble in the mixture to be distilled and which forms a constant boiling or azeotropic mixture with one or more of the original components. If the volatility of the azeotrope formed from the added component and one substance of the mixture is markedly different from the volatility of the other materials present, ordinary distillation will separate the azeotrope from the remaining components. A familiar example is the preparation of pure anhydrous ethyl alcohol by the addition of benzene to ethyl alcohol containing a small proportion of water. On distillation, an azeotropic mixture containing all the benzene and water passes over with a small amount of alcohol and leaves a residue of anhydrous alcohol. Azeotropic distillation is not practical if the component desired enters into the formation of the azeotrope and cannot easily be recovered from it.

Extractive distillation is a somewhat similar method. In this process a liquid which is relatively nonvolatile is added near the top of a fractionating column in order to increase the relative volatility of one of the original components and to allow it to distill in a comparatively pure state. Normal butane may thus be separated from 2-butene by addition of acetone, even though the normal volatilities of the hydrocarbons are nearly the same. This separation is of importance in producing raw materials for synthetic rubber and high-octane gasoline.

Distillation of Gases.—Gaseous mixtures may be distilled after liquefying them through use of high pressures or low temperatures or both. Once liquefaction is accomplished, distillation may be carried out as usual except that the apparatus must be such as to withstand the abnormal temperature or pressure. Oxygen, nitrogen, neon and the other rare gases are separated from air by liquefaction and distillation at low temperatures. Liquefied petroleum gases are separated and purified by distillation under pressure.

Distillation of Solids—Sublimation.—When solid substances are heated to give gaseous or liquid products, the operation is termed dry distillation. If the procedure involves a breakdown of complex materials into simpler substances (elementary or compound), the process is described as destructive distillation. (*See* Coal Tar; Tars, Low-Temperature.) Sublimation is a related process in which a solid distills to give a gas without the intervention of a liquid phase.

Analytical Distillation.—A mixture of substances of the same chemical class is often difficult to analyze by conventional chemical methods. Such a mixture may sometimes be analyzed by distillation. Sharp separation between components is essential. Analytical distillation has been most useful in studying the composition of petroleum.

Batch and Continuous Distillation.—In most of the previously described varieties of distillation, the material to be distilled (the charge) is introduced into the apparatus at one time before the start of the distillation, and distillate is removed at one point only. All such operations are referred to as batch distillations. In continuous distillation, the charge is introduced in a constant stream into the side of the column, where part of it descends with the reflux and the remainder is vaporized by the heated vapours rising from the still (fig. 8). The most volatile product is concentrated in the overhead product that is removed continuously at the top of the column and the least volatile similarly removed from the bottom. Intermediate fractions are sometimes withdrawn from various levels of the column through side streams. Continuous distillation is seldom used on a small scale, but it is of major importance in industrial operations, particularly in the manufacture of alcohols and petroleum products and in the technology of liquid air.

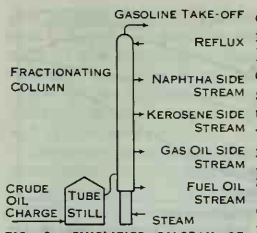


FIG. 8.—SIMPLIFIED DIAGRAM OF CONTINUOUS DISTILLATION

The portion of the column above the point at which the charge is introduced is called the enriching section, and the lower portion is the exhausting section

Distillation in Industry.—In addition to the last-mentioned substances, distillation in various forms is used in the processing or production of liquefied fuel gases, coal tar and its products, turpentine, glycerin, fatty acids and a host of other chemical and pharmaceutical products. These range from butadiene and styrene for synthetic rubber manufacture to formaldehyde, phenol, camphor, etc. The type of apparatus used varies with the nature of the mixture to be distilled, the product, the difficulty of the separations involved and the means of heating required or available. Equipment is identical in principle with laboratory equipment already described (*see* fig. 9). All varieties of construction materials are used, including particularly cast and wrought iron, copper, mild steel, stainless steel, nickel, monel and aluminum. Lead-lined stills, glass-lined stills, fused silica, glass, structural carbon and stoneware are used where special purity or resistance to corrosion is required.

Stills for batch distillation are usually cylindrical shells. In addition to an outlet to carry away vapours, a cylindrical still is often fitted with: (1) a bottom outlet and valve; (2) an agitator for stirring the charge to prevent local overheating; (3) a pressure or vacuum gauge; (4) an inlet and outlet for closed steam coil; (5) a tube reaching to the bottom to introduce live steam; (6) closed tubes to carry thermometers or thermocouples; (7) manholes for

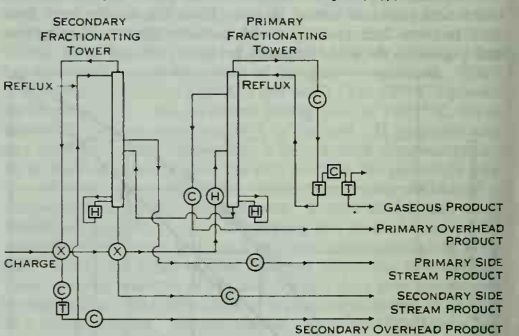


FIG. 9.—FLOW DIAGRAM FOR INDUSTRIAL CONTINUOUS DISTILLATION UNIT. KEY: C, COOLER OR CONDENSER; H, HEATER; X, HEAT EXCHANGER; T, TANK

charging or cleaning; (8) inspection ports; and (9) a safety valve. In many cases the still has a double bottom and double side walls, forming a jacket for circulation of heating fluid. Steam is most frequently used. It may be passed through the jacket or a coil (closed steam) or sent directly into the liquid to be distilled (open steam). The still may also be heated directly by an open fire of coal, coke, oil or gaseous fuel, but such direct methods have a tendency to local overheating and have been largely superseded. Indirect heating with steam is subject to closer control.

In continuous distillation, pipe stills are most used. The material to be heated is pumped rapidly and continuously through coils or pipes that pass through a furnace. The rapid flow inside the pipes allows higher temperatures and more rapid heating without damaging the pipes or decomposing the charge.

Many industrial distillation setups consist only of still, vapour line, condenser and receiver, because the liquid mixtures involved are easily separated. A growing number of installations equipped with fractionating towers have come into use. The more efficient towers are either packed or fitted with perforated plates or bubble plate arrangements (fig. 10) to give more intimate contact between descending reflux and ascending vapour. Perforated plate towers are particularly useful when the feed material contains solids, as in the distillation of alcohol from fermentation mash. The bubble plate design is by far the most widely used. Another device causes descending liquid to cascade over a weir, while rising vapour forces its way through the cascade.

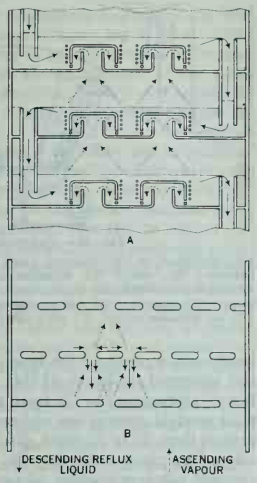


FIG. 10.—SECTIONAL DIAGRAMS ILLUSTRATING PLATE CONSTRUCTION AND INTERACTION OF LIQUID AND VAPOUR IN (A) BUBBLE PLATE COLUMN AND (B) PERFORATED PLATE COLUMN

Large industrial columns may have as many as 100 bubble plates, and diameters up to 32 ft. Two towers may be connected in series to obtain the desired number of plates. There is no theoretical limit to the number of plates, but practical difficulties usually restrict the number in any one unit.

Condensers may be open surface, tubular or worm. In the first type, cooling is effected by trickling water over a bank of tubes through which the vapour is passing. A tubular condenser consists of a group of parallel vapour tubes within a shell, through which cooling water flows. A worm condenser involves spiral vapour tubes. Proper choice and design of condensers depends upon rates of heat transfer from the condensing vapours to the cooling water, as well as knowledge of the probable condenser water temperatures and the quantity and character of the vapour to be liquefied.

The cost of distillation operations lies chiefly in the need for continual heat at the still and cooling at the condenser. The piping arrangements of large continuous units are often quite complex because of the economy of exchanging heat between hot materials leaving the process and cold materials entering it.

Distillation of Water.—Water free from dissolved salts is indispensable in many scientific and industrial operations. Laboratory stills consist of a boiler, fed by warm water from the condenser, and suitable devices for eliminating entrainment. The condenser and all receivers are usually of tin, or at least tin plated. Ordinary glass is not suitable for condensing or storing highest-purity water. Double distillation is frequently used to ensure removal of traces of impurities. The preparation of very pure water is a laboratory operation requiring the greatest care.

The problem of the economic production of potable water from sea water is very old. In 1683 Fitzgerald patented a process for the "sweetening of sea water." S. Hales (1739) gives a history of the earlier attempts in his book *Philosophical Experiments*. The modern plant consists of an evaporator, distiller and condenser. Condenser tubes may be oval, crescent shaped or indented. The latter are self-scaling. For shipboard use, emphasis is on compactness, whereas multiple-effect evaporators of high economy are favoured for use on land.

Compressive Distillation.—During World War II pure water was produced by compressive distillation characterized by very high fuel economy (175 lb. distillate per 1 lb. of fuel). The steam from boiling sea water is slightly compressed and circulated through a coil in the still. The compression raises the temperatures of the steam sufficiently to allow it to maintain the charge of sea water at its boiling point. The temperature loss to the still cools the steam and condenses it to distilled water. No separate condenser or cooling water is required. The principle is applicable to distillation of substances other than water. (A. RE.)

MOLECULAR DISTILLATION

When the high-vacuum still is constructed so as to impose no hindrance to the passage of vapour from evaporator to condenser, a device known as the molecular still is achieved. Distillation occurs in this still at the lowest temperatures believed possible. Unstable substances which can be purified by no other means of distillation can often be treated without harm in the molecular still. The apparatus takes many forms but the simplest, which typifies the action of all the others, is little more than a flat vessel, like two saucers sealed together, which is held under high vacuum. The material to be distilled is heated in the lower saucer and the vapour condenses on the upper, cooled saucer. The saucer arrangement and two practical molecular pot stills for laboratory use are shown in fig. 11.

The names of many inventors are associated with the origins of molecular distillation. The first record of a truly molecular apparatus, where the evaporating and condensing surfaces were separated by a distance less than the free path of most of the vaporized molecules, is the mercury still of J. N. Brönsted and G. von Hevesy (*Phil. Mag.*, 1922). The first truly molecular still for the separation of heavy organic substances was described by C. R. Burch (*Nature*, 1928). Early molecular distillations were performed by H. I. Waterman (1929) in the Netherlands, by E. W. Washburn at the bureau of standards in Washington, D.C. (1929), and by K. C. D. Hickman (1929) in Rochester, N.Y. The potentially immense value of molecular distillation in processing of

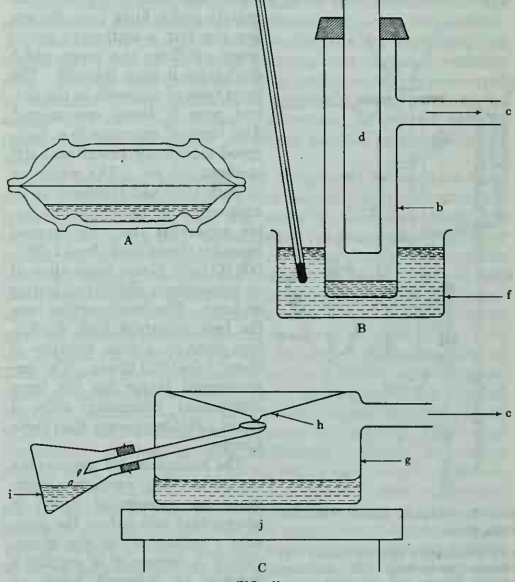


FIG. 11

(A) Pair of saucers; (B) micropot still: (b) body of still, (c) vacuum pump connection, (d) condenser, (f) oil bath; (C) one-piece pot still: (g) body of still, (h) re-entrant surface serving as condenser, (i) distillate receiver, (j) hot plate for heating

natural oils, fats and waxes which could not be distilled by any other known means was pointed out by Burch and was echoed and implemented by other workers. The three categories of distillands (materials to be distilled)—heavy oils, glyceride fats and natural waxes—accommodate production amounting to more than 5,000,000,000 lb. annually in North America, but of this enormous quantity, commercial molecular stills handled only little more than 0.1% in the early 1960s; the capacity, however, was expanding rapidly.

The vacuum required for molecular distillation ranges from one to ten one-millionths of an atmosphere which is equal to a pressure of residual air of .00075–.0075 mm. mercury, or ¾ to 7½ microns (one micron = 1μ = .001 mm. mercury). Small laboratory stills operate at pressures as low as one-half micron, but not nearly so low as pressures erroneously recorded in the literature. Commercial stills operate at about three microns, the advantages of lower pressures being offset by the higher cost of pumping.

The time factor is very important in molecular distillation since the degree of destruction of labile substances is proportional to the duration of exposure in the hot still. All kinds of devices have been explored to reduce the time to the minimum. Early stills exposed the distilland in shallow trays. Then came the falling-film still, where the distilland is allowed to tumble down a heated surface contained within an evacuated condenser. The evaporator is generally a vertical polished metal tube heated by electricity; the condenser a large glass tube or bell jar which surrounds and encloses the evaporator.

Individual stills 1½ ft. wide and 6 ft. high have been used in industry. Smaller cyclic batch falling-film stills, constructed chiefly of glass, are in use in research laboratories for the multiple recycling and distillation of natural oils. A diagram is shown in fig. 12.

Industrially, the falling-film still has been superseded by the centrifugal evaporator. The distilland, generally a natural oil, is fed onto the centre of a rapidly rotating metal cone which is warmed on the outside by an electrical radiant heater. The entire assembly is housed within a tank which is maintained under high vacuum by a train of fast pumps (fig. 13). The oil climbs up the inside of the cone under a centrifugal force of 10–100 times gravity and is flung from the upper rim into a stationary gutter whence it flows to a pump which discharges it from the still. The total time of exposure in the hottest zone is about one second. The time of exposure in a high-speed laboratory centrifugal still is about .02 sec. The reduction in both time and temperature of exposure is so drastic in the latter apparatus that the thermal hazard is diminished about 1,000,000,000,000 times from that of an atmospheric distillation lasting an hour. The improvement over the best industrial flash distillation done at 1 mm. mercury is about 1,000,000 times. The improvement factor for the large commercial molecular stills is about 100 times poorer than these figures.

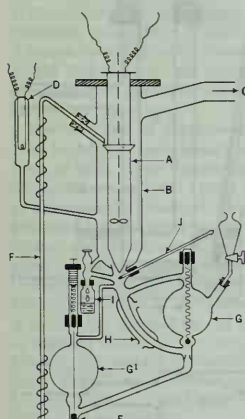


FIG. 12.—CYCLIC BATCH FALLING-FILM STILL

(A) Evaporator; (B) condenser; (C) vacuum connection; (D) electrical vacuum gauge; (E) magnetic pump; (F) preheating tube; (G) upper reservoir; (G¹) lower reservoir; (H) cooling labyrinth; (I) distillate receiver; (J) thermometer

The molecular still requires the service of fast vacuum pumps. Since no economical pump is known that will reduce the pressure a millionfold in one operation, it is necessary to employ a number of different kinds of pumps in series. The fastest pump, operating at the lowest pressure, is always an oil-vapour

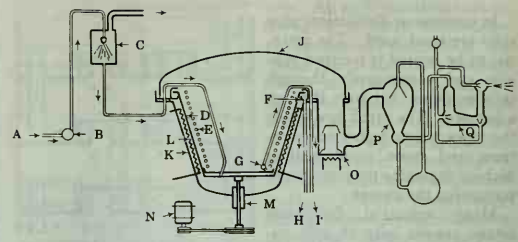


FIG. 13.—CENTRIFUGAL EVAPORATOR

(A) Distilland, in (B) metering pump for incoming distilland; (C) degassing chamber; (D) rotor; (E) condenser coils; (F) distilland collecting gutter; (G) distillate withdrawal pump; (H) distilland, out; (I) distillate, out; (J) dome; (K) housing; (L) heater elements; (M) bearing housing; (N) motor; (O) oil diffusion pump; (P) oil booster pump; (Q) steam ejector pumps

condensation pump of the type invented by I. Langmuir (1916) and improved by Burch (1928). It may have self-conditioning features introduced by Hickman (1936). The condensation pump pulls residual gases at one to five microns from the still and compresses them 10 to 20 times, discharging them at .075 to .15 mm. into a fore pump which may be, variously, a large oil-sealed mechanical pump or another oil-vapour booster pump. This latter then discharges into a mechanical pump or steam ejectors.

Uses of the Molecular Still.—The falling-film still found commercial use on a small scale in 1935 for the distillation of vitamin A alcohol prepared by the saponification of fish livers. The apparatus came into extended use in 1937 for distilling vitamin A esters from dogfish-liver oils and shark-liver oils. Centrifugal stills were introduced in 1941 and these continued to produce the majority of vitamin A concentrates in North America. The large-scale processing of vegetable oils commenced in 1945. This had the curious effect of displacing the synthetic vitamin E of pharmacy by mixtures of natural tocopherols, chiefly the α and γ homologues.

Mono- and diglycerides of fatty acids distilled from industrial mixtures came into large supply in 1949. They are used extensively in the baking and cosmetic industries.

The application of molecular distillation to heavy chemicals, plasticizers and petroleum residues lagged somewhat, though the use in these fields is extending. The laboratory molecular still has become a routine step in the analysis of natural products for vitamin E, and for the separation of oils, waxes, sterols and hormones. *See* also references under "Distillation" in the Index volume. (K. C. D. H.)

BIBLIOGRAPHY.—Laboratory distillation is discussed in all books on practical organic chemistry, and its theory in treatises on physical chemistry and chemical engineering. *See* A. A. Morton, *Laboratory Technique in Organic Chemistry* (1938); C. C. Ward, "Review of the Literature on the Construction, Testing, and Operation of Laboratory Fractionating Columns," U.S. Bureau of Mines *Technical Paper 600* (1939). C. S. Robinson and E. R. Gilliland, *Elements of Fractional Distillation*, 4th ed. (1950), takes up the application of the principles to the problems of industrial design and operation. The standard older text is S. Young *et al.*, *Distillation Principles and Processes* (1922). Section 23 of vol. 2, pp. 1543–1670, of *The Science of Petroleum* (1938) is devoted to a discussion of distillation. Descriptions of industrial procedures and equipment can be found in the technological literature of particular substances.

For further information on molecular stills *see* K. C. D. Hickman, "High-Vacuum Short-Path Distillation—A Review," *Chem. Rev.*, 34:51 (1944). (A. RE.)

DISTRESS, at common law, is the process whereby a person, without any prior legal process, seizes and detains from a wrongdoer some chattel or item of personal property as a pledge for the redressing of an injury, the performance of a duty or the satisfaction of a demand. Distress also signifies the property distrained.

England.—The main cases in which distress can be levied are: (1) the nonpayment of rent due under a tenancy or rentcharge; (2) trespass and damage by cattle or other chattels (distress damage feasant); (3) the nonpayment of local rates, taxes or certain fines. Initially the right was a mere passive right to detain the

goods distrained until payment or recompense was made, and this is still the case with distress damage feasant; but in most other cases statute has conferred a power to sell the goods and to pay the sum due and the expenses out of the proceeds of the sale. Distress for rates, taxes and fines is subject in each case to special statutory provisions which make it more akin to the process of execution than to distress for rent.

The law of distress for rent is highly technical, and in practice distress is nearly always levied by certificated bailiffs experienced in this law, acting under a warrant of distress signed by the landlord. *Prima facie*, all goods found on the land in question may be distrained, irrespective of ownership, but this is subject to many qualifications. Certain goods are absolutely privileged from distress, such as goods entitled to crown or diplomatic immunity, goods delivered to be repaired or worked on in the way of some public trade, goods in actual use, perishable goods, the apparel and bedding of the tenant and his family and his tools of trade to a total value of £20, and various gas, water and electricity fittings. Other goods are conditionally privileged, so that they may be distrained only if there is no other sufficient distress on the premises. This heading includes beasts of the plow, sheep and tools of a trade or profession. Further, by the Law of Distress Amendment act, 1908, undertenants and lodgers may protect their goods from a distress levied on the tenant by claiming their goods and undertaking to pay their rent to the landlord. In some cases, no distress can be levied without the permission of the court; *e.g.*, where the tenancy is protected by the Rent acts, where the tenant is in the armed forces (in some cases) and where the tenant is a company being wound up by the court.

Distress may be levied as soon as the rent is overdue. It cannot be levied for rent that is more than six years overdue (or one year in the case of an agricultural holding); and, if the tenant is bankrupt, distress is limited to six months' rent accrued prior to his adjudication. No distress may be levied at night or on a Sunday. The premises may be entered in any way short of breaking into them; but, once in, the bailiff may break an inner door in search of distress. Goods are distrained by seizing them, either actually or constructively, and then impounding them for safe custody, usually on the premises. The landlord may not use any goods or cattle impounded, except for their own benefit (as *e.g.*, by milking cows); and he must not only select a suitable pound (as by putting furniture under cover) but also feed and water any cattle impounded. If more goods are seized than are reasonably necessary to satisfy the arrears of rent and costs of distress, an action for damages for excessive distress will lie. However, if the tenant fraudulently or clandestinely removes goods from the premises to avoid distress, he is liable to forfeit to the landlord double the value of such goods, as is any person knowingly aiding him. The landlord can also sue for treble damages if any person is guilty of rescue (*i.e.*, the taking of goods distrained but not impounded) or of pound-breach (*i.e.*, the taking of goods impounded); and pound-breach is a misdemeanour.

No distress can be sold until five days have elapsed after the levy of distress and notice thereof to the tenant; and this may be extended to 15 days if the tenant so requests in writing and gives security for the additional costs. At any time before sale the tenant can replevy the goods; *i.e.*, recover them by paying all that is due, with costs. Subject to this, the goods may be sold for the best price obtainable, usually (though not necessarily) by auction (*q.v.*). Any surplus will be paid to the tenant, but if there is a deficiency the landlord usually cannot levy a second distress unless the deficiency was no fault of his. (R. E. My.)

United States.—In the United States the right of distress, where recognized, includes the power (first conferred in England by statute enacted in 1690) to sell chattels seized in exercise of the right. Because it affords an opportunity for injustice and discriminates in favour of one particular class of creditors, however, this form of self-help has not been favoured in this country. In some states the courts have refused to recognize the remedy of distress as part of the common law of the particular jurisdiction; in other states it has been abolished by statute. Where the remedy remains, it generally has been modified so as to do away with the self-help features by vesting enforcement in a public official, to restrict the right to goods of the tenant himself located on the premises and exempt items which were not exempt at common law, and to limit the length of the period for which a claim for overdue rent may be enforced by this process.

See also Landlord and Tenant. (H. H. Lr.)

DISTRIBUTION. In economics the term distribution generally refers to (1) explanations of how prices for the services of productive resources are determined; (2) how the total product of an economy is divided among the various productive resources (frequently termed functional distribution); or (3) a description of the number of income-receiving units in each of various income classes (usually called personal distribution). Since the term is a generic one, it also has been used to describe the processes by which various commodities are made readily available for purchase by consumers (*see* Marketing) as well as the geographic placement of a working force, the occupational distribution of workers according to age and sex and the geographic distribution of capital.

How Resource Prices Are Determined.—Most economists accept the theory that the price for the service of a resource (a particular kind of labour, a given grade of land in a particular location or a capital agent, such as one kind of machine) is determined, as is the price of a commodity, by supply and demand (*see* Supply and Demand). The quantities of the service of a resource that a user (buyer) will take from the market will be inversely related to the prices that he might pay; the quantities that will be offered to him by sellers will be directly related to the prices at which they might sell. Unless the market "clears" (*i.e.*, unless the quantity demanded by buyers is equal to the quantity that will be provided by sellers) the price will adjust. If buyers and sellers respond to price changes in the manner described above, the price will move upward if demand exceeds supply and downward if supply exceeds demand. The equilibrium price—the price that would prevail unchanged if it were the initial price and there were no change in the behaviour of buyers and sellers—can be only the price at which the quantity supplied and the quantity demanded are equal. The market price is, on the average, an equilibrium price according to this explanation.

Equilibrium prices for the services of resources are thus explained in the same manner as equilibrium prices for commodities. A single general theory of price is adequate for explaining the equilibrium price of all things entering into exchange, whether they are things used in production or things ultimately purchased by consumers. Any modifications made in this general theory to explain how particular resource prices are determined are the result of demand or supply conditions peculiar to the particular market.

It has long been recognized that the demand for resource services is a derived demand; *i.e.*, that the user desires to purchase these services because they are useful in producing goods and services that he can sell. Consequently the demand for a resource service will reflect the desires of customers for the commodities produced with this service and the physical productivity of the technology employed in transforming these services into final products. Since the physical productivity of a service also may depend upon the amounts of other services employed with it in production, the demand for any resource will be related to the amounts of other resources used and generally will vary directly with the quantities of these other services. Thus, an increase in the demand for wheat increases the demand for land that can be used in wheat production; improvements in technology that increase the physical productivity of labour increase the demand for labour; and events such as wars, which destroy capital, reduce the demand for labour.

Any buyer of a resource service is assumed to purchase a quantity of that service that is at least as profitable as any other that he might use. It follows from this assumption that an employer will not employ an additional unit of a resource unless the amount added to his gross receipts as a result of such action is expected to equal or exceed the amount added to his total costs. Nor would he reduce the amount of a service employed if he expected this action to reduce his receipts by more than his costs. Thus, for each price of the service of the resource there is a most profitable

amount of this service for each user to purchase. If one were to add together these amounts for all of the users at each price, the resulting relation between the prices and the most profitable quantities would describe the demand for this service for the economy (the world, the nation, the state or whatever the geographic area for which the users are enumerated).

That this demand for a resource service will be a relation in which the amount demanded varies inversely with the price follows from two considerations. (1) Physical production relationships are assumed to conform to the law of diminishing returns. This implies that the rate of change in physical output with respect to a change in the amount of one resource service employed diminishes as the quantity of this service used is increased, the amounts of the services of other resources used remaining fixed. Economists also term this phenomenon "diminishing marginal physical productivity." With constant product prices, this characteristic would assure that the value added by each successive increment of a resource would diminish and that lower resource prices would be required to make higher levels of employment the most profitable ones. (2) A product price is assumed to decrease as the amount of the product placed upon the market is increased. Even if diminishing marginal productivity was not characteristic of the technology, this product price-quantity relation could result in a resource price-quantity relation of the kind assumed.

Supplies of resource services are determined by the actions of resource owners. Each owner is assumed to sell to the buyers offering him the most attractive terms, including not only money rates of compensation but also such features as working conditions. The larger the quantity of a service that any user wishes to purchase, the higher the price he must pay. This relationship between the price and the quantity supplied to any user follows from two kinds of considerations.

First, if the total quantity of a resource is fixed and there are a number of possible uses for the services of this resource, a user generally can increase the amounts that will be made available to him only by bidding the services away from other users. For given market and technological conditions of production, the terms that other users offer increase in attractiveness as the quantities which they use become smaller. This follows from the assumptions of diminishing marginal physical productivity and the inverse relation between product price and quantity offered for sale. The demands of other users determine the supplies available at various terms to a particular user. Imagine, for example, that there were a given number of workers available for employment in two industries, farming and mining. As more and more workers are employed in mining, and thus are removed from farming, labour becomes more valuable in agriculture. Farm managers would find it advantageous to offer higher wages to farm workers. Similarly, a larger number of workers employed in farming (and a smaller number employed in mining) would increase the prices that mine operators would find it profitable to pay for labour.

Second, if the quantity of a service supplied can be altered by resource owners, more favourable terms are required in order to obtain a larger over-all supply. For example, if there were no unemployment, and employers were to induce an expansion in the size of the U.S. labour force, both older and younger workers and additional females in the same age groups as those now employed would have to be drawn into the market. Unless such persons are prevented from entering into employment at existing wage rates, higher wages would be required to expand the number of workers supplied.

It should be noted that the supply of labour may not be such as to conform to the kind of relationship between price (wage rate) and quantity described above. The alternative to working for income to exchange for commodities is leisure—including producing for one's own consumption. Because higher wage rates can make workers richer as well as make the price of leisure higher, and more leisure is desired as wealth increases, the result of a wage increase may be less labour supplied. Although this possibility appears unlikely, existing empirical studies have not been sufficiently complete to assure that it is not the case.

The division of resource use and the pattern of prices will be altered by such factors as technological change, population change, increased capital and alterations in consumers' preferences for various commodities. For example, it has been estimated that if the future conformed to past experience, technological improvement combined with an increased ratio of capital to labour in the United States would nearly double the real wage rate (before taxes) in a period of about 30 years if the number of workers were to remain unchanged. It would also increase the ratio of wage rates to returns on capital.

An increase in the employed labour force from, say, 65,000,000 to 75,000,000—with no change in the amount of capital or in technology—would cut the real wage rate (before taxes) by about 7% and reduce the ratio of wage rates to returns on capital. Increases in demands for goods requiring relatively large ratios of capital to labour probably would reduce the ratio of wage rates to returns on capital if the total supplies of capital and labour were constants.

The explanation sketched above of how resource prices are determined usually is referred to as the marginal-productivity theory. It is an extension of certain features of the rent theory of David Ricardo (*q.v.*) but was developed independently by English economists of the neoclassical school and by John Bates Clark (*q.v.*), a U.S. economist, during the last part of the 19th century and early part of the 20th. In the early stages of formulation of this theory the demand for resource services was overstressed in explaining resource-price determination; the forces of supply were frequently ignored or the quantity of the resource made available assumed to be fixed. The theory outlined above came to be widely accepted among professional economists because, with the appropriate empirical estimates, it is believed to yield the best predictions and because it is a special case of the general theory of price determination.

However, this theory has been criticized on two counts: (1) its reliance upon the assumption of rationality among resource users and sellers; and (2) its necessity for explaining observed differences in prices for a particular service in different uses as being due to nonobservable factors. Rationality among resource users is incorporated into the theory in the form of the assumption that profit maximization is the determinant of users' actions in deciding how much of a resource to employ at various prices. If users do not make choices in accordance with profitabilities, the magnitudes of changes predicted by the theory would be in error, but the direction of the change could be correct providing that choices are made systematically rather than at random. For example, pricing products so that the price is always a given percentage of cost would not necessarily be pricing in a manner which would be most profitable. But a change in technology, product demands or resource supplies would still induce producers to alter the direction of resource use in the same manner as if they were choosing in order to maximize profit.

Rationality among resource sellers is defined as choosing to sell where terms are most favourable. Whether this assumption is realistic is extremely difficult to determine.

The theory would explain such phenomena as higher wages for a particular kind of labour employed in one industry or one locality rather than another as being attributable to differences in nonwage factors, which are frequently nonobservable. The theory thus may be tautological with respect to explanations of such differences. However, such differences also may be the result of the fact that technological conditions of production permit an indeterminacy of resource prices within certain limits.

Where market or production conditions are such that equilibrium is compatible with a range of different prices, bargaining positions of buyers and sellers have been introduced to explain how a particular price might be established. Economists of the "institutional" school—a group which exerted considerable influence upon economic thought during the first quarter of the 20th century—have been interpreted to argue that these indeterminacies were so important that the bargaining aspects of such problems as wage determination far outweighed those aspects that lent themselves to conventional analysis of supply and demand. Thus it was believed that wage rates could be varied within rather wide limits

without affecting employment and that, since labourers' bargaining positions were inferior to those of employers, strong trade unions were desirable to raise wages without adverse effects upon the allocation of resources.

Bargaining is recognized as a feature of actual price determination under certain conditions. However, general theories of bargaining—including those derived from modern game theory—have not contributed significantly to more accurate predictions of the outcome of most pricing situations.

Functional Distribution of Income.—The functional distribution of income is a description of how the total income of an economy is divided among the various resources; *e.g.*, the amount of total wages, total rent and total interest and profits. Since the total return to any resource is by definition the price paid per unit of service derived from this resource, multiplied by the number of units of such service rendered during any time period, determining the amount of income that will accrue to the owners of any resource requires knowing how much service has been used during a particular time as well as the price. The measurements of the amounts of some resource services employed, particularly those of capital agents, have been relatively crude. Also, considering broad aggregates, such as all labour or all capital, may obscure important differences in the working forces and capital structures among countries at a particular time and within a country over time.

However, estimates of the shares of income distributed to the various classes of resources in the United States and some countries in western Europe during the 20th century indicate that from three-fifths to two-thirds of national income typically goes to labour, the remaining two-fifths to one-third being divided among capital agents, including land. Explaining the shares is an important theoretical problem and also offers opportunities to test theories of how resource prices are determined. Real-wage rates of employed workers normally rise during periods of unemployment. Insofar as unemployment of labour is accompanied by a fall in the labour-capital ratio, this increased real-wage rate is consistent with the general features of the technology and employer behaviour postulated in the theory of resource-price determination described above. However, for the shares of income to be constant within a given economy over time requires that the technology always be such that changing the employment of all resources by a given percentage changes national income by this same percentage. For the shares to be approximately the same in each of several countries requires that the technologies among countries all have this property and differ only by a scale factor; *e.g.*, that both labour and capital in one country be twice as productive or two-thirds as productive as in the other.

Personal Distribution.—The income of any person depends upon quantities of various resources that he owns and the prices paid for the services of these resources. Hence, how resource prices are determined is an integral part of an explanation of how the pattern of individual incomes are determined. Activities directed at changing particular commodity prices—through tariffs, internal excise taxes and government purchase programs, for example—reflect awareness of a relationship between resource prices and product prices of the kind described previously. In addition to the patterns of resource ownership and resource prices, the expenditure and tax patterns of government also must be considered in explaining the distribution of income among persons. The larger the share of national income transferred by or originating in governmental activities, the more important the role of government as a force altering the pattern of income distribution.

Prior to government reliance upon collections from income taxes and widespread social security programs, differences in personal incomes reflected differences in the amounts of various resources owned by different individuals as well as differences in resource prices. There were substantial differences in income among individuals whose primary source was wages (including income from professions). These differences reflected inherent variations in individual skills and variations resulting from differences in training. Very large nonproperty incomes were received primarily by a few business executives and motion-picture actors, etc. Nearly half the income of those persons in the moderate income brackets was professional income. The percentage of total income made up by income from property (various forms of capital) increased as income increased, although a number of persons in the lowest income brackets received all their income from property.

It is generally believed that a strong relationship exists between the size of nonproperty income and the skill of the income recipient. However, chance factors also are of importance. Poor forecasts of future demands for certain skills can make large investments in training result in unusually small returns in income. Discrimination according to race or sex results in some jobs not being effectively open to women or Negroes and to lower incomes than otherwise would be the case for members of these groups with certain skills.

Preferences for employing one's resources in an occupation yielding a lower income than another are important in explaining why some individuals with particular skills receive less income than others with the same skills. Preferences for white-collar jobs have resulted in incomes from such jobs generally ranging below those in manufacturing. To some extent the relative slowness of migration from agriculture to higher-paying industrial opportunities reflects a preference for agricultural employment. Institutional impediments to entry into particular occupations also result in income differentials among persons with comparable skills.

Chance, together with preferences for taking risks, also plays an important role in determining the distribution of property income. Individuals with identical attitudes toward risk taking, identical initial resource endowments and comparable forecasting abilities may experience different income patterns because of chance factors. Technological discoveries and changes in tastes contain relatively large random components that make choosing an investment activity similar to participating in a fair gambling game. However, differences in attitudes toward risk taking are also of importance. It can be demonstrated that from a given group of individuals with equal initial stakes but different preferences for risk taking, there will emerge a distribution of property (and hence property income) with a greater dispersion among individuals than would be the case if all had identical preferences. A larger percentage of those preferring to assume risks will emerge richer or poorer than those who prefer less risky opportunities.

Inflation (depreciation in the value of money) has been of importance in redistributing wealth and income. Since it reduces the value of cash balances and both the value and burden of commitments made in terms of money, inflation has favoured those persons who held their wealth in forms other than money or claims to it and those who were debtors. Persons who held money or claims that were fixed in money terms have been losers. The wars of the late 19th and 20th centuries together with the expansion in demand for governmental services unaccompanied by an equal expansion in the willingness to pay taxes have been important factors in redistributing income among individuals in a way that probably would not have been sanctioned if its impact were widely understood. In particular, inflation probably has tended to make the poor worse off and the rich somewhat better off insofar as the ability to incur financial liabilities has been directly related to wealth position.

The increased importance of government—particularly the rise of personal-income taxation combined with increased levels of direct governmental payments to individuals and increased governmental services to persons—has diminished the role played by ownership patterns and prices in determining the distribution of income. In the United States the average person with a low income pays a smaller percentage of his income in taxes than does the average person with a high income, although there is considerable variation among individuals within any income-size class. To complete the picture, however, it is necessary to estimate the allocation of the benefits of governmental expenditures among individuals in the various income groups.

An estimate that generally would be considered to be accurate is extremely difficult to make because governmental services are difficult to value and because their distribution among persons would be very costly to determine. In national-income accounting

commodities are valued according to the prices received for them. Thus, if commodity A has a price twice that of commodity B, each unit of commodity A is considered to be worth two units of commodity B. Most governmental services have no prices. They are valued at cost. Consequently, if two units of government are producing identical amounts of a given service and one unit produces at twice the cost of the other, the value of the one's services is said to be twice that of the other's. This convention cannot be accepted in accurately evaluating governmental services.

Even though the value of governmental services could be determined, estimates of the distribution among persons must be somewhat arbitrary. As a first approximation some research workers have attempted to classify governmental services according to whether they were to persons or to property. Services to persons are assumed to be shared equally among the individuals in a particular governmental unit whereas services to property are allocated proportionately to the wealth positions of individuals. Estimates of the benefits from state and local governmental expenditures for a few states and the local governments within them in the U.S. suggest that the ratio of such benefits to income is considerably larger for income-receiving units with low incomes than for those with high ones. However, characteristics such as age and size of family also are important in determining the distribution of benefits so that there is considerable variation among units within any income class. Applying this estimation procedure in allocating the services of the federal government yields less reliable estimates since large elements of federal expenditure, particularly that for defense, cannot readily be divided between persons and property.

Comparisons of the distribution of income at different times in the U.S. generally indicate that it is becoming more equalitarian. In particular the percentage of persons with persistently low incomes has been steadily declining. On the other hand, for the world as a whole, the distribution probably is becoming less equalitarian. National-income growth rates in countries with the highest incomes generally have been exceeding those in countries with the lowest incomes whereas population growth rates among many low-income countries have been exceeding those in high-income countries. Within many of the low-income nations inflation has made for greater inequality than otherwise would exist. *See* also PRICE; SUPPLY AND DEMAND; WEALTH AND INCOME.

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(O. H. B.)

DISTRIBUTIVE LAW, in algebra, is the law which asserts that the result of first adding several numbers and then multiplying the sum by another number is the same as the result of first multiplying each of the several numbers separately by the other number and then adding the products. In symbols it is expressed by $a(b + c + d) = ab + ac + ad$, one of two factors (a) being distributed among the parts $(b, c$ and $d)$ of the other factor $(b + c + d)$. For example, $2(5 + 3) = 2 \times 8 = 16$; and $2 \times 5 + 2 \times 3 = 10 + 6 = 16$. The law is equally valid for negative, fractional, irrational and complex numbers.

See ALGEBRA; ALGEBRAIC GEOMETRY; ARITHMETIC; FIELDS; LATTICE THEORY: *Distributive Law.*

DISTRICT OF COLUMBIA: *see* WASHINGTON, D.C.

DISTRITO FEDERAL, MÉXICO: *see* MEXICO, FEDERAL DISTRICT OF.

DISTURBING THE PEACE (BREACH OF THE PEACE) is a legal phrase which has three distinct meanings. In its broadest sense, the term is synonymous with crime itself and means any indictable offense. In another and more common sense, however, the phrase includes only those crimes which are punished primarily because of their disrupting effect upon the peace and security of the community. Among these offenses are affray, unlawful assembly, rout and riot, libel, forcible entry and detainer, disturbance of public assemblies, keeping a disorderly house and malicious mischief. In its third and narrowest meaning, the phrase is confined to willful conduct which does not fall within the definition of any other specific crime but which unreasonably disrupts the public tranquillity or has a strong tendency to cause a disturbance thereof. At common law and under many statutes, such a disturbance or breach of the peace is punishable as a misdemeanour. *See* also MISDEMEANOUR.

(C. R. SE.)

DITHMARSCHEN, an area on the west coast of the Jutland peninsula between the Eider and Elbe rivers, now in the *Land* of Schleswig-Holstein, Federal Republic of Germany, but down to 1866 a semi-independent territory under the king of Denmark. First mentioned in the 9th century in connection with the church at Meldorf, Dithmarschen was then one of the three Saxon *Gaue* (districts) north of the Elbe. Till 1140 it was a part of the countship of the Lower Elbe and developed a system of parishes. In 1144 the count was killed in a popular rising, and after a dispute between the duke of Saxony and the archbishop of Bremen Dithmarschen passed to the latter. Nevertheless from the mid-13th century onward, the increasingly prosperous peasantry was able to assert its effective independence from Bremen. The archbishop's bailiffs became absorbed into the peasant society and the communities leagued together while the Hanseatic towns, interested in Dithmarschen's harbours and therefore opposed both to the archbishop and to the count of Holstein, assisted the peasants' pretensions. In 1283 the peasants concluded a defensive alliance with the count, even if the aggressor should be the archbishop. In 1319 an attempt of Count Gerhard III of Holstein to conquer Dithmarschen failed, and in 1404 another Holstein attack was repulsed.

Dithmarschen had favourable frontiers: the sea, rivers and marshes. In 1434 the federated parishes created a central judiciary which developed into an administration by 48 regents, and in 1447 the customary laws were codified. In 1473 the Holy Roman emperor Frederick III enfeoffed Christian I of Denmark with Dithmarschen, but the Danish kings' attempts to make good this grant ended in the humiliating defeat of John at Hemmingstedt (Feb. 1500). However, despite increasing prosperity, the province lost political significance, and in June 1559 its forces were defeated near Heide by those of Frederick II of Denmark. In 1580 the province was divided into royal South Dithmarschen and ducal (Gottorp) North Dithmarschen; these districts remained even when in 1773 the whole territory fell to the king of Denmark. In 1867 Dithmarschen, together with Schleswig and Holstein, became Prussian. The district retains political peculiarities in its highly developed parish system and in the relative absence of class divisions.

(A. KA.)

DITHYRAMBIC POETRY, a type of poetry described in the Oxford English dictionary as "resembling a dithyramb in irregularity of style; wild, vehement, boisterous." In the 7th century B.C. the dithyramb (etymology unknown) was an improvised song in honour of the god Dionysus, sung by banqueters under the leadership of a man "wit-stricken by the thunderbolt of wine" (Archilochus); it was contrasted with the more sober paean, sung in honour of Apollo. The dithyramb is said to have attained literary respectability about 600 B.C., when, according to Herodotus, the poet Arion composed works of this type, gave them names and formally "produced" them at Corinth. None of Arion's dithyrambs survives; but they may have been narrative lyric poems similar to those composed by his younger contemporary, Stesichorus of Himera. By the end of the 6th century B.C. the dithyramb was a fully recognized literary genre; its most famous composer was Lasus of Hermione, who is said to have been one of Pindar's teachers. The great age of the dithyramb was also the great age of Greek choral lyric poetry in general; Simonides, Pindar and Bacchylides all composed dithyrambs. Of Simonides' and Pindar's dithyrambs little is known; but two of Bacchylides' are complete (xvii and xviii) and there are considerable fragments of several others. In these there is no suggestion of the origins of the dithyramb (xvii, indeed, should strictly have been classified as a paean); the metrical schemes, language and narrative style are closely comparable with those which are known from other choral lyrics of the great period, and only a casual remark by the comic poet Cratinus, "There is no dithyramb when you drink water," shows that the old-style dithyramb still survived in the 5th century.

Bacchylides xviii is peculiar in that it consists of a dialogue between a chorus and a soloist, and this attempt to increase the dramatic interest of the narrative may help to explain why the classical dithyramb had to give way before the more vivid methods of tragedy. In any case, from about 450 B.C. onward dithyrambic poets employed ever more startling devices of language and music, until for ancient literary critics "dithyrambic" acquired the senses "turgid" and "bombastic." True dithyrambs are rare in modern literature; the resemblance between (for example) Dryden's *Alexander's Feast* and a Bacchylidean dithyramb, or between William McGonagall's compositions and what is known of 4th-century dithyramb, is only coincidence. The nearest modern parallel for the nonliterary dithyramb, such as is referred to by Archilochus and Cratinus, would appear to be the calypso.

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DITTERSDORF, KARL DITTERS VON (1739–1799), Austrian violinist and composer of instrumental music and light operas which established the form of the *Singspiel,* was born in Vienna on Nov. 2, 1739. He was a brilliant child violinist, and was engaged at the age of 12 in the orchestra of Prince von Sachsen-Hildburghausen. Later he played in the orchestra of the Vienna opera and became friendly with Gluck, whom he accompanied in 1763 to Bologna; his violin playing brought him considerable celebrity in that city. In 1765 he became director of the orchestra of the bishop of Grosswardein (Oradea) in Hungary. He set up a private stage in the episcopal palace and wrote for it his first opera, *Amore in musica.* His first oratorio, *Isacco,* was also written during this time. Not unexpectedly, performances of light opera by the bishop's company, even on fast days and during Advent, caused a scandal; the empress Maria Theresa censured the bishop, who dismissed his orchestra in 1769.

The following year Ditters was again in the service of an ecclesiastical patron, Count Schaffgotsch, prince-bishop of Breslau, at Johannisberg, Silesia. There he composed 11 comic operas, among them *Il Viaggiatore americano* (1770), and an oratorio, *Davidde penitente* (1770). In 1773, ennobled under the name Ditters von Dittersdorf, he produced the oratorio *Esther* in Vienna. After the peace of Teschen (1779) he again became music director for the prince-bishop of Breslau, who had reconstituted his orchestra. About this time he formed a close friendship with Haydn, who introduced his operas to Esterhazy, and from 1783 he played in string quartets in Vienna with Mozart. From this period onward his output was enormous. He produced the oratorio *Giobbe* (1786) and several operas, three of which, *Doktor und Apotheker* (1786), *Hieronymus Knicker* (1787) and *Das rote Käppchen* (1788), had great success. *Doktor und Apotheker,* in particular, became one of the classic examples of the German *Singspiel.* He also wrote a large quantity of instrumental music. In 1796, following the bishop's death, he was dismissed with a small pension. Poor and broken in health, he accepted a post with Baron Ignaz von Stillfried at Schloss Rothlhotta, Neuhof, Bohemia, where he died on Oct. 24, 1799. On his deathbed he dictated his autobiography which, although naïve in concept, is of great interest to students of 18th-century music.

Dittersdorf was one of the earliest composers of the Viennese classical school. His work is uneven but at its best displays true Viennese gaiety. His symphonies, although overshadowed by those of Haydn, are often of great interest, especially those of a programmatic nature, such as the six surviving symphonies on Ovid's *Metamorphoses.* His violin concertos are worthy of study, and several of his string quartets, although lacking the depth of Haydn or the graciousness of Boccherini, have their own personality. His partitas for wind instruments are notable for the formidable nature of the horn parts. As an opera composer Dittersdorf is chiefly remembered for his light-hearted and sometimes sentimental *Singspiele.*

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DIU (DIÓ), an island and town of former Portuguese India, which was taken over by India in Dec. 1961, lies at the southern extremity of the peninsula of Kathiawar. The district (area 14 sq.mi.) included the village of Gogolá on the mainland and the fortress of Simbor (Pani Kota Island) 12 mi. E. The population of the district (1950) was 21,138. The anchorage is protected from the sea, but the depth of water is only about two fathoms. The channel between island and mainland is navigable only by small craft.

The Portuguese, under treaty with Bahadur Shah of Gujarat, built a fort at Diu in 1535, but were besieged in 1538 and 1545. The second siege, the subject of an epic by Jerónimo Côrte-Real (*q.v.*), is one of the most famous events in Indo-Portuguese history. The town is surrounded by a wall with towers at regular intervals. There are remains of several fine ancient buildings. The cathedral of Sé Matriz, dating from 1601, was formerly a Jesuit college. Many of the inhabitants became Banyan merchants of the east coast of Africa and Arabia. Industries which were established include salt processing, fishing, and distillation of spirits from the palm. The trade of the town, however, decayed. Diu was subject to the governor general of Goa as part of the Portuguese overseas province, Estado da Índia.

See also GOA. (L. D. S.)

DIURETICS are drugs that produce an increased flow of urine. They are used for: (1) the removal of excess water and salt from the body, thus relieving or preventing edema such as may result from circulatory and nutritional disorders; (2) the hastening of the excretion of ingested poisons; (3) the removal of accumulated metabolic products; and (4) the dilution of urine in order to prevent precipitation of drugs in the kidney tubules (*see* SULFONAMIDES).

In general, diuretics act either by increasing the filtration through the glomeruli of the kidneys or by decreasing the absorption from the tubules (*see* URINARY SYSTEM). The first group includes drugs that alter the osmotic pressure or electrolyte balance of the plasma, such as the saline diuretics, urea and intravenous sucrose, and drugs such as digitalis and strophanthin that improve the circulation by strengthening the heart. Drugs that decrease the tubular reabsorption include the mercurial diuretics such as mersalyl (salyrgan) and merbaphen (novasurol) and probably also the xanthine diuretics (theobromine, theophylline and caffeine). (F. L. A.)

DIURNAL MOTION, the apparent daily motion of the heavens from east to west which causes the rising and setting of celestial objects and which results from the earth's rotation on its axis from west to east. The axis of this apparent motion is coincident with the axis of rotation of the earth and intersects the celestial sphere at the celestial poles.

The great circle intersection of the plane of the earth's equator with the celestial sphere defines the celestial equator. The apparent daily paths of celestial objects are circles parallel to the celestial equator and are termed diurnal circles. In the northern hemisphere, the diurnal motion causes the stars to appear to describe circles about a point within one degree of the star Polaris. (R. L. DE.)

DIVER, a name applied to many aquatic diving birds, but usually applied to the loons, especially in Europe. The loons, constituting the family Gaviidae of the order Gaviiformes, all belong to a single genus, *Gavia. See* LOON.

DIVERTICULITIS AND DIVERTICULOSIS. Diverticulosis generally denotes the presence of one or more diverticula or outpouchings of the colon (large bowel). Diverticulitis means inflammation of these diverticula. In medicine, these two terms usually are applied only to conditions in the colon and are not used to describe diverticula or the corresponding diverticulitis of the following common varieties: pulsion (Zenker's), traction or epiphrenic of the esophagus; duodenal; Meckel's (of the ileum); or the vermiform appendix.

Diverticulosis occurs in about 20% of persons over 40 years of age and is commoner in older people. Its cause is unknown. The diverticula, which are found by X-ray (barium enema) examina-

tion, are confined to a 4- to 8-in. segment of the left colon, especially its sigmoid (lower) portion. In reference to the circumference of the bowel, the diverticula are situated near, but not at, the mesenteric attachment and occur where the small blood vessels penetrate the muscular portion of the colonic wall, creating a weak point. The diverticula tend to become "teardrop" shaped with growth. They do not perforate unless inflamed but may bleed massively into the bowel lumen, serving as a cause, but not a frequent one, of massive bleeding from the rectum. Except when the rare complication of massive bleeding occurs, diverticulosis is symptomless.

Diverticulitis, on the other hand, is usually accompanied by pain. Chills and fever are also common. Because of the pain and the fact that the left colon is involved in 80% of cases, diverticulitis is sometimes referred to as "left-sided appendicitis." Medical treatment is used for mild or uncomplicated cases, while surgery is preferable when complications ensue. Complications include hemorrhage in about 15% of cases, usually milder but more protracted than in simple diverticulosis; perforation, sometimes with a fistula into surrounding organs; obstruction of the sigmoid to the passage of stools, often because of adhesions or local edema; and intractability and chronicity. Quite often the attending physician is unable to differentiate diverticulitis from cancer. The preferred surgical treatment is excision of the involved segment of the colon with end-to-end anastomosis (joining) of the remaining colon, preferably with interrupted sutures.

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DIVERTIMENTO, a musical term (from the Italian word meaning a diversion) in fashion in the second half of the 18th century, and given, particularly by Haydn and Mozart, to an instrumental work of a light or entertaining nature that usually consisted of several movements, for strings or wind, with or without harpsichord, or for both of these types of instruments combined. The movements were in sonata form, variation form, or followed the style of dance movements in the suite. Among the numerous divertimenti of Haydn are his sextet, in the form of a double string trio to be played by two groups simultaneously in different rooms, and his "Children's Symphony" for string trio and seven children's instruments. The divertimenti of Mozart resemble his works having the name serenade or cassation. The style of the divertimento was to some extent maintained in the Septet, Op.20, by Beethoven and the Octet, Op.166, by Schubert, both for wind and strings. The term was also applied in the 20th century to compositions by Bartók and others.

DIVIDE, in geomorphology, is a height of land from which the natural drainage of an area flows in opposite directions. *See* WATERSHED.

DIVIDEND. An ordinary dividend consists of earnings distributed among stockholders of a corporation in proportion to their holdings and as determined by the class of their holdings. Dividends are usually payable in cash, although on occasions distributions are made in the form of additional shares of stocks. The actual payment is made to stockholders of record. The preferred stockholders are entitled to a preferential dividend, usually at a fixed rate, and the common stockholders get a portion of what remains after payment of the dividends on preferred stock. *See* STOCK OR SHARE; *see* also references under "Dividend" in the Index volume.

DIVI-DIVI, the native and commercial name for the astringent pods of *Caesalpinia coriaria,* a leguminous shrub or small tree of the subfamily Caesalpinioideae, growing in open, semiarid regions, especially above tidal flats of the coast from Mexico to northern South America and the West Indies. The plant is between 20 and 30 ft. in height and bears white flowers. The pods are flattened and curl up in drying; they are about three-fourths of an inch broad, from two to three inches long and of a rich brown colour. Divi-divi was first taken to Europe from Caracas in 1768. The pods yield a high percentage of tannin (*q.v.*) of exceptional qualities.

DIVINATION, the process of obtaining knowledge of secret or future things from contact with superhuman or divine sources. Divination is practised in all grades of culture, the information received being commonly held to come directly or indirectly from superior, nonhuman sources. Divinatory methods may be classified as internal, conditioned by change in the consciousness of the soothsayer; and external.

Internal Methods.—These depend for their results on sensory or motor automatisms or mental impressions. Among sensory automatisms, crystal gazing is analogous to dreams, except that the vision is voluntarily initiated, though little, if at all, under the control of the scryer. Shell hearing and similar methods in which the information is gained by hearing a voice are less common. The divining rod is the best-known example of motor automatisms. Water divining or dowsing has been widely used; similarly a sieve held suspended gives indications by turning; and divination by a suspended ring is found from Europe to China and Japan. The ordeal by the Bible and key is equally popular; the book is suspended by a key tied in with its wards between the leaves and supported on two persons' fingers, and the whole turns round when the name of the guilty person is mentioned. Divination by automatic writing is practised in China. Trance speaking may be found in any stage of culture and in many cases the procedure of the magician or shaman induces a state of autohypnosis; at a higher stage these utterances are termed oracles and are believed to be the result of inspiration. (*See* also DIVINING ROD; ORACLE.)

Observation shows that by the aid of mental impressions, akin to clairvoyance, fortunes are told successfully by means of palmistry or by laying the cards; for the same "lie" of the cards may be diversely interpreted to meet different cases. In other cases the impression is involuntary or less consciously sought, as in dreams, which, however, are sometimes induced for purposes of divination by the process known as incubation or temple sleep. Dreams are sometimes regarded as visits to or from gods or the souls of the dead, sometimes as signs to be interpreted symbolically. (*See* also PARAPSYCHOLOGY; PALMISTRY.)

External Methods.—In external divination the process is by inference from external facts. The methods are very various. The casting of lots, sortilege, was common in classical antiquity. Similarly dice and knuckle bones are thrown for purposes of sortilege. In Polynesia the coconut is spun like a teetotum to discover a thief. In ancient times the poets were often consulted, more especially Virgil, just as the Bible is used for drawing texts in modern times.

In haruspication, or the inspection of entrails, in scapulimancy or divination by the spealbone or shoulder blade, in divination by footprints in ashes, the diviner must take active steps to secure the conditions necessary to divination. (*See* also HARUSPICES.) In the case of augury and omens, the behaviour and cries of birds, and meeting with ominous animals, etc., may be voluntarily observed (*see* AUGUR). Astrology is a divining method of great antiquity (*see* ASTROLOGY). *See* also references under "Divination" in the Index volume.

DIVINE RIGHT: *see* KING.

DIVINE WORD, SOCIETY OF THE (DIVINE WORD MISSIONARIES; SOCIETAS VERBI DIVINI; S.V.D.), a Roman Catholic religious organization, composed of priests and brothers, founded in 1875 in Steyl, Neth., by Arnold Janssen for the propagation of Catholicism among pagan peoples, and approved in 1901. Its members are engaged in all phases of missionary activity, from teaching in universities, colleges and secondary schools to "bush" missionary work among primitive peoples. Over 5,000 members work in 14 European countries, in North and South America, Africa, Australia, Formosa, India, Indonesia, New Guinea, Philippines and Japan. The training of a native clergy has always been a major work of the society in all its missions. It also publishes about 50 periodicals in 14 different languages. The general mother-house is at Rome. Some of its members, particularly Wilhelm Schmidt, have made valuable contributions in the fields of anthropology and ethnology. (N. F. B.)

DIVING: *see* Diving Apparatus; Swimming; Skin Diving; Olympic Games.

DIVING APPARATUS, the equipment designed to permit men to work under water in salvage, commercial (pearl and sponge fishing) and scientific operations. For the techniques and equipment employed in sports, *see* Skin Diving.

This article is divided into the following sections:

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I. HISTORY

1. Early Divers.—The earliest reference to the practice of diving occurs in the *Iliad*, 16, 745–750, where Patroclus compares the fall of Hector's charioteer to the action of a diver diving for oysters. Since remote times swimming and diving have been practised as a special industry among Greeks and Romans and professional divers have recovered pearls, coral, sponges and lost treasures from the sea bed. One diver, Scyllias, contrived the shipwreck of Xerxes' galleys near Mt. Pelion by cutting adrift their moorings during a storm. Thucydides mentions the employment of divers during the siege of Syracuse to saw down the barriers which had been constructed below the surface of the water with the object of obstructing and damaging any Grecian war vessels which might attempt to enter the harbour. At the siege of Tyre, divers were ordered by Alexander the Great to impede or destroy the submarine defenses of the besieged as they were erected.

2. Early Diving Appliances.—The earliest mention of any appliance for assisting divers is by Aristotle, who says that divers were sometimes provided with instruments for drawing air from above the water and thus they were able to remain a long time under the sea, and also that divers breathed by letting down a metallic vessel which did not get filled with water but retained the air within it. It is also recorded that Alexander the Great made a descent into the sea in a machine called a *colimpha*, which had the power of keeping a man dry and at the same time of admitting light.

Pliny also speaks of divers engaged in the strategy of ancient warfare who drew air through a tube, one end of which they carried in their mouths while the other end was made to float on the surface. It is the same "tube" that enables modern underwater explorers to examine the sea bed while swimming, without having to come to the surface to breathe. Vegetius, a Latin writer of the 4th century A.D., has a drawing representing a diver wearing a tight-fitting helmet to which is attached a long leather pipe leading to the surface where its open end is kept afloat by means of a bladder.

Various writers refer to a passage in Roger Bacon's works in which he alludes to "instruments whereby men can walk on sea or river beds without danger to themselves" (1240). The diving apparatus described by G. A. Borelli in 1679 comprised a leather bottle containing a supply of air which was carried on the diver's back and a piston to regulate his specific gravity, but it could not have proved practicable.

John Lethbridge, a Devonshire man, in 1715 produced a contraption in the form of a leather barrel with two sleeves for the arms and an observation porthole; it could, however, be used only in depths of up to ten feet. It is said that Lethbridge made a considerable fortune by his invention. In 1797 K. H. Klingert of Breslau invented a form of diving gear provided with ingenious devices that opened the way to designers. This consisted of an egg-ended metallic cylinder enveloping the head and the body to the hips. The diver was encased first of all in a leather jacket having tight-fitting arms, and in leather drawers with tight-fitting legs. To these the cylinder was fastened in such a way as to render the whole equipment airtight. The air supply was drawn through a pipe which was connected with the mouth of the diver by an ivory mouthpiece. Klingert perfected his apparatus by adding an air container for breathing.

In 1819 Augustus Siebe invented his open diving dress worked in conjunction with an air force pump. The dress consisted of a metal helmet formed with a shoulder plate attached to a jacket of waterproof leather. The helmet was fitted with an air inlet valve to which one end of a flexible tube was attached, the other end being connected to the air pump. The air, which kept the water down below the diver's chin, found its outlet at the edge of the jacket, exactly as it does in the case of the diving bell. Excellent work was accomplished with this dress—work which could not have been attempted before its introduction—but it was still far from perfect. It was absolutely necessary for the diver to maintain an upright or but very slightly stooping position while under water; if he stumbled and fell, the water filled his dress, and, unless brought quickly to the surface, he was in danger of being drowned.

To overcome this and other defects, Siebe carried out a great many experiments, which culminated, in the year 1830, in the introduction of his close dress in combination with a helmet fitted with air inlet and regulating outlet valves. Though, of course, many great improvements were introduced after Siebe's death in 1872, his principle remained in universal use. The submarine work which it has been instrumental in accomplishing is incalculable.

II. MODERN APPARATUS

1. Diving Suit With Helmet.—A set of ordinary modern diving apparatus consists essentially of seven parts: (1) an air pump; (2) an incompressible helmet with breastplate, or corselet; (3) a compressible, or flexible, waterproof diving dress; (4) a length of flexible noncollapsible air tube, with metal couplings joining it to pump and helmet; (5) a pair of weighted boots; (6) a pair of lead weights for breast and back; and (7) a lifeline. Most apparatus is fitted with a telephone, and submarine lamps are also largely used.

Helmet.—The helmet proper is separate from the corselet, and is secured to the latter by segmental neck rings which are provided on both these parts, enabling them to be connected by one-eighth of a turn, a catch on the back of the helmet preventing any chance of unscrewing. The helmet and corselet are usually made of highly planished tinned copper, the valves and other fittings being of gun metal.

The helmet has a nonreturn air inlet valve to which the air-supply pipe is attached. This valve allows air to pass from the pump to the helmet but not in the reverse direction. A regulating air outlet

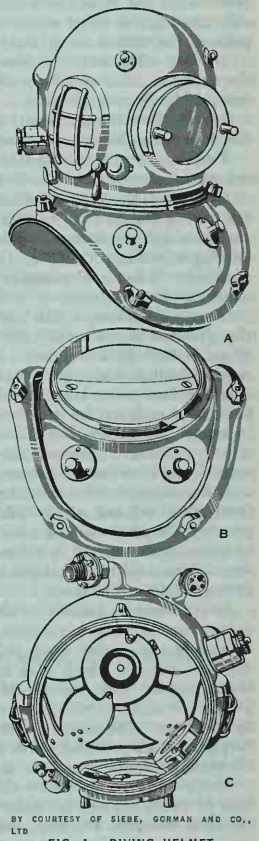

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FIG. 1.—DIVING HELMET
(A) Helmet complete with corselet; (B) corselet; (C) interior of helmet showing valves and telephone connections

valve fitted to the helmet enables the diver to control the amount of air in the dress, and hence his buoyancy. By screwing up the valve, he retains the air in the dress, and so maintains or increases his buoyancy; by unscrewing it he allows the air to escape, thus causing the dress to become deflated, with a consequent loss of buoyancy. On reaching the bottom and starting work, the diver will adjust his valve so as to maintain himself comfortably in equilibrium, altering the adjustment only when he wishes to ascend; that is, of course, assuming, as should be the case, that air is pumped to him at a uniform rate. Thick plate-glass windows are fitted to the helmet. The front window is detachable from the helmet, usually by unscrewing though some helmets are fitted with hinged windows. (*See* fig. 1.)

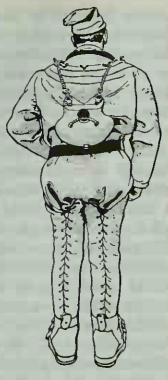

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FIG. 2.—DIVING DRESS WITH LACED LEGS

Dress.—The diving dress is a combination suit made of two layers of tanned twill with pure rubber between, and which envelops the whole body from foot to neck, the sleeves being fitted with vulcanized rubber cuffs which make a watertight joint round the diver's wrists. The dress is also fitted with a vulcanized rubber collar which is secured to the corselet or breastplate of the helmet so as to render all watertight. (*See* fig. 2.)

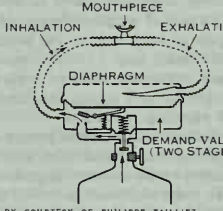
Air Pipe.—The diver's air pipe is flexible and noncollapsible. At the ends are fitted metal couplings for securing the pipe to the pump and helmet respectively.

Boots.—To maintain himself in an upright position under water, the diver wears heavily weighted boots (about 32 lb. the pair).

Weights.—Two lead weights, 40 lb. each, one on the back and one on the chest, ensure the diver's equilibrium under water.

Lifeline.—The diver's lifeline is for use in case of emergency, for hauling the diver to the surface and also for making signals, the diver and his attendant having a prearranged code in which varying numbers of pulls or jerks on the lifeline have definite meanings. When a telephone is provided, the telephone wires are embedded in the lifeline.

Diver's Telephone.—This instrument provides means whereby the attendant at the surface can converse with no. 1 or with no. 2 diver, or with both together. He can also put no. 1 diver into communication with no. 2, himself hearing their conversation. The telephone wires are embedded in the lifeline, which has connections at each end for attaching to helmet and battery box. The diver's receiver is situated generally in the crown of the helmet, and the transmitter between the front glass and one of the side glasses. The diver can ring a bell or buzzer at the surface by pressing with his chin a contact piece situated inside the helmet.



BY COURTESY OF PHILIPPE TAILLIEZ

FIG. 3.—COUSTEAU-GAGNAN COMPRESSED-AIR, OPEN-CIRCUIT BREATHING APPARATUS

Air Pumps.—Diver's air pumps are of various patterns, depending principally upon the depth of water in which work is being carried out, since the greater the depth of water the greater the quantity of air required by the diver. The pumps are of the reciprocating type and pressure gauges are provided which indicate the pressure of air which the pump is supplying and the depth at which the diver is working.

Air Compressors driven by electric motors or internal-combustion or steam engines are sometimes employed. In these cases the air is delivered into steel reservoirs, the divers' air pipes being connected to an air control panel which receives its air from the reservoir so that in case of a breakdown of the motive power, a reserve of air sufficient to bring the diver safely to the surface is assured.

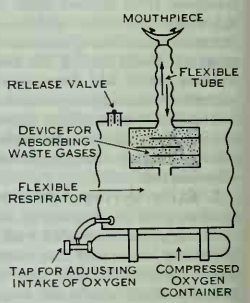
In the pearl and sponge fisheries the small boats from which the divers work are sometimes propelled by internal-combustion engines which also drive the air compressors.

The type of air-pumping apparatus employed varies with the depth of water and the conditions under which the diving operations are conducted.

2. Air Supply.—The diver's air supply must be adequate both in volume and pressure—the volume sufficient to ensure proper ventilation of the helmet, and the pressure fully equal to that which corresponds to the depth of water at which the diver may be working. In fresh air there is only .03% of carbon dioxide, and, at ordinary atmospheric pressure, no ill effects are felt until 3% of the gas is present. As a diver descends, the pressure is increased and the effect of a small percentage of carbon dioxide in his helmet becomes greater.

J. S. Haldane, who conducted deep-diving experiments for the British admiralty in 1906, established that 1.5 cu.ft. of air per minute would be needed to keep the percentage of carbon dioxide at a safe level. This volume of air is required at all depths, so that the actual quantities required at different depths down to 231 ft. are as shown in the table.

3. Self-Contained Diving Apparatus.—The traditional diving suit with helmet described above lost nothing of its value for industrial work, but other forms of apparatus, self-contained and less heavy and cumbersome, assumed increasing importance. They are of two main types: with compressed air and an open circuit—the first industrial application of which was made by the Frenchmen A. Rouguayrot and Denayrouze in 1864; and with oxygen and a closed circuit. The first really practicable example of the latter was designed by H. A. Fleuss.



BY COURTESY OF PHILIPPE TAILLIEZ

FIG. 4.—CLOSED-CIRCUIT OXYGEN APPARATUS

Combined with a diving mask, a weighted belt and means of propulsion, and eventually with a protective covering, these forms of apparatus enabled men to swim and explore under water. Apparatus designed by J. Y. Cousteau and E. Gagnan on the compressed-air and open-circuit principle employs from one to three aluminum cylinders, containing air to the pressure of 200 atm., strapped to the diver's back. Inhaling and exhaling breathing tubes connect a mouthpiece to the demand valve (two stage) mounted at the top of the cylinders. The fall in pressure produced by each inhalation displaces the diaphragm of the demand valve and lifts the valve admitting air. At exhalation the air is discharged into the water (fig. 3).

The apparatus using oxygen and a closed circuit supplies a synthetic but breathable atmosphere by means of a watertight chamber containing caustic soda which fixes the carbon dioxide produced in expiration. Fleuss and R. H. Davies were the first to combine the apparatus with the classical diving suit and helmet. During World War II a number of diving devices using oxygen were employed by frogmen, human torpedoes and demolition teams to attack the moorings of enemy ships and destroy coastal defenses.

The practicable limit of self-contained compressed-air appara-

Quantities of Air Required at Varying Depths

Depth in fathoms	Depth in feet	Pressure per sq.in. above atmospheric pressure (in lb.)	Quantity of air at atmospheric pressure required per minute by the diver (in cu.ft.)
0	0		1.5
5½	33	14.7	3.0
10½	99	44.0	6.0
33	198	88.1	10.5
38½	231	102.8	12.0

tus is 130 ft. Oxygen apparatus cannot safely be used below 26 ft., for beyond that depth breathing of pure oxygen under pressure is apt to cause physical disturbances and make drowning more likely.

4. Diving Bells.—When a container is immersed in water, with its opening pointing downward, the volume of air enclosed in it diminishes in proportion to its depth in the water, the air pressure being balanced by that of the water at its own level. Thus at 33 ft., when the pressure of the water is double the atmospheric pressure, the volume of air in the container is reduced by half. If one continues compressing the air in the container at a pressure slightly above the pressure already existing, the level of the water inside can be seen to drop until the air escapes from the rim of the vessel.

Such is the principle of the diving bell. It does not differ from that of the diving suit and helmet, and rudimentary forms of the apparatus have been used since antiquity. From 1671, when letters patent were introduced in England, to the end of the 18th century nearly 30 patents were issued for diving bells and suits.

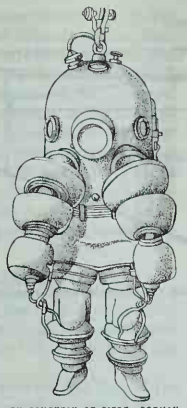


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FIG. 5.—SELF-CONTAINED DIVING DRESS MADE OF CAST-STEEL CYLINDERS, INVENTED BY NEUFELDT-KUHNKE

An important advance in the diving bell was introduced by the English astronomer Sir Edmund Halley in 1690. This consisted of renewing the air of the bell by means of barrels filled with air which were lowered to its level.

Diving bells are used in industry for laying bridge foundations and work in docks and harbours. Several Siebe-Gorman ordinary diving bells, built of steel, were used during the construction of the National harbour at Dover. Each measured 17 ft. long by 10½ ft. wide by 7 ft. high, and weighed 35 tons. They were lighted electrically and fitted with telephonic apparatus which enabled the bell divers to converse with the engineers and crane and compressor attendants at the surface.

Air was supplied to the bell by a steam-driven compressor housed on the gantry which carried the traveling cranes for lowering and raising the bell through the water to a maximum depth of 60 ft. and also for lowering the concrete blocks. The air tube for the compressors was connected to a nonreturn air inlet valve fitted in the crown of the bell, the excess escaping at the lower edge of the latter. The bell divers were employed in leveling the sea bed in readiness to receive the blocks, which weighed 40 tons each. Having leveled one section, the bell was moved to the next. The blocks were then lowered and were placed in position by helmet divers.

The air-lock diving bell comprises a steel working chamber, similar to the ordinary diving bell already described with the addition of a steel shaft attached to the roof. At the upper end of the shaft is an airtight door, and about eight feet below this is another similar door, the space between the two forming an air lock. When the men wish to enter the bell, they pass through the first door and close it after them, and then open a valve and let into the lock compressed air from the working chamber till the pressure is equalized; they then open the second door and pass into the main shaft, closing the door after them. Access to the working chamber is by ladder, secured to the side of the shaft. When returning to the surface, they reverse the operation, opening the lower door, entering the lock and closing the door again; then opening a valve to release the air pressure, when the upper door is opened and the men emerge to atmosphere. (Some bells of this type are fitted with two shafts, each with its air lock—one for the passage of the bellmen, the other for materials.)

5. Rigid Diving Apparatus and Observation Chambers.—In contrast with the apparatus already described, in which the diver has, of necessity, to breathe at a pressure equal to that of the water at his level, rigid diving apparatus and observation chambers have an outer cover for resisting the pressure of the water, and the diver himself continues to breathe at a pressure nearly that of the atmosphere; there is a device for absorbing carbon dioxide and regenerating oxygen.

In 1882 the brothers Carmagnolle took out a patent for an armour-plated diving suit. The most satisfactory modern version of this apparatus is the rigid jointed Neufeldt-Kuhnke type, which is lowered and raised by means of a cable and allows the diver to observe and make limited movements. There is a growing tendency for observation chambers to replace rigid diving gear and several types of these are in use. They are equipped with numerous portholes, searchlights and telephones and can reach a depth of 1,625 ft.

6. The First Bathyscaphes.—Credit for the name, the idea and the construction of the first bathyscaphe belongs to Auguste Piccard. It was a transposition into aquatic terms of the free stratospheric balloon with a tightly sealed cabin which had been built by Piccard and which in 1932 reached a height of 53,153 ft. with Piccard himself and Max Cosyns as passengers. Because it was built with the help of the Fonds National de la Recherche Scientifique Belge (F.N.R.S.) this balloon had been called F.N.R.S.1.

The construction by Piccard and Cosyns of the first bathyscaphe, also financed by the F.N.R.S. and called F.N.R.S.2, was interrupted by World War II and was not finished until 1948. The sealed steel cabin, equipped with Plexiglas observation portholes, was able to resist a pressure of 5,700 lb. per square inch, which corresponds to the pressure at a depth of 13,000 ft. The weight of the cabin was compensated for by a buoyancy chamber, containing 7,000 gal. of gasoline, a liquid lighter than water. The releasable ballast, controlled from inside the bathyscaphe by an electric circuit, made it possible to brake its descent and to begin the ascent. The bathyscaphe was equipped, among other accessories, with floodlights, twin screws and a guide rope which controlled the rate of descent and held it stable near the bottom.

The trials made in 1948 at the Cape Verde Islands, assisted by the French navy, were a failure because the apparatus was not strong enough to withstand the action of the seas at the surface. However, a descent without passengers to a depth of 3,600 ft. was completed, and it proved at least that the principle of the bathyscaphe was sound and capable of development. A second bathyscaphe, called F.N.R.S.3, was then put into construction at the arsenal at Toulon, making use of the experience gained with F.N.R.S.2. The spherical cabin of F.N.R.S.2 was the only part to be retained. More robust in construction, the F.N.R.S.3 included notably a shell round the buoyancy chamber making it possible to tow it in high seas, and a flooding chamber facilitating the emergence of the passengers when the bathyscaphe resurfaced. The successful trials of the F.N.R.S.3 ended on Feb. 15, 1954, with a descent into the Atlantic off Dakar to a depth of 13,287 ft. by G. S. Houot, the captain of a corvette, and P. Willm, a naval engineer. After having collaborated with the arsenal at Toulon during part of the construction of F.N.R.S.3, Auguste Piccard built in Italy with the help of the Italian navy a new bathyscaphe of his own, the "Trieste," similar to the F.N.R.S.3 in principle and appearance. After successful trials it was bought by the U.S. navy and on Jan. 23, 1960, Jacques Piccard and Lt. Don Walsh, U.S.N., descended in it to the bottom of the Pacific's Mariana trench, a record depth of 35,800 ft.

III. EFFECTS OF AIR PRESSURE ON THE DIVER

When a diver descends into the sea, the extra air pressure to which he is subjected is instantly transmitted to the whole inside of his body. In the lungs the blood is practically in contact with the air, which consists of three important gases—oxygen, nitrogen and carbon dioxide. The oxygen is used up by the tissues, and the breathing prevents the pressure of carbon dioxide from increasing, but the nitrogen is dissolved in the blood in the same way as a gas is absorbed by a liquid on which it has no chemical action in amounts proportional to the pressure of the gas.

Toward the mid-19th century, at the time of the first great practical applications of the Industrial Revolution, work involving compressed-air apparatus (caissons or diving bells) began in

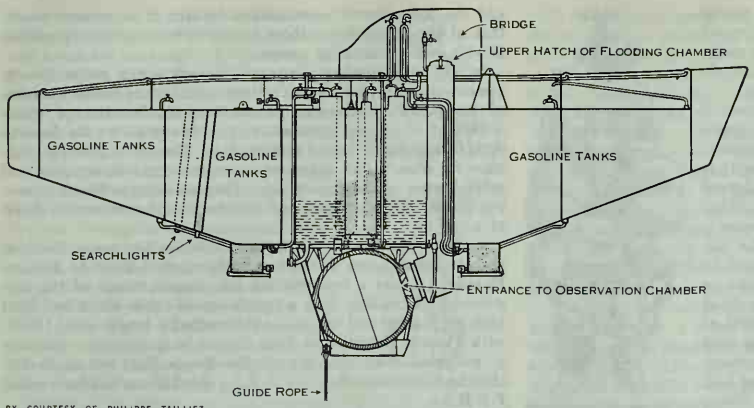

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FIG. 6.—BATHYSCAPHE F.N.R.S.3. SELF-CONTAINED AND SELF-PROPELLED OBSERVATION CHAMBER WITH GASOLINE FLOAT AND RELEASABLE WEIGHTS FOR PRESERVING EQUILIBRIUM AND RETURNING TO THE SURFACE

earnest with the sinking of bridge piers and the construction of underwater foundations, etc. Workers employed in these activities would return to atmospheric pressure without taking precautions after long hours spent in pressures sometimes higher than 30 lb. absolute.

After leaving the caisson, or several hours later, disorders occurred, taking many different forms: irritation, depression, extreme fatigue, respiratory troubles and nervous upsets. These aftereffects, sometimes fatal and at times making their victim an incurable invalid, could also pass without leaving a trace.

Divers, naturally tempted to enlarge their field of action—salvaging shipwrecks, fishing for sponges, etc.—prided themselves on descending lower and remaining longer underwater. The same mishaps occurred.

Medical science was powerless to deal with this mysterious "caisson disease" but theories about it and proposed treatments abounded. The lowering of air pressure which caused a cooling down of the system was blamed by some and in 1863 a certain Dr. Foley, in a pamphlet called "Work in Compressed Air," went so far as to advise divers to speed up their movements should they find themselves being overcome by a "thick and icy haze." To Paul Bert in *Barometric Pressure* (1878) goes the credit for showing precisely the cause of such illnesses.

During the descent and period spent at the bottom, the diver breathes air at a pressure higher than atmospheric and at each breath a certain amount of nitrogen is dissolved in the lungs.

The tissues, in their turn fed by the blood, are charged with nitrogen in an amount dependent on the duration of the dive. Admittedly, about six hours would be the minimum time for the whole body to become saturated.

On returning to the surface the process is reversed. The excess nitrogen dissolved in the different tissues is carried by the blood to the lungs and is then eliminated in respiration. If the rise is too rapid, the difference between the pressure of the nitrogen dissolved in the tissues and the hydrostatic pressure is such that bubbles form, as when champagne is poured out quickly. It is these bubbles that cause decompression illnesses. Bert had already recommended a slow and steady rise to avoid the formation of such bubbles. However, even when the return to the surface was prolonged, accidents still sometimes happened.

It was only in 1907, on the publication of findings of the British admiralty's board of deep diving, that rules safeguarding divers' and caisson workers' return to atmospheric pressure were adopted. These rules, which were universally accepted, were the work of Haldane who based his investigations on the fact that when a diver surfaces rapidly from a depth of 45 ft. he does not suffer any trouble however long the duration of his dive has been. At the end of surfacing, the pressure of nitrogen dissolved in the tissues may exceed double the pressure of the surrounding air. The volume of dissolved nitrogen which shows a tendency to escape in the form of bubbles when the pressure is reduced from two to one is the same, whatever the initial pressure. Haldane suggested that it should be possible for the diver to rise without trouble to a first stage where the hydrostatic pressure was half that of the nitrogen dissolved in the most highly charged part of the body.

This hypothesis having been confirmed experimentally, it was then possible to effect the decompression of the diver without risk, provided the speed of his rise was regulated so that the hydrostatic pressure always remained at least equal to half that of the dissolved nitrogen in the most heavily charged part of his body. Surfacing in these conditions involving a variable speed is difficult in practice and Haldane adopted a scheme whereby the diver stops every ten feet for a certain time.

1. Compressed-Air Illness.—Although the rules laid down are calculated to prevent compressed-air illness completely, cases do sometimes occur, as a result of accidents or mistakes, where the diver comes up too quickly from deep water. In such cases, whether the diver has already shown symptoms of compressed-air illness or not, he should be sent down again without delay to the depth at which he has been working and kept there for five minutes, after which he can start to come up again at prescribed rates.

On some deep-diving operations, however, a Siebe-Gorman recompression chamber, as shown in fig. 7, is provided, the use of which is a much better and more comfortable method of treatment than sending the diver into deep water again. This chamber is of steel, provided with a bench on which the diver can sit or lie, electric light, telephone, etc. Windows are provided through which the diver can be watched during the process of decompression; a small hand air lock attached to the chamber allows refreshments, etc., to be passed in to him. It is usually found sufficient to raise the pressure in the chamber to 30 lb., but it should never exceed 45 lb. As soon as the diver is relieved of any symptoms, the pressure is allowed to fall at prescribed minimum rates.

2. Helium and Oxygen for Deep-Sea Diving.—Helium, an inert and light gas (molecular weight 4 as against 28 for nitrogen), was the subject of experiments by the U.S. navy in an attempt to reduce the time taken in surfacing without increasing the risks of accident caused by decompression. These hopes were disappointed, however, for helium is less soluble in the body than

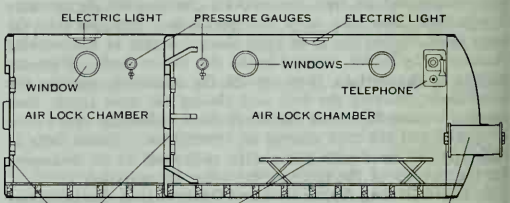

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FIG. 7.—RECOMPRESSION CHAMBER FOR TREATMENT OF CASES OF COMPRESSED-AIR SICKNESS (BENDS) CAUSED BY TOO RAPID ASCENT FROM DEEP WATER

nitrogen and spreads more quickly. Decompression after a dive using helium proved to be a longer and more difficult process than when air was used, and accidents were much more common. For short dives—the most usual at great depths—the use of air still requires the shortest periods for decompression. It has been established, however, that in dives using a mixture of helium and oxygen the intoxication produced by great depths does not occur at maximum depths reached, *i.e.*, 536 ft.; whereas, using air, it starts at 162½ ft. and prevents descent below 292½ ft. That is why helium is employed for deep diving. U.S. navy regulations provide for its use from 146 ft. In practice it is not used below 211 ft. because of the complexity of the apparatus and, more especially, the difficulties of decompression.

IV. GREATEST DEPTHS FOR USEFUL WORK

The greatest depth at which useful work has been accomplished by divers is 275 ft. This was at the salvage of the U.S. submarine "F_4," sunk off Honolulu, by divers of the U.S. navy using the British admiralty decompression system.

The greatest underwater treasure ever recovered was that of the liner "Laurentic," torpedoed in 1917 off the coast of Ireland in 114 ft. of water. On board were 40 tons of gold and silver bound for the United States. Work by divers with helmets, under Cmdr. G. C. C. Damant, lasted six years and resulted in the salvaging of about 99% of the total.

The greatest depth from which treasure has been recovered—using an observation chamber—was 475 ft., reached in the case of the "Niagara," sunk by a mine in 1940 off New Zealand. There were eight tons of gold on board. The salvage work, directed by Capt. J. P. Williams, lasted 11 months and recovered about 95%.

The most ancient and important artistic recovery made by divers was the galley of Mahdia, Tunisia, discovered in 1907 by Greek sponge fishers and lying in 120 ft. of water. The cargo was composed of temple columns and capitals, bronze and marble statues and bowls—all dating from the Greek period (1st century B.C.). The finds were placed in Bardo museum. Research begun between 1908 and 1911 was continued by Commanders P. Tailliez and J. Y. Cousteau in 1948 and marked the beginning of underwater archaeology.

See Sir Robert H. Davis, *Deep Diving and Submarine Operations* (1936; 5th ed., 1951); *La Plongée*, diving manual of the French navy (1955). (R. H. D.; P. M. Tz.)

DIVINING ROD. The divining rod has been used for centuries to search for hidden things. According to modern usage it is a Y-shaped forked stick, metal rod or wire. When an operator firmly grasps the branches of the Y, squeezes them together, then walks about, the rod is supposed to indicate by dipping (or rising) that it is over or near water, precious metals, oil, criminals, buried coins or whatever is being sought.

The ancient Scythians, Medes, Persians, Greeks and Romans used divining rods. Marco Polo found them used for divination (*q.v.*) throughout the orient in the late 13th and early 14th centuries. The best evidence seems to point to Georgius Agricola's *De re metallica* (1556) as the first printed description of the modern rod and its applications. His interest was chiefly in features associated with mining and the location of minerals, but the technique was identical with that of many searchers for water, sometimes called dowsers or water witches. Agricola reported that the consensus among rod users was that the hazel bush was most effective for revealing mineral veins, especially if it grew above a known vein. There were some, however, who recommended a different material for each mineral: hazel for searching for silver, ash twigs for copper, pitch pine for lead and tin and rods of iron and steel for gold.

The divining rod is used primarily in searches for water and it is supposed to locate subterranean springs and streams, two things which in general do not exist. Extensive scientific investigations of the divining rod have proven that it does not react in any way to the underground presence of water, oil, metals or any substance. Springy wood or metal shaped and held as described above will twist vigorously when the squeezing force is relaxed slightly, without any regard whatever for its surroundings. Slight muscular fatigue can lead to such relaxing of pressure without the operator even being aware of it. Sometimes this movement happens at places where water or other substances are later removed from the ground but there is no causal connection between the two.

In spite of this, social scientists who have investigated the phenomenon conclude that use of the divining rod may be expected to continue indefinitely in areas where water and other desired substances are difficult to locate. (L. D. L.)

DIVISION, a general term for the action of breaking up a whole into parts (from Lat. *dividere*, to break up into parts, separate). Thus, in political economy, the phrase "division of labour" implies the assignment to particular workmen of the various portions of a whole piece of work; in the musical terminology of the 17th and 18th centuries, the term was used for rapid passages consisting of a few slow notes amplified into a florid passage; *i.e.*, into a larger number of quick ones. The word is used also in concrete senses for the parts into which a thing is divided; *e.g.*, a division of an army (*see* DIVISION, MILITARY), and an administrative or electoral division. Similarly, a "division" is taken in a legislative body when votes are recorded for and against a proposed measure. (X.)

Mathematics.—In mathematics, division is the process of finding one of two factors when their product and the other factor are given. The given product and factor are called the dividend and divisor respectively. The factor to be determined is called the quotient. In the system of numbers consisting of the integers and fractions there is a uniquely determined quotient for every choice of dividend and divisor except when the latter is zero. In dealing with integers, however, the division is possible only when the dividend is a multiple of the divisor. If the dividend D lies between dq and $d(q+1)$—two consecutive multiples of the divisor d—then the integer q is called the quotient and the integer $D-dq$ the remainder; the process of finding the quotient and remainder is referred to as division with remainder. Unique division with remainder is also definable in the division of polynomials in a single variable x by requiring the remainder to be of lower degree in x than the divisor. The details of the division process are given in elementary arithmetic and in high-school algebra textbooks.

A contraction of the usual division process when the dividend is a polynomial in the variable x and the divisor is $x-r$ is known as synthetic division. Thus, if the dividend is ax^3+bx^2+cx+d the synthetic division by $x-r$ is arranged as follows:

a	b	c	d	$\lfloor r$
	ar	er	fr	
a	e	f	g	

The numbers e, f, g are the sums of the two numbers directly above each. The remaining numbers are self-explanatory. The quotient and remainder are read from the bottom line; the quotient is ax^2+ex+f and the remainder is g. For instance, the quotient and remainder when $x^4-3x^3+x^2-7$ is divided by $x+1$ are seen to be x^3-4x^2+5x-5 and -2, respectively, from the following calculations:

1	−3	1	0	−7	⌊−1
	−1	4	−5	5	
1	−4	5	−5	−2	

(*See* ARITHMETIC; NUMBER; POLYNOMIAL.) (G. Y. R.)

Logic.—Logical division is the division in thought of a class into subclasses, resulting in a statement such as this: "Every tree is either evergreen or deciduous." Any subclass can be subdivided in its turn; *e.g.*, "Every evergreen tree has either broad or narrow leaves." A logical division may be constructed for its own sake, the logician taking a pure aesthetic pleasure in surveying the related classes so exhibited and, generally, in the unified knowledge of the field contained in such a division. It has, however, often been held to be also useful for ulterior purposes among which are the following:

1. The inventor of the concept of logical division, namely Plato, thought of it as a method of reaching definitions (*see* DEFINITION). Thus, to define the angler we place him in a large class to which

he belongs, say that of technicians. We then divide this class, determine in which of its subclasses the angler falls, divide that again, and so on down to a class equivalent to the angler. The names of the classes we have gone through together constitute the definition of the angler. Plato regarded this as a sure way both of discovering and of proving any desired definition. Aristotle showed, however, that it cannot amount to a proof. In fact, a logical division is not a method of doing anything; it is merely a system of concepts or else our knowledge of that system; and there is no sure method of arriving at such knowledge. The idea that logical division is an intellectual method is an error analogous to the idea that the method of getting to know geometrical truth is the same as the order of exposition in a completed work of geometry.

2. Knowing a logical division of a field may, as Aristotle said, put us in a better position to ask the right questions in that field.

3. A logical division may help us to understand and talk about the individuals belonging to the classes concerned; *e.g.*, about the millions of particular trees.

4. Logical divisions are especially useful for enabling beginners to assign specimens to their species. Divisions for this purpose are often called "keys." The examples given at the beginning of this section are the first two stages of A. F. Blakeslee's key to the trees of northeast America.

There appear to be certain rules for logical divisions, or conditions which we wish them to meet, as follows:

1. A division should always be exclusive, so that no particular specimen belongs to more than one subclass. This rule would be broken if we divided human beings into males, females and children.

2. Similarly, a division should always be exhaustive, so that every particular specimen belongs to some subclass. But here we must distinguish between exhausting all the specimens there are and exhausting all the specimens there might be. A division intended to help people to identify trees need not include all the trees there might be. It need not have a class for trees having seven buds at a node if no such trees are known.

3. Plato held that a division should be dichotomous; *i.e.*, that there should only be two subclasses, or at any rate very few. A division into more than five subclasses is hard to remember or grasp as a whole, but the demand for dichotomy or trichotomy often conflicts with other demands made on division. For example, in a field where specimens vary by very small degrees from one form to a very different form, insistence on dichotomy will result either in inexhaustiveness or in producing subclasses that lack unity.

4. It has been thought that a division should be not merely a dichotomy, but a dichotomy into two contradictories. The chief advantages of this are that such divisions are easier to understand and are automatically exclusive and exhaustive. Contradictories are often and successfully used in botanical keys; *e.g.*, plants are divided into those that are flowering and those that are non-flowering.

5. On the other hand, we often want a division to give us information of what there is in a field, and for this purpose every subclass needs to be positively characterized. "There is no division of negation as such, for not-being cannot have species" (Aristotle).

6. It is often desired that each stage of a division shall arise naturally out of the previous stage. "When the division is carried further than one stage, the same *fundamentum divisionis* should be retained in the later stages which was used in the first" (H. W. B. Joseph). But this seems to be an aesthetic or at least a purely theoretical requirement, and must be sacrificed sometimes when the divider has an ulterior purpose in mind.

7. Plato held that divisions should be "through the middle," and not cut off a small part from a larger; *e.g.*, Greeks from foreigners. Since, however, it is obvious that this particular division of mankind is sometimes good and useful, we have here another purely aesthetic demand.

8. It has been held from Plato on that divisions should give "true species" by "dividing at the joints instead of breaking the bones." But, as Darwin observed, the concept of "true species" is only a confused notion of some particular kind of division which is desired for a particular field. In the realm of organisms what is mainly desired is a division that brings out propinquity of descent.

9. It is sometimes hoped to find divisions sufficient for all purposes; however, this is impossible. For example, it will always be necessary to divide animals for some purposes into wild and tame, and for others into mammals, birds, etc.

10. It has been hoped to construct divisions without experience of what there is in nature, or at least to show that they are a priori necessary, but this is possible only in mathematical realms. *See* also CLASSIFICATION.

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DIVISION, MILITARY. In modern armies the division is the smallest formation that comprises a balanced team of all the arms and services needed for the independent conduct of operations. It usually numbers between 12,000 and 20,000 men and is commanded by a major general. In naval usage a division is a group of ships, usually four, forming part of a fleet or naval task force. It also denotes units into which a ship's company is divided for administrative purposes. The term "air division" denotes a tactical command, comparable to an army corps, forming part of an air force. The wing is the air force counterpart of the ground division.

The military strength of an army for the conduct of war may be roughly measured by the number and quality of the divisions it can bring to bear against an enemy. Divisions, together with additional supporting combat and service troops, are formed into corps and field armies for the conduct of military campaigns.

To meet specialized requirements in warfare, divisions have evolved into several types, falling within two general classifications: infantry and armoured. Infantry divisions, known as rifle divisions in the Soviet army, are organized and equipped for combat under all conditions of terrain and weather; they comprise the principal portion of the fighting forces of an army. An infantry division consists chiefly of foot soldiers equipped with light weapons but also includes supporting artillery, armour and engineer units, and has its own communication, supply, maintenance and evacuation services. Divisions of this general type, modified by the introduction of light equipment and given special training, may perform specialized roles. Examples are air-borne (parachute) divisions and mountain (alpine) divisions. Some armies also have formed motorized (U.S. usage, mechanized) divisions by adding truck transport and light armoured vehicles sufficient to mount all the troops of an infantry division. The armoured, or (except in U.S. usage) mechanized, division also contains elements of all arms and services, but is comparatively much stronger in tank forces than the infantry division. It makes extensive use of armoured vehicles to increase the mobility and protection from small arms fire of the infantry, engineers and other troops operating in close support of tanks. During World War II the Soviet army organized a large number of artillery divisions, each consisting of from 18 to 24 artillery battalions.

Armoured division operations are characterized by great speed of movement over favourable terrain, heavy firepower and shock effect. Higher commanders often employ them as a mobile reserve and as a striking force against objectives deep in enemy territory when the progress of the battle creates an opportunity for bold maneuver. Infantry divisions have a greater capability for sustained action and their movement is less hindered by terrain obstacles. By replacing battle losses as they occur, infantry divisions may remain continuously in combat for weeks or months at a time. Air-borne divisions pose a strategic threat, since they may be moved by air to any part of a considerable area. To offset their lightness in weapons and austere support, they depend greatly on surprise and rapid execution for success of an air-borne assault.

They are ordinarily committed to battle only for brief periods unless reinforced with additional troops. (*See* AIR-BORNE TROOPS.)

Historical Background.—The divisional system originated in the long period of French world leadership in military science during the 18th and 19th centuries. Gen. Lazare Nicolas Carnot (*q.v.*) organized the forces of the armies of the Revolution into permanent divisions. Napoleon Bonaparte altered the divisional organization, provided supporting corps artillery and eventually formed separate cavalry divisions. The Prussian army organized divisions in 1813, and other European armies had adopted the divisional system by the end of the 19th century.

At the beginning of World War I, continental European divisions generally were composed of two infantry brigades (each of two regiments), two artillery regiments, a cavalry squadron and engineer, medical and administrative units. A typical division had a strength of about 12,000 men and 36 artillery pieces. The British division, organized by Lord Haldane in 1908, was considerably larger; it included three infantry brigades of four battalions each and four artillery regiments. The British army retained essentially the same structure in its infantry divisions through World Wars I and II, although firepower and mobility were greatly increased by the addition of light automatic weapons and motorization. During the American Civil War the United States had used the term "division" for a tactical subdivision of an army corps and later for a geographical area of military command. It experimented with provisional divisions along the Mexican border in 1911–14. Upon its entry into World War I, the U.S. army formed divisions of 27,000 or 28,000 officers and men, twice the size of most European divisions.

By 1928, the U.S. army had organized its peacetime regular and reserve forces into "square" divisions, so-called because their structure included two infantry brigades of two regiments each, with a total strength of nearly 20,000 men. In 1939 it adopted a "triangular" organization that eliminated the brigades and provided three infantry regiments of three battalions each. The divisional artillery regiments were reorganized into three battalions of light howitzers and one medium battalion. The new division, with only 15,000 men, had greater firepower and more flexibility than its predecessor. Conversion to the triangular organization was carried out during the mobilization for World War II, the divisions adding "infantry" to their title to distinguish them from the new armoured divisions organized beginning in 1940.

Following World War II, infantry and air-borne divisions retained the triangular structure, with an increased strength of about 17,000 men to accommodate the addition of organic tank and antiaircraft battalions, through the conflict in Korea (1950–53). In 1957 the U.S. army began tests of a "pentomic" divisional structure to meet the demands of atomic war. It included five battle groups (of about 1,400 officers and men each) in place of the former three infantry regiments. The new division had fewer but more varied artillery pieces, some light aircraft and a more flexible organization of supporting services. The strength of the pentomic infantry division was reduced to less than 14,000, that of the air-borne division to about 11,500.

U.S. armoured divisions originally were similar to the *Panzer* divisions developed by the German army at the start of World War II, and included three armoured regiments as the principal combat units. Following the war, the U.S. armoured division consisted of four tank battalions, four armoured infantry battalions, four battalions of self-propelled artillery, one antiaircraft artillery battalion, a reconnaissance battalion, an engineer battalion, signal company and other supporting services. Three combat command headquarters provided an echelon of tactical control of the combat units which could be arranged in various combinations to carry out the division plan of operations. The 1957 reorganization did not greatly alter this armoured division structure.

In 1961 the U.S. army announced plans to discard the pentomic structure and to reorganize its forces into four types of divisions: infantry, mechanized (motorized), armoured and air-borne. Under this reorganization all divisions would have the same type of base, including a divisional headquarters and three brigade headquarters. Other elements of the division base would be an artillery brigade of one missile battalion and four howitzer battalions; reconnaissance, engineer, signal and aviation battalions; and various supporting elements. To this base would be added various combinations of combat maneuver elements—infantry, mechanized, armoured or air-borne battalions—to form one of the four types of divisions. From two to five of these battalions would be under the tactical control of each of the brigade headquarters. By thus tailoring each division to fit its current mission by varying the number and types of combat maneuver elements, the division was made more flexible to cope with every type of warfare—nuclear, conventional or guerrilla.

See Gordon R. Young (ed.), *The Army Almanac* (1959); B. H. Liddell Hart (ed.), *The Red Army* (1956). (E. SR.)

DIVORCE. In modern legal terminology divorce is the act by which a marriage is dissolved in a way other than through the death of one of the spouses, and so that the parties are free to remarry immediately or after a certain period of time. Divorce—the dissolution of a valid marriage—must be distinguished from annulment (*q.v.*), where a competent authority declares that a marriage that has been celebrated is void.

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I. THE CHRISTIAN TRADITION

Divorce law in western Europe is based on a combination of Roman law and Roman canon law, and this twin tradition has spread outward from Europe to influence the whole Christian world. Divorce *a vinculo, i.e.*, from the bonds of marriage, thereby enabling a remarriage, was not generally obtainable from the time that Christianity became the established religion until the 18th century; then the Enlightenment revived Roman legal ideas and the French Revolution attempted to put some of them into practice. From the 18th century on, many states began to provide a formula by which divorce might be obtained in a small number of cases; in the 19th and 20th centuries this was extended to a larger and poorer public.

1. Evolution of Roman Law of Divorce.—Among the Greeks of the Homeric age divorce seems to have been almost unknown, but later it became very common in Greece. According to Attic law the husband could repudiate his wife whenever

he liked and without stating any motives, while the wife could demand a divorce by appealing to the archon and stating the motives for her demand.

The conception of the *patria potestas*, or the power of the head of the family over its members, entered deeply into the jurisprudence of ancient Rome. The wife was transferred at marriage to the authority of her husband, *in manus;* consequently she became so far subject to him that he could, at will, renounce his rule over her and end the marriage, subject at least to an adjustment of pecuniary rights.

In the case of a "free" marriage, in which the wife did not fall under the *manus* of her husband, divorce was allowed either by mutual consent or at the will of one party only.

The *lex Julia de adulteriis coercendis* (the Julian law concerning the restraint of adulteries), passed under Augustus in *c.* 18 B.C., was an attempt to protect the dignity of marriage. It recognized the power of divorce in both the husband and wife, but imposed restrictions, in the public interest; serious consequences followed conviction for adultery. At least in certain cases it required a written bill of divorce (*libellus repudii*) to be given in the presence of seven witnesses, who must be Roman citizens of age; and the divorce had to be publicly registered. In this way a wife could divorce a lunatic husband, or the *paterfamilias* (head of the family) of a lunatic wife could divorce her from her husband.

A sequence of imperial edicts laid down certain grounds for divorce, of which adultery by the wife was the most usual. Justinian, in particular, enacted a strict code for the dissolution of marriage: a woman might divorce her husband for reasons including a false accusation of adultery, treason, bringing a concubine into the house or continuing to live with another woman in the same town after admonition. A man might divorce his wife for treason, adultery, abortion and for other reasons including visiting dinners, balls, the circus or the theatre with men other than her husband, or without her husband's permission, or conversely, for staying at home against his wishes.

The spread of Christianity eventually resulted in marriage being treated not only as a civil contract but as a sacrament which was necessarily indissoluble.

2. Canon Law of Divorce.—How far Christ laid down any moral law in regard to divorce is a matter of controversy because of the form of his declaration that has come down to us and the different conceptions then existing of the connubial relations; exclusive marital fidelity, so far as a husband was concerned, was not in his time an established ideal, while concubinage was generally sanctioned.

The Pharisees asked Jesus, "Is it lawful to divorce one's wife for any cause?" Jesus replied: "What therefore God has joined together, let no man put asunder" and "For your hardness of heart Moses allowed you to divorce your wives, but from the beginning it was not so." Then came the declaration that is the main basis of the canon law: "Whoever divorces his wife, except for unchastity, and marries another, commits adultery; and he who marries a divorced woman commits adultery" (Matt. xix, 3–9). Practically the same formula was used in the Sermon on the Mount (Matt. v, 32) and in Luke xvi, 18 and Mark x, 11–12.

The canon law of the Roman Catholic Church is based on two main principles: (1) that there could be no divorce *a vinculo matrimonii, i.e.,* from the bonds of marriage, permitting remarriage, but only *a mensa et thoro, i.e.,* separation from board and bed; (2) that no divorce could be had at the will of the parties but only by the sentence of an ecclesiastical court. The same effect, however, could sometimes be achieved by a declaration that the marriage was a nullity. In canon law the term *divortium,* though generally applied to divorce *a mensa et thoro,* was often used as a synonym for annulment. In the middle ages the degrees of consanguinity and affinity which invalidated a marriage became so extended that, for instance, the marriage of Eleanor of Aquitaine to Louis VII could be annulled in 1152 after 14 years and the birth of two daughters.

The *Codex juris canonici* promulgated in 1917 lists the following 13 direct impediments to marriage: existing marriage bond, impotence, insufficient age, blood relationship, affinity, public propriety, spiritual relationship, legal adoption if it civilly voids marriage, abduction, crime (a technical term including adultery and conjugicide, or conjugicide only), sacred orders, solemn religious profession, disparity of religion. In the 16th century canon law included the further impediments of lack of consent, error, clandestinity, fear and duress, and insanity: these are now reclassified under the general headings of form and consent. (X.)

In the Orthodox Church there is no universal legislation on divorce, but only several principles as a basis. Strictly, divorce is permitted only in cases of adultery (*see* canon 9 of St. Basil). In practice other equally grave types of misconduct are deemed equivalent to adultery (*e.g.,* an attempt by one of the spouses to murder the other). The idea of death is also extended, by a legal fiction, to cover conviction for a serious crime, bringing with it the end of civilian life, or insanity.

A marriage to be valid must have the Orthodox Church's blessing, and therefore dissolution falls within the ecclesiastical competence, as was recognized by the novel 27 of the emperor Alexius I Comnenus. In fact, in modern times, the diocesan officials content themselves with setting aside or, much more often, with confirming the decision of the civil tribunal. In certain cases the guilty party is censured. In Greece, for members of the Orthodox Church, a civil procedure must always be preceded by an attempt at conciliation made by the bishop (art. 55 of the fundamental law of the church). (P. L'H.)

3. Divorce in the Protestant Churches.—Among the churches which developed out of the Reformation, the attitude toward divorce has varied, and it is only possible to make certain generalizations.

Luther and Calvin cast doubt on the sacramental nature of marriage and therefore on its indissolubility; in any case, they did not feel bound by Roman canon law. Luther declared marriage a "worldly thing" and thus not necessarily indissoluble. Lutheran churches regarded dissolution as certainly being justified in the case of an adulterous wife. Although the Calvinists were reluctant, Lutheran and Reformed princes in Germany and Scandinavia and city governments in Switzerland began to grant divorces in the modern sense either directly or through their consistories or special tribunals—the grounds being either adultery or such grave misconduct as cruelty or deception which were considered equivalent to adultery.

The Church of England, on the other hand, inherited Roman canon law unchanged, though in the 20th century it began to be slowly reformed. It will not marry a divorced person, but it will give a formal blessing in church to the marriage. It does not excommunicate persons divorcing, and divorced persons remarrying may eventually be readmitted to communion by episcopal sanction.

Many other Protestant groups, while upholding the importance of the marriage tie, have followed the line of the reformers in accepting the possibility of divorce—which in modern times means the civil divorce laws—and their attitude both to divorce and to subsequent remarriage is determined by the facts of each individual case. (X.)

II. ENGLAND AND WALES

1. History.—Before 1858 the ecclesiastical courts in England, *i.e.,* the consistory courts of the diocese and the superior court of arches, exercised jurisdiction in matrimonial disputes in accord with the canon law of Rome; but there was no complete divorce *a vinculo,* except by the costly procedure of a private act of parliament. The number of such divorces until the procedure ceased in 1859 was 317. The ecclesiastical courts could only pronounce a decree of divorce *a mensa et thoro,* from board and bed, equivalent to the modern judicial separation, which left the parties still married. For about 50 years after the Reformation there were a number of cases in which the ecclesiastical courts did allow complete divorce, but it was finally decided in 1602 (*Rye* v. *Fuliame*) that a marriage would not be dissolved by judicial action.

Early in the 19th century a movement arose in England for a reform and it was given a special impetus by a masterpiece of judicial irony uttered by Justice Maule in 1845 at the trial of a man

for bigamy. He said:

Prisoner at the Bar; you have been convicted of the offence of bigamy, that is to say, of marrying a woman while you had a wife still alive, though it is true she has deserted you and is living in adultery with another man. You have, therefore, committed a crime against the laws of your country, and you have also acted under a very serious misapprehension of the course which you ought to have pursued. You should have gone to the ecclesiastical court and then obtained against your wife a decree *a mensa et thoro*. You should then have brought an action in the courts of common law and recovered, as no doubt you would have recovered, damages against your wife's paramour. Armed with these decrees, you should have approached the Legislature and obtained an Act of Parliament which would have rendered you free and legally competent to marry the person whom you have taken on yourself to marry with no such sanction. These proceedings would have cost you many hundreds of pounds, whereas you probably have not as many pence. But the law knows no distinction between rich and poor. The sentence of the court upon you, therefore, is that you be imprisoned for one day, which period has already been exceeded, as you have been in custody since the commencement of the assizes.

Lord Campbell presided over a royal commission on divorce which reported, in 1853, in favour of setting up a special court for granting divorce *a vinculo* in appropriate cases. Effect was given to this recommendation by the Matrimonial causes act of 1857, which removed the jurisdiction from the ecclesiastical courts and transferred it to the civil court for divorce and matrimonial causes. This court was empowered to grant a man a divorce *a vinculo* on the ground of his wife's adultery, and a woman a divorce on the ground of her husband's adultery coupled with cruelty or desertion for two years or more. Other grounds for divorce by a wife were rape, sodomy or bestiality, incestuous adultery, or bigamy with adultery.

As the result of the report of a royal commission in 1912 presided over by Lord Gorell, it was enacted in 1923 that a wife could divorce her husband on the ground of adultery alone without the additional offense of desertion or cruelty; the Matrimonial Causes act, 1937 (introduced by Sir Alan Herbert, M.P., as a private member's bill), gave effect to most of the commission's other recommendations.

Under the Legal Aid and Advice act, 1949, which vastly extended the previous rules relating to poor persons, solicitors and counsel acting for assisted persons are paid out of a special legal aid fund to which persons aided may be asked, according to their income and assets, to contribute. This brought divorce within the range of people of small means and resulted in an increase in the number of petitions.

2. Grounds for Divorce.—The grounds for the divorce of either spouse consolidated in the Matrimonial Causes act of 1950 were: adultery, cruelty, desertion for three years or more, incurable insanity, communication of venereal disease, wilful refusal to consummate marriage, and the older grounds of sodomy or bestiality. Pregnancy at the time of marriage by another man without the husband's knowledge is a ground for the marriage to be declared void. A further ground of divorce was presumption of death of a vanished spouse. To discourage premature divorces the court was debarred from hearing a petition during the first three years of a marriage unless there had been exceptional hardship or depravity.

Adultery in law means willing sexual intercourse between a husband or wife and one of the opposite sex during the subsistence of the marriage. Proof of adultery is usually inferred from evidence of inclination and opportunity. The criterion of cruelty, first promulgated by Lord Stowell in *Evans* v. *Evans* (1790, 1 Hagg. Co. 35) and accepted by the house of lords in *Russell* v. *Russell* (1897, A.C. 395), is conduct by a husband or wife of such a character as to have caused danger to the life, limb or health, bodily or mental, of the other spouse, or as to give rise to a reasonable apprehension of such danger. Desertion is in essence the abandonment of one spouse by the other without just cause, or it may take the form of such conduct by one spouse to the other as reasonably compels the other to leave. Incurable unsoundness of mind of a spouse is decided in the main by medical evidence as to the patient's condition at the time of the hearing, but the patient must have had five years' treatment in a mental institution before a petition for divorce on these grounds may be brought. The great majority of such cases are undefended, but a public official represents the patient in nearly all cases.

As regards presumption of death, coupled with a decree of divorce, if it is proved that for a period of at least seven years a spouse has been continually absent from the petitioning spouse, and the latter has no reason to believe that the other spouse has been living within that period, a decree of divorce may be granted. But such a decree does not amount to a decision that the absent spouse is dead for the purpose of succession, for which separate proceedings in the probate court are necessary.

The Royal Commission on Marriage and Divorce, in its report of 1956, recommended as further grounds of divorce wilful refusal to consummate a marriage (ground for nullity under the act of 1950) and artificial insemination of a wife by a donor without her husband's consent. The commission was set up as a result of a private member's bill that would have made seven years' separation a ground of divorce by either spouse. The main issue was whether divorce should continue to be granted on the basis of certain specified matrimonial offenses or on the ground that the marriage had irretrievably broken down; its members were equally divided for and against this proposal.

3. Impediments to Divorce.—There are three absolute bars to a petition for divorce: collusion, connivance and condonation.

Collusion involves an agreement between husband and wife or their agents to present a false case, as when a man spends a night at a hotel or elsewhere with a woman on the pretense of adultery, in order to furnish the wife with evidence for divorce in an undefended suit.

However, an act of 1963 has recognized the right of a wronged wife to secure for herself and children of the marriage adequate maintenance before she divorces her husband, provided that the transaction is sanctioned by the court.

Connivance involves the conduct of a spouse in encouraging or being accessory to adultery by the other spouse, or recklessly exposing the other to the probability of adultery. Corrupt intention must be proved in most cases, but the presumption of law against connivance must be overcome by evidence.

It is also the duty of the court to inquire into facts which point to condonation; *i.e.*, forgiveness and reinstatement of the offending spouse with full knowledge of the offenses committed. Nevertheless, if the forgiven spouse later commits a matrimonial offense it may be held to revive the condoned offense. Thus in *Beard* v. *Beard* (1946, P. 8), where a wife's adultery had been condoned by her husband, she left him a short time afterward; her desertion, which had not continued for three years when the petition was presented to enable him to obtain a decree on that ground, was held to have revived her condoned adultery, and he was granted a decree. But by an act of 1963 the doctrine of a revival of condoned adultery was abolished.

In order to prevent divorces in cases of connivance and collusion or of undisclosed misconduct of the petitioner, the Matrimonial Causes act, 1860, provided that a claim of dissolution (a provision afterward extended to decrees of nullity) should in the first instance be a decree nisi, not to be made absolute until the expiration of a period then fixed at not less than three months.

Subsequent legislation increased the time to not less than six months. This delay was reduced in 1946 to six weeks, but was again restored to three months in 1957. The queen's proctor could, on suspicion of collusion, intervene before decree absolute, and, by direction of the court, he could intervene during the hearing itself, not only when collusion was in question but in regard to other matters.

By the act of 1950 there are discretionary bars to a petition for divorce for the following reasons: (1) unreasonable delay in petitioning; (2) the petitioner's cruelty to the other spouse; (3) when the petition is based on adultery or cruelty, where the petitioner has deserted the other spouse; (4) the petitioner's misconduct conducing to the other spouse's adultery, or unsoundness of mind, or leaving the petitioner; (5) when the petitioner has committed adultery during the marriage. Under this head the petitioner must disclose to the court the facts of his or her adultery by way of a "discretion statement." In the first case the courts very

seldom reject a petition because there has been delay in bringing a suit. Comparative poverty or a spouse's disinclination to petition until the children have grown up is usually regarded as an adequate excuse. In another judgment Lord Merrivale enlarged the exercise of the court's discretion to give relief to guilty petitioners in *Wilson* v. *Wilson* (1920, P. 20). He said that in exercising discretion, four points should be considered: (1) the position and interest of any children of the marriage; (2) the possibility of the marriage of the petitioner and the party with whom misconduct had been committed; (3) the prospect of reconciliation of the husband and wife; (4) the interest that the petitioner should be able to marry and live respectably. To these four points Viscount Simon, then lord chancellor, added a fifth in *Blunt* v. *Blunt* (1943, A.C. 471), "namely, the interest of the community at large, to be judged by maintaining a true balance between respect for the binding sanctity of marriage and the social considerations which make it contrary to public policy to insist on the maintenance of a union which has utterly broken down." In practice decrees are seldom refused by the court to guilty petitioners, though in some cases it is the other spouse who is granted the relief; in cases where the wrongdoing is more or less equally balanced, decrees are granted to both parties simultaneously except where the only ground is desertion.

4. Divorce Rate.—In 1867, the earliest year for which figures are available, petitions numbered 233 and decrees nisi 119. Until 1875 the annual average of decrees was 200, while a progressive increase started from 1892. In the first full year of World War I the number of decrees was 1,060; in 1919 it was 2,630, increasing annually thereafter to 5,044 in 1937. World War II brought a rush of divorces, the peak being in 1947 with 52,249 decrees; the lowest postwar figure was 23,868 in 1960.

5. Maintenance and Provisions After Divorce.—The ecclesiastical courts provided for the pecuniary rights of the wife by granting alimony to her during the progress of a suit, and a proper allowance afterward if she was successful. Such payments were dependent on the means or faculties of the husband and were, and are still so, subject to subsequent increase or diminution. The Matrimonial Causes act, 1950, provides a divorce with variation of prenuptial and postnuptial settlements and for settlement of a divorced wife's separate property on her husband or children.

On a decree of divorce or nullity granted to a wife she is entitled to apply for an order for what is styled "permanent" maintenance for herself and minor children; but as any such order is variable by the court in changing financial conditions "permanent" nowadays is a misnomer. In suitable cases the husband may be ordered to secure a portion of the amount of maintenance for the wife's life. Even if she marries again, it is not unusual for the court to decree that a considerable part of the amount order should continue to be paid. In exceptional cases, where the circumstances justify it, the order may be *dum sola, i.e.,* while she remains unmarried, or *dum casta,* while she remains celibate. Even a wife judged guilty of adultery or some other matrimonial offense may be granted maintenance if her fault occurred after an otherwise blameless married life, or if there are young children to bring up and educate; but this "compassionate allowance," as it used to be termed, is usually smaller than that accorded to an innocent wife.

Where the husband is very wealthy and the wife does not have separate means, the order may well be much less than a rule-of-thumb rate of one-third of his income, with additional provisions for the children. The nature of his assets has to be considered, as well as the position he has to maintain. The general principle is that a petitioning wife should be awarded fair subsistence after taking into account what is left to the husband after his income has been taxed. In insanity cases, husband petitioners are usually ordered to pay some small sum toward the maintenance of patients in mental institutions, and such orders may be made against petitioning wives if they have substantial means.

Where there is a decree of judicial separation, the order is styled "permanent alimony," and the same principles apply except that no order may be made to secure the alimony. When a wife brings a divorce suit she may claim alimony pending suit, formerly termed alimony *pendente lite,* the proportion of which is on a lower scale than permanent maintenance.

Although marriage settlements in the strict sense have gone out of fashion, there are still a number in existence and the court is still called upon to vary such settlements after divorce, usually for the benefit of the wife and children. Postnuptial settlements of this kind cover a wide range—from a covenant by a husband to pay periodical sums to the wife, to a conveyance of a freehold house to husband and wife as joint tenants. The court frequently orders the extinction of a husband's interest in a postnuptial settlement.

The provision in the act of 1957 that the custody, maintenance and education of children after divorce or judicial separation should be ordered has been further developed by subsequent legislation (*see* CHILDREN, LAWS CONCERNING). The old rule that a guilty mother was not entitled to access to her children was reversed by the court of appeal in *B.* v. *B.* (1924, P. 174).

The Matrimonial Proceedings (Children) act, 1958, extended the power of the courts to make orders for the welfare of children in matrimonial proceedings and to require satisfactory arrangements to be made for children before granting decrees. This was one of the recommendations of the 1956 royal commission. Legislative effect has been given to other of the commission's recommendations as follows: the Maintenance Agreements act, 1957, empowered the court to vary financial arrangements made between married couples whether separated or divorced, or after the death of one spouse. The Matrimonial Causes (Property and Maintenances) act, 1958, empowered the divorce court: (1) to order maintenance at any time after decree absolute; (2) to set aside dispositions made by the husband to defeat the wife's claims for financial relief; and (3) after the death of a party to a marriage which has been dissolved or annulled to make provision out of his estate in favour of the other party. The Maintenance Orders act, 1958, introduced the system of compulsory attachment of earnings where husbands ordered to pay maintenance were in default, though the commission had declared itself opposed to this remedy.

The Legitimacy act, 1959, put an end to the bar imposed by the Legitimacy act, 1926, which withheld legitimacy from the bastard child of a married couple one of whom was married to another person at the time of the child's birth. The act also provided that the child of a void marriage should be treated as the legitimate child of his parents if at conception one or both of the parents reasonably believed that their marriage was valid.

After a decree of divorce, a wife may choose either to retain her married name or to resume her maiden name. This applies also to the wife of a peer who after divorce marries a commoner.

6. Summary Proceedings for Separation.—Under the Summary Jurisdiction (Separation and Maintenance) act, 1895, married women were empowered to resort to magistrates' courts for maintenance and custody of children on specified grounds including desertion, however short. It was provided that no married woman guilty of adultery should be granted relief, unless the husband had condoned or connived at the adultery or conduced to it by wilful neglect or by misconduct. An appeal could be made to two judges of the divorce court. By the Matrimonial Proceedings (Magistrates' Courts) act, 1960, the maximum amount of maintenance which could be ordered for a wife (which had been increased from £2 to £5 a week by the Married Woman [Maintenance] act, 1949) was further raised to £7 10*s.* a week, together with £2 10*s.* a week maximum for each child.

7. Jurisdiction in Divorce.—In *Le Mesurier* v. *Le Mesurier* (1895, A.C. 517), a decision of the judicial committee of the privy council established that courts have jurisdiction to entertain divorce proceedings only where both parties are domiciled in England at the commencement of the proceedings. After this decision the rule that a wife automatically has the domicile of her husband led to hardship, and by the act of 1949 (repeated in the consolidating act of 1950) a wife's petition for divorce or nullity may be entertained if she has ordinarily been resident in England for at least three years immediately preceding the petition and the husband is not domiciled in any other part of the United Kingdom or in the Channel Islands or in the Isle of Man.

English courts will only entertain divorce petitions relating to monogamous marriages. Thus polygamous marriages cannot be dissolved, nor can they be recognized in the divorce jurisdiction as marriages, even if contracted in countries where polygamy is allowed.

In Northern Ireland (an autonomous part of the United Kingdom) the divorce law is practically the same as in England. In the Republic of Ireland the Roman Catholic law prevails, and divorce is excluded (*see* below). For Scotland *see* SCOTS LAW.

8. Marriage Guidance.—Impetus was given to the marriage guidance movement by the report of a committee presided over by Mr. Justice (later Lord) Denning in 1946 and that of the Royal Commission on Marriage and Divorce in 1956. It was urged that further state aid should be provided for development of the work of the National Marriage Guidance council and similar bodies, including the probation services, for conciliation and advice.

III. COMMONWEALTH OF NATIONS

1. Canada.—Though divorce is a matter within the control of the dominion parliament, that body has not seen fit to pass any general, overriding act, with the result that the divorce laws of the ten provinces, which remain in force until altered or repealed by dominion legislation, vary considerably. The provinces of British Columbia, Alberta, Saskatchewan and Manitoba adopted English law after 1857 (1858 for the first-named, 1870 for the other three), so that their courts have jurisdiction, as was available in England after the Matrimonial Causes act of that year, to grant decrees of divorce. As to Ontario, by a dominion act of 1940, the English law of divorce as in July 1870 was made to apply therein: the idea behind the date chosen in this enactment was to make the law of Ontario uniform with that of Manitoba, Saskatchewan and Alberta. In the case of Nova Scotia, New Brunswick and Prince Edward Island, English law was introduced well before 1857; but, by legislation of the provinces themselves (effected before the dominion was established in 1867), the power to grant divorce was given to the respective provincial courts. The courts of Quebec were not given divorce jurisdiction. "Marriage can only be dissolved by the natural death of one of the parties; while both live, it is indissoluble": the law is the same for Newfoundland, incorporated as a province of the dominion in 1949, but in both these provinces divorce can be obtained by private act of parliament, normally on the ground of adultery.

Thus judicial divorces can be obtained in eight of the ten provinces, but not in Quebec or Newfoundland. In the provinces where judicial divorce can be obtained, the English law of divorce prevails, subject to variations as to the grounds of divorce.

2. New Zealand.—The grounds of judicial divorce in New Zealand include all those existing in England, together with: (1) habitual drunkenness for four years coupled with cruelty or desertion by the husband, or neglect of household duties by the wife; (2) conviction and sentence of imprisonment for seven years or more for attempting to commit the murder of the petitioner, or wounding of the petitioner or a child of the parties; (3) conviction for the murder of a child of the parties; (4) incurable unsoundness of mind for at least 10 years (subject to confinement for seven of these years); (5) three years of separation agreed either orally or in writing (or after judicial separation). A married woman who, if she were a feme sole (single woman), would be domiciled in New Zealand, may present a divorce petition in that country, regardless of her husband's domicile elsewhere, providing that they have been living apart for at least three years.

3. Australia.—The Australian Matrimonial Causes act, which came into force in 1961, brought about uniformity of jurisdiction and of grounds for matrimonial causes throughout the country. One striking change was to make domicile in the country at large, instead of in each state, the test of jurisdiction in divorce. The grounds of divorce were: (1) adultery; (2) desertion for not less than two years; (3) wilful and persistent refusal to consummate the marriage; (4) cruelty; (5) rape, sodomy and bestiality; (6) habitual drunkenness or drug addiction for not less than two years; (7) a husband's frequent convictions for crime within five years of the marriage with a minimum of three years' imprisonment, and habitually failing to support his wife; (8) imprisonment since marriage for not less than three years for an offense punishable by death or life imprisonment, or imprisonment for five years or more and still in jail; (9) conviction since marriage, within one year immediately preceding the petition, for grievous bodily harm, or the intent to inflict such, or attempt to murder the other spouse; (10) habitual and wilful failure for two years immediately preceding the petition to maintain the petitioner under order or separation agreement; (11) failure to comply with a decree for restitution of conjugal rights after a year; (12) unsoundness of mind, subject to five years' confinement in a mental institution; (13) separation whether by order or agreement for not less than five years last preceding the petition with no reasonable likelihood of resuming cohabitation; (14) absence of a spouse in circumstances and for a time sufficient to presume death.

This consolidating act also introduced conciliation as part of the machinery of the divorce courts.

IV. UNITED STATES

1. Background.—Divorce has the same meaning in the United States as in England; *i.e.*, the legal dissolution of the marriage bond. In the British colonies of North America before independence, the only method of divorce was by the act of a legislative assembly, comparable to divorce by means of a private act of parliament in England, a costly and cumbersome procedure. At that time the canon law of divorce *a mensa et thoro*, the equivalent of modern judicial separation, prevailed in England and was administered by the ecclesiastical courts. Though the principles and practice of those courts never became part of the common law of the United States after the Revolution, they exercised much influence in U.S. courts, and still do in Maryland. Derived, as they are for the most part, from the same origin, a great deal of the basic premises and operation of the divorce law in England, summarized above, applies to that in force in the United States.

Under the U.S. constitution divorce law became the province of each state, with the result of considerable diversification between state and state, differing as they did in national and religious origins and social customs. The grounds of divorce vary from adultery to incompatibility of temper to separation of the spouses for a statutory period.

Justice Frankfurter, of the U.S. supreme court, made the following pronouncement in the celebrated case of *Williams* v. *North Carolina*, 317 U.S. 287 (1942): "Divorce, like marriage, is of concern not merely to the immediate parties. It affects personal rights of the deepest significance. It also touches basic interests of society. Since divorce, like marriage, creates a new status, every consideration of policy makes it desirable that the effect should be the same wherever the question arises."

This case brought into the limelight the practice of divorce in the state of Nevada, where a sojourn of six weeks suffices to create domicile and jurisdiction for a divorce decree. In the bigamy trial of Williams, the North Carolina supreme court declared invalid a decree of divorce in Nevada because the parties were domiciled in North Carolina. The husband had married again and was convicted of bigamy. On appeal to the U.S. supreme court, the conviction was quashed because the divorce decree was considered valid by virtue of the "full faith and credit" clause, art. iv, of the U.S. constitution. Under this clause the judgment of a state court must be recognized in every other state court. But the case did not end there, because the husband was again prosecuted for bigamy on the ground that he had not acquired a genuine domicile in Nevada. He was convicted and again appealed. This time the U.S. supreme court upheld the conviction on the new ground, which was held not to come within the full faith and credit clause. Subsequent decisions have not cleared up the confusion.

The ease with which so-called migratory divorces could be obtained in Nevada and in one or two other states by U.S. nationals whose real domicile and habitual residence were in another state, where divorce was more strictly administered, has been a frequent topic of comment among social reformers. Nevertheless, this type of divorce comprises only a small proportion of the total number of divorces, the vast majority being obtained by parties married

and domiciled in the state where their petition is heard.

2. Movement for a Uniform Divorce Law.—A movement was gathering weight in the 1960s for a uniform law of divorce throughout the United States. It was hoped that eventually all courts would administer principles which, though recognizing divorce as a necessary loophole for broken marriages, would render casual and ill-considered petitions more difficult. A Gallup poll in 1954 throughout 48 states showed that 85% of the voters favoured a uniform divorce law.

A project was drafted in 1952 by a committee of the National Association of Women Lawyers under the chairmanship of Matilda Fenberg of Chicago. The proposed Uniform Divorce act specified as grounds of divorce: violation of mutual fidelity or respect, or of the right of consortium. Jurisdiction of the courts was based on the principles of domicile for at least six months. The project made a strong point of the court's conciliation services.

3. Divorce Rate.—Statistics concerning divorce have been gathered by the U.S. department of labor, the bureau of the census and the national office of vital statistics. The latter agency collated data showing that the ratio of divorces to population rose steadily after 1867 with the exception of temporary dips in the general upward curve after wars and business depressions. The 1867 rate was 0.3 divorces per 1,000 population. By 1887 it was 0.5 and by 1907 had reached 0.9 per 1,000 population, increasing at an accelerated pace to a high in 1946 of 4.3 per 1,000 population including the armed forces overseas.

The ratio of divorces to marriages in the United States in 1867 was negligible and did not increase substantially until World War I. World War II had the effect of increasing the number of divorces in 1946 to about 610,000. For several years thereafter there was a notable decrease. The rate of divorces per 1,000 population declined to 3.4 in 1947 and 2.8 in 1948. By 1954 it had dropped to 2.5. According to the national office of vital statistics, about 377,000 divorces (including annulments) were granted in 1955. Prosperous economic periods seem to have enlarged the volume of divorces, contrary to the experience of the depression years following 1929, while the divorce boom and decline following World War II repeated the post-World War I pattern.

The average duration of the dissolved marriages was estimated to be about 6½ years. There were no children by a little over half the marriages concerned. In about 25% of the cases there was more than one child, and in almost 23% only one child. Wives were granted seven out of ten decrees. Taking the statistics of marriages and divorces in the United States as a whole between 1949 and 1959 the ratio of marriages dissolved to the number of marriages celebrated in any one year was roughly one in four.

The rate in Nevada for many years ran from 24 to 35 times that for the nation as a whole; and the Florida rate averaged between 2 and 3 times the national rate. These states, and a few others, attracted "divorce business" through the enactment of laws making quick divorce easily available to persons from other states where the divorce laws were less liberal.

4. Advisory and Conciliation Services.—The frequency of divorce in the United States has been the subject of endless discussion, with general agreement that marital maladjustments and the breaking up of families have grave social consequences, especially through the weakening of parental controls and the inevitable insecurity felt by the children of divorced couples. The high rate of delinquency among children may fairly be ascribed very largely to the disorganization of their family life.

It is generally accepted that the way to reduce the number of divorces is to improve and increase the preparation for marriage by training young people to understand the responsibilities as well as the rewards of family life. Premarital clinics and advisory services were established in many cities in the hope of equipping prospective husbands and wives with a sound attitude toward marriage, and in the hope of advising married couples about their difficulties.

Conciliation services have likewise been set up in connection with divorce courts. One of the pioneers of this movement, Judge Roger A. Pfaff, described the operation of the conciliation court of Los Angeles county in detail before the American Bar association convention in 1960. In the previous year 3,661 petitions were presented in the conciliation court of which 48% resulted in reconciliation, and during the first half of 1960 over half of such couples became reconciled. A check made one year after each reconciliation showed that three out of four remained reconciled. The work of the court was given a special impetus by Judge Louis H. Burke, president of the superior court of Los Angeles county, when he was assigned to the conciliation court. The procedure is to assign a qualified marriage counselor to a couple after a petition has been presented; if conciliation is achieved, husband and wife then sign an agreement relative to their particular problems.

5. Grounds for Divorce.—In every state adultery is a ground for divorce; in New York it is the only ground.

Cruelty as variously and widely defined in state statutes is also a mutual ground in most states. The broad principle that the court may find cruelty when a spouse, by his or her inhumane treatment, renders the continuance of married life impossible is widely established. Habitual drunkenness is a ground in all but approximately 10 states, and in about an equal number of states what is statutorily defined as "personal indignities" is a ground for divorce. Denial of marital intercourse for a long time does not usually rank as cruelty, though the contrary has been held in two states.

Desertion for periods varying between one and five years is a ground for divorce in nearly all the states. In about half the states persistent refusal of marital intercourse is treated as desertion. Constructive desertion may be found where one spouse, by misconduct, compels the other to leave. In almost the same category comes wilful neglect to support the wife: this is operative in most states. In many states there is provision for granting divorce to spouses whose partners have been absent and unheard of for a specified period of years.

Insanity at the time of the marriage is in a large number of states ground for dissolution of the marriage rather than annulment, though the distinction is more or less a matter of form. In more than half the states, if a spouse becomes incurably insane after marriage the other spouse is permitted to obtain a divorce, subsequent to safeguards against abuse, and with the proviso that the patient must have been in a mental institution for stated periods.

Separation of the spouses for specified periods is a ground for divorce in about 15 states, in some of which a petitioner's own wrongdoing is a bar. Among other grounds of divorce are: incompatibility; sodomy; wife pregnant at the time of marriage by other than the husband; communication of venereal disease; leprosy; attempted murder; and defamation.

Defenses to a divorce petition may include—apart from a denial of the charges—collusion, connivance and condonation as defined in English law; and in about half the states the state attorney has the same duty to perform as the queen's proctor in intervening in a suit, if a fraud on the court is suspected, whether that suspicion is raised by a party or emerges in evidence. As regards delay in filing a divorce suit, many states have imposed limitations of time for such proceedings. Serious provocation may be a defense.

6. Maintenance After Divorce.—"Permanent" alimony may be ordered much on the same basis as maintenance in the English system, and is subject to variation. Final alimony is frequently awarded in a gross sum, a procedure allowed in England only by special consent of the court and after agreement between the parties. In some states a husband may claim alimony from a guilty wife if she is possessed of substantial means, and in particular when the husband is destitute and incapable. Statutes regulate the power of the courts to adjust property rights of the parties in divorce. (*See* ALIMONY: *United States.*)

7. Jurisdiction.—Each state has its own jurisdiction in divorce: federal courts have none at first instance, though they try appeals based on the "full faith and credit" clause. Although "residence" and "domicile" are usually treated as synonymous, in strict law the Anglo-American concept remains; *i.e.*, residence in a state coupled with the intention of continuing to live there for an indefinite period. In *Andrews* v. *Andrews* (176 Mass. 92) the supreme court of Massachusetts held that it was not sufficient to live 90 days in South Dakota, the period of domicile prescribed by statute in the latter state, for a petitioner for divorce to acquire a *bona fide* domicile, when it was his intention to leave that state

after having obtained the decree.

Nevertheless, the multiplicity of jurisdictions in the United States involves considerable differences in the periods laid down by statute for the acquisition of domicile to found a divorce suit. The periods of residence laid down vary from six weeks in Nevada to three years in Connecticut, with most of the states requiring residence for a year. In New York no specific period is laid down. There is a well-established exemption to the ordinary conception that a wife by marriage acquires the domicile of her husband; for the purposes of a divorce a wife may require a separate domicile.

8. Recognition of Foreign Decrees.—Although, within the limitations mentioned, under the full faith and credit clause the divorce decree of a state will be recognized in any other state, this rule is not applicable to judgments of divorce made outside the United States. Such judgments are generally recognized if made by competent courts in foreign countries, even if the ground is not one allowed in the particular state. The same applies to Jewish rabbinical divorces abroad.

In Mexico the principles of jurisdiction and divorce are somewhat loose when considered from the Anglo-American view. The English case of *Mountbatten* v. *Mountbatten* (1959) illustrated a marked difference between the laws of New York and of England with regard to jurisdiction. The husband, domiciled in England, arranged with his wife, resident in New York, for her to bring an undefended divorce suit in the state of Chihuahua, Mex. She petitioned on one day in 1954 and appeared in court next day and obtained the decree, the husband submitting to the jurisdiction. According to decided American cases the New York court would recognize the Mexican decree. The husband, in order to clarify his legal position, petitioned in England for a declaration that the Mexican decree was valid. The court held that since the husband had always been domiciled in England the Mexican decree was invalid and could not be recognized owing to the interposition of a residential qualification by the wife in New York state.

(W. La.)

V. EUROPE

1. Italy, Spain, Ireland and Portugal.—Complete divorce *a vinculo matrimonii* (from the bond of marriage) is not legally possible in those countries in which the Roman Catholic Church preserves its ancient powers. In rare cases the same result may be achieved by the ecclesiastical courts declaring that the marriage was a nullity. A partial divorce *a mensa et thoro* (from board and bed), which is the equivalent of a judicial separation, may be granted on certain grounds, but leaves the parties still married.

The Italian courts do not recognize foreign divorces relating to Italian subjects; but if a national of a foreign country celebrates his marriage in Italy and then gets a decree of divorce in another country, this decree, under certain conditions, may be enforceable in Italy through special proceedings (*delibazione*) in a court of appeal. In Spain and Portugal the law is practically the same as in Italy. Portugal, however, has a comprehensive divorce law relating to non-Catholic marriages.

2. France.—Before the Revolution divorce was regulated by Roman canon law, and marriage was considered indissoluble. By the law of Sept. 20, 1792, however, marriage in France was declared a civil contract and divorce was easily obtained for a wide variety of causes including mutual agreement, though not for the insuperable aversion of one party to the other. The civil code of 1804 allowed divorce for adultery, condemnation for a serious crime, *excès* (violence) and cruel treatment or a serious insult. Divorce by mutual agreement was permitted, owing to Napoleon's personal support of it, but it was cumbersome, expensive and time consuming. Shortly after the restoration of the monarchy, divorce *a vinculo* was abolished, in 1816.

Under the third republic divorce was re-enacted by a law of July 27, 1884, which utilized much of the original legislation of 1804, while dropping the ground of mutual agreement. These provisions were simplified by the laws of 1886 and 1907. Divorce was allowed for: (1) adultery by either party to the marriage at the suit of the other without, in the case of adultery by the husband, the aggravation of introduction of the concubine into the home required by the code; (2) violence (*excès*) or cruelty (*sévices*); (3) *injures graves*, acts reflecting on honour or reputation and such things as unjustifiable refusal of marital rights or habitual drunkenness; and (4) *peine afflictive et infamante*, infliction of a punishment involving confinement and moral degradation. If, however, *séparation de corps* has existed for three years, it might be turned into a divorce upon the application of either party to the court. Subsequent measures made divorce simpler until a statute of 1941 (partly upheld in 1945) narrowed the grounds and slowed down procedure. The publication of divorce proceedings has always been forbidden under heavy penalties. After a divorce the wife may not continue to use the name of her divorced husband.

3. Germany.—Divorce was introduced in Prussia at the same time it first became possible in France. The *Allgemeines Preussisches Landrecht*, a great codification of laws started by Frederick II and published 1791–94, gave divorce for adultery, cruelty and desertion a statutory basis. In addition, divorce was available by mutual consent, providing there were no children by the marriage, or if one party had formed "an insuperable aversion" to the other. The precedent was thus established for divorce as an escape from an unhappy marriage. Divorce on the grounds of insuperable aversion was, however, expensive. Divorce was effected by a court decree after an investigation.

The law of divorce in the Federal Republic of Germany (West Germany) is contained in law no. 16 of the Allied Control, which is based on the code of 1900 that was in force until World War II. The matrimonial offenses which constitute grounds for divorce are much the same as in France and other European countries, except that where a marriage has hopelessly broken down, the parties, in effect, may obtain a divorce by mutual consent.

4. Other Western European Countries.—The law is almost the same in Austria and Belgium as it is in Germany. In Scandinavian countries and in the Netherlands the usual matrimonial offenses afford ground for divorce, coupled with the right of dissolving marriages by mutual consent after certain periods of separation. In Switzerland divorce by mutual consent has been abolished, but may follow the usual matrimonial offenses. (W. La.; X.)

5. U.S.S.R.—Divorce after the Revolution was granted on application of either spouse, but by the decree of July 8, 1944, it was made a matter of legal process. The decree imposed on the courts the responsibility of determining the grounds on which divorce might be granted. The overriding principle was, however, stated to be the strengthening of the family in Soviet society; accordingly, the courts, wherever possible without causing suffering or injustice, seek to prevent the dissolution of a marriage. In most cases applications for divorce are heard first by a people's court, the purpose of which is to reconcile the parties. If reconciliation proves impossible, the application is passed to a superior court which considers the evidence and circumstances of the parties and makes a decision. The court will usually refuse divorce where minor children are involved, unless convinced that they may benefit. (I. Gv.)

6. Other Eastern European Countries.—In Hungary, Poland and Czechoslovakia the main ground for a judicial divorce is the breakdown of the marriage. In Yugoslavia the grounds of divorce include an attempt on the life of the other spouse and unexplained absence for six years. (X.)

VI. AFRICA, ASIA AND THE FAR EAST

1. Middle East and North Africa.—Muslim religious courts have exclusive jurisdiction in matters of the personal status of Muslims in accordance with the provisions of Islamic law. Under Muslim law the contract of marriage may be dissolved by the husband at will, without the intervention of a court or by mutual consent of the parties. Marriage may also be dissolved by a judicial decree in a suit by the husband or wife, or by the operation of law.

A divorce by *talaq* is the method of repudiation by or on behalf of the husband. Any Muslim of sound mind who has attained puberty may divorce his wife whenever he desires without assigning any cause, though on doing so he becomes liable for the payment to her of any outstanding part of her marriage settlement.

A revocable pronouncement of *talaq* does not dissolve the marriage until the period of *iddat* (a period of continence imposed on

a woman on the termination of a marriage in the interests of certainty of paternity) has expired and may be revoked during this time. An irrevocable pronouncement dissolves the marriage immediately. In the absence of words showing a different intention, a divorce in writing is irrevocable and takes effect immediately.

The custom differs according to the circumstances of a particular community in different parts of the Islamic world. Indeed, even different sections of the same community have their own customs, but within the general principles of Islamic law. In Saudi Arabia and Yemen, for example, the principles of Islamic law are strictly adhered to and the scope of interpreting these principles is limited. In the 1960s efforts were being made in some of the middle east and north African countries, such as Egypt, Iraq, Jordan and Tunisia, to restrict divorce which, according to a saying of the Prophet Mohammed, is "the most detestable of all permitted things." A law was passed in Tunisia whereby *talaq* can only take place before the court. (J. Nr.)

2. Israel.—In ancient Hebrew practice husbands could divorce their wives at will, but in the 11th century A.D. this right of repudiation was limited by the husband having to show good cause to the rabbinical authority. This is still the Jewish law, and the rabbinical courts alone have jurisdiction. The wife's procedure for obtaining a divorce consists in putting her case to the rabbinical court, which may require the husband to give her *get* or a bill of divorce. The main ground of divorce is a wife's childlessness, while mutual consent is also a ground if the rabbi cannot bring about reconciliation. In the state of Israel there is no civil law of divorce, and the religious courts have exclusive competence. (No. B.)

3. Asia and Africa.—In such Asian countries as Ceylon, India and Pakistan and in the republics of Africa, family relations are governed by the personal law of the citizens based either on religion (as among Muslims and Hindus) or on the customary law of the territory (as in the republics of Africa or the North East Frontier agency of India).

Hindu marriage is regarded as a sacrament and as a union for life. Divorce was, therefore, unknown to Hindu law except in certain parts of south India where, both by statute and by custom, marriages could be dissolved. In 1955 the Hindu Marriage act brought the law for Hindus in line with that governing the other communities such as the Parsees and Christians; under s. 13 the right of divorce was introduced for nine reasons, including desertion, adultery and the ground, uncommon in the west, that one party was converted to another faith. The equality of husband and wife has been recognized by no longer regarding the right of alimony and maintenance as the prerogative of women. This act, however, applied to India only and to persons who, though married outside, are domiciled in India.

Muslim divorces are distinctive because the intervention of the court is not necessary to validate them. The husband has the right to terminate the marriage at will, by *talaq*, without assigning reasons. Divorce after *talaq* is irrevocable, even if it is proved that he uttered the words under compulsion or in a state of intoxication. The wife's right is restricted, and she usually has to purchase her divorce: a divorce known as *khula*. A feature of Muslim law is that divorce can be brought about by consent, marriage being considered a contract. This is also true of divorce under the Special Marriage act, 1954, which governs all secular marriages in India.

The husband, almost throughout Africa, has the right to dissolve the marriage unilaterally and also extrajudicially. The restraining influence is the possibility of forfeiture of the dowry; under customary law the African husband forfeits the dowry if he divorces his wife without justification. But the wife of a customary union in Africa cannot herself dissolve the marriage; the consent of her guardian is essential. Even in divorces by common consent, the wife and her guardian have to be party. In many parts of Africa, particularly in Ghana, the wife's adultery alone is not regarded as sufficient justification for a divorce. Such adulterous behaviour must be followed by the wife's continued misconduct to justify the claiming of the dowry by the husband. (La. S.)

4. Former French Africa.—The customary rights of the diverse peoples of these territories have far more homogeneity in divorce than in marriage. Excluding the cases where the requisites of marriage were not fulfilled, the principal cause of divorce is sterility—procreation being the main object of marriage; sterility in the man must be proved. Another cause is grave illness or other infirmities. Insults to the family-in-law are a frequent cause of rupture. Divorce is also pronounced against the party who is failing in his or her obligations; the husband is bound to maintain the family home (and children), the wife must live with her husband, prepare his meals and remain faithful. She may visit her family in circumstances fixed by custom. Adultery more often ends in an arrangement than in a divorce. (J. L. P.)

5. China.—Under the code of 1930, which still applies in Formosa, divorce is permitted by mutual consent in writing with the signatures of at least two witnesses, and may be granted by the court for adultery. In the Chinese People's republic divorce can take place by mutual consent.

6. Japan.—Divorce was allowed under the old law of the Horei, 1896, by mutual consent, for three years' unexplained absence, and imprisonment for a grave crime. This was reformed after 1947 in the new civil code. Divorce was allowed by mutual consent and for such offenses as adultery and desertion. The family court adjudicates in cases of dispute. (X.)

See Adultery; Alimony; Annulment; Marriage, Law of. *See* articles dealing with the law of particular countries; also the references under "Divorce" in the Index. For recent divorce statistics, *see* "Vital Statistics" in the *Britannica Book of the Year*.

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DIWAN (Divan), a word of near eastern origin with the Arabicized plural *dawawin*, primarily meaning a "register," whence "administration" and "finance department"; also a poet's collected verse, arranged according to the last letter, in alphabetical order, of the rhymes. Meaning "register" in a financial context, it appeared under the caliph Omar (A.D. 634–644) as the record of Muslim warriors with their entitlements to spoil. It later acquired the meaning of a register of state financial transactions, and under the Abbasid caliphs (750–1258) it denoted treasury and then the whole civil administration, separate *diwans* being designated according to function. It lost its bureaucratic connotation in Iran but retained it under the Ottomans in Turkey and the Moguls in India. There it meant in modern times a court of law, but from the time of Akbar (1556–1605) it was chiefly associated with government finance, the chief finance minister being the *diwan* with provincial *diwans* under him (*diwani* designating revenue, as opposed to general, administration). Under the Ottomans it meant the imperial chancery headed by the grand vizier.

In 1515 a consultative assembly of senior officials summoned by Selim I also was called a *diwan*. It was early extended to mean the audience chamber of important government officers. These offices were furnished with mattresses and cushions along the walls, and this accounts for the extension of the meaning to "sofa" (*see* Chair and Sofa) common in Europe and now returned to modern Turkish.

See R. Levy, *The Social Structure of Islam* (1957). (P. W. A.)

DIWANIYAH (Ad Diwaniyah), a town in Iraq, capital of the *liwa* of the same name. It lies on the Hillah branch of the Euphrates river, approximately 100 mi. S. of Baghdad, to which it is joined by road and rail, and 50 mi. S.S.E. of Hillah. Pop. (1957) 33,204. The town is situated on both sides of the river, which is embanked by partly natural and partly artificial levees 12–16 ft. above low-water level and is spanned by a bridge. The greater part of the town is on the left (eastern) bank. Diwaniyah

is largely built of brick and sun-dried mud. The chief buildings include the administrative centre (serai), hospital, barracks, schools and commercial buildings with a covered bazaar. Formerly known as Hiska, the town became a centre of government in the 18th century and was later elevated to the capital of an Ottoman sanjak. It has strategic importance, covering approaches to Baghdad from the southwest, and is the centre of a rich though turbulent province.

DIWANIYAH LIWA (area 32,328 sq.mi.; pop. [1960 est.] 520,757) is of considerable agricultural importance, being noted for its cereal production based on intensive irrigation from the Euphrates system. Rice, of which Diwaniyah and Amarah are the two main producing areas in Iraq, is in some years the principal crop, with barley second and wheat a close third. Many water buffalo are kept, an indication of the generally marshy and low-lying terrain, which is on the average less than 100 ft. above sea level.

(W. B. FR.)

DIX, DOROTHEA LYNDE (1802–1887), U.S. social reformer and humanitarian, whose devotion to the welfare of the mentally ill led to widespread reforms in the U.S. and abroad, was born on April 4, 1802, in the frontier town of Hampden, Me. She was a granddaughter of Elijah Dix, a prominent Boston physician. Dorothea's early life was one of poverty and neglect. At the age of 12 she left her parents' home for that of her grandmother in Boston, and finished her schooling with an aunt in Worcester, Mass. In 1821 she opened a school for girls in Boston, where, until 1835, she alternated periods of intensive teaching with bouts of poor health. During illness and convalescence she wrote books for children, traveled abroad and made important contacts as tutor to the children of William Ellery Channing.

Her primary career, however, opened in 1841 when she accepted an invitation to teach a Sunday school class in the East Cambridge (Mass.) jail. There the sight of insane persons thrown into prison with criminals of both sexes stirred her deeply. In the next 18 months she visited every conceivable place in Massachusetts where mentally ill persons were confined, and revealed the shocking conditions in a report made to the state legislature in 1843. When improvements followed, she turned her attention to neighbouring states and then to the west and south, and saw special hospitals for mental patients built in more than 15 states and in Canada, and improved treatments practised throughout the nation. Her efforts to secure public lands for her cause failed, but she did arouse a new interest in the problems of mental illness both in the United States and Europe.

During the Civil War Miss Dix served as superintendent of women nurses for government hospitals, and at its close returned to her work for the insane. She died on July 17, 1887, in the state hospital in Trenton, N.J., which had been established through her efforts.

See Francis Tiffany, *Life of Dorothea Lynde Dix* (1892); Louisa May Alcott, *Hospital Sketches* (1863); Helen Marshall, *Dorothea Dix, Forgotten Samaritan* (1937). (AY. CX.)

DIX, JOHN ADAMS (1798–1879), U.S. political leader and army officer who served in both the War of 1812 and the American Civil War, was born at Boscawen, N.H., July 24, 1798. He attended Phillips Exeter academy and the College of Montreal, and entered the U.S. army at the age of 14. He served during the War of 1812 and remained in the army after the war. Meanwhile he took up the study of law and was admitted to the bar in 1824. From 1828 to 1830 he practised law in Cooperstown, N.Y., where his wife's father owned large areas of land. He was appointed adjutant general of New York in 1830 and became a member of the "Albany regency" (*q.v.*), a politically powerful group of New York Democrats. He rose rapidly in politics, serving as secretary of state and superintendent of public schools (1833–39); as a member of the state assembly (1841); and as United States senator from New York (1845–49). He supported the antislavery wing of the Democratic party. In 1860 he was appointed postmaster of New York city and in 1861 served a short term as secretary of the treasury of the United States. While holding the latter office he issued to a treasury officer in New Orleans the famous order: "If any one attempts to haul down the American flag, shoot him on the spot." He was appointed major general of volunteers (1861) and as commander of various departments he rendered valuable service to the cause of the Union. He was U.S. minister to France (1866–69), and in 1872, although a Democrat, he was elected governor of New York by the Republicans. He died in New York, April 21, 1879.

See D. S. Alexander, *Political History of the State of New York*, vol. ii (1906); Morgan Dix, *Memoirs of John Adams Dix* (1883).

(R. E. AT.)

DIX, OTTO (1891–), German painter and engraver of socially critical realism, was born on Dec. 2, 1891, at Untermhaus, Thuringia. Trained in Dresden, he was joint founder in 1919 of the "Dresden Secession" and held his first exhibition with the Dresden "1919 group." He executed 50 etchings, "War," in 1923–24 and innumerable portraits in 1923–25. In 1925 he held an exhibition at the National gallery, Berlin, and in 1927 was appointed professor at the Academy of Fine Arts, Dresden, but was later dismissed under the Nazi regime in 1933. Dix was featured in the Nazi exhibition of "Degenerate Art," and his pictures were

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"SOCIETY WOMAN" BY OTTO DIX

removed from the museums in 1938. He had settled in 1933 at Randegg in the Hegau, and in 1936 at Hemmenhofen on Lake of Constance. After 1933 he painted symbolic religious paintings and landscapes, tending toward the old German masters. In 1946 his subject matter changed again, tending toward religious pictures and landscapes. Between 1948 and 1956 he made more than 100 lithographs. Dix's stylistic development has moved away from the prototype of the Italian Renaissance, through surrealism ("The Moon-Woman," 1919), to socially critical realism, which in 1924 became romantic ("Nelly in the Flowers") and close to the idea-painting of A. Böcklin ("The Temptation of St. Antony," 1936–37). After World War II he modified his painting both in colour and draftsmanship.

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(W. GN.)

DIXIE, a term with two meanings: (1) a popular name generally applied to the southern states of the U.S., particularly those which formed the Confederate States of America, and (2) the title of a song written and set to stirring music in 1859 by Daniel Decatur Emmett, a native Ohioan of Virginia parentage.

Several explanations of the word as applied to the region are current. The most popular is that it had its origin in ten-dollar notes issued before 1860 by the Citizens Bank of New Orleans. Because of the large numbers of French-speaking inhabitants in the area these notes carried the French word *Dix* ("ten") on the reverse side. Thus, Louisiana, and later the entire South, became known as the land of Dixies or Dixie Land. In another story, a kindly, paternalistic New York slaveowner named Dixie moved to the deep south and his slaves called the new home Dixie Land. A variation of this version had Dixie selling his slaves to southern masters when abolitionist sentiment in New York became strong. These slaves, lamenting their new lot, wanted to go back to "Dixie's Land," in this case, New York. How the name was transferred to the South is not explained. There was also an early attempt to connect the term with the Mason and Dixon line.

Emmett, songwriter and performer for Jerry Bryant's minstrel troupe, composed "Dixie" as a "hooray song" or "walk-around" for the company's show. It is said that he got the idea from strolling showmen who, on cold, dreary days in New York, would say, "I wish I was in Dixie Land."

First sung under the title "Dixie's Land" in New York city, "Dixie" received wide acclaim when played by Carlo Patti and sung by Susan Denin at the Variety theatre in New Orleans in Jan. 1861. Played at the inauguration of Confederate President Jefferson Davis at Montgomery, Ala., on Feb. 18, 1861, "Dixie" soon became what was probably the most popular marching song of the Confederacy and is often regarded as the Confederate national anthem. Albert Pike, poet and general from Arkansas, composed the words for a Confederate version that was published on April 30, 1861, and Mrs. M. B. Moore of North Carolina began in 1863 a *Dixie Series* of Confederate school books that included primers, spellers, readers, histories and arithmetics. Although the word Dixie quickly became synonymous with the South, the North continued to claim the song and there was at least one set of pro-Union lyrics written for it. Speaking to a crowd that had gathered on the White House lawn to celebrate Gen. Lee's surrender, President Lincoln asked the marine band to play "Dixie," jokingly insisting that the Union armies had "fairly conquered it."

Despite the various versions written during the Civil War, Dan Emmett's lyrics were the ones that survived, and, although Dixie, the land, refers only to the South, "Dixie," the song, is beloved by the entire nation. (F. M. G.)

DIXON, GEORGE (*c.* 1755–*c.* 1800), English navigator who explored the shores of the present British Columbia. He served under Capt. James Cook in his third expedition (1776–79), and on his return became a captain in the merchant navy. In the autumn of 1785 he sailed in the "Queen Charlotte," in the service of the King George's Sound company of London to develop the fur trade in what is now British Columbia. His chief discoveries along the coast were those of Queen Charlotte's Islands and sound (the latter only partial), Port Mulgrave, Norfolk bay, and Dixon's Entrance and archipelago. Dixon disposed of his cargo in China and returned in 1788. In 1789 he published *A Voyage Round the World, but More Particularly to the North-West Coast of America,* the bulk of which consists of descriptive letters by William Beresford, his supercargo. Dixon's own contribution to the work included valuable charts and appendixes. He is usually identified with the author of *The Navigator's Assistant* (1791), who was a teacher of navigation at Gosport, Eng.

DIXON, JOSEPH (1799–1869), U.S. inventor and manufacturer who pioneered in the industrial use of graphite, was born in Marblehead, Mass., on Jan. 18, 1799. He received little formal education but had a strong scientific bent and a natural aptitude for mechanics. He became a printer and lithographer and in experiments with type-casting discovered that graphite crucibles withstand high temperatures. He also became familiar with other properties of the mineral and in 1827 began the manufacture of lead pencils, stove polish and lubricants in Salem, Mass. Twenty years later he moved his business to Jersey City, N.J. In 1850 he received patents on graphite crucibles for use in making steel and pottery. He also developed a process for using graphite to grind lenses. He experimented with photography and photolithography and in collaboration with Francis Peabody devised a technique for printing bank notes in colour to prevent counterfeiting. His other inventions included a process for printing calico in fast colours, a wood-planing machine for shaping pencils and a galvanic battery. He died in Jersey City on June 15, 1869.

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DIXON, ROLAND BURRAGE (1875–1934), U.S. cultural anthropologist and organizer of the valuable anthropological material at the Peabody museum, Cambridge, Mass., was born in Worcester, Mass., on Nov. 6, 1875. He was educated at Harvard university (A.B., 1897; A.M., 1898; Ph.D., 1900). His professional career was also entirely at Harvard, where he rose from assistant in anthropology in 1897 to professor in 1915. After assuming chairmanship of the division of anthropology, he built up at Harvard one of the leading schools for the training of professional anthropologists. Although his interests were oriented toward the organization and interpretation of anthropological facts rather than field work, Dixon wrote several ethnographies on California Indians. In addition he made notable field studies in Siberia, Mongolia, the Himalayas and Oceania. His work dealt with problems of material culture, mythology, linguistics and primitive religion, and was organized so as to extract historical inferences. Despite the professional tenor of the times, which emphasized culture change resulting from diffusion, Dixon maintained a constructive interest in the importance of ethnic migrations. His system of cross-filing all anthropological articles by area and subject, as well as by author and title, produced one of the most useful and largest libraries in anthropology, at Harvard's Peabody museum. He died Dec. 19, 1934, at Harvard, Mass.

Dixon's books included *The Racial History of Man* (1923), *The Northern Maidu* (1905), *The Building of Cultures* (1928), *The Shasta* (1907) and *Oceanic Mythology* (1916).

DIXON, a city on the Rock river, northern Illinois, U.S., seat of Lee county, is 35 mi. S.W. of Rockford and approximately 100 mi. W. of Chicago. John Dixon (1784–1876), for whom the city was named, established a ferry service and tavern there on his mail route between Peoria and Galena. His arrival in 1830 marked the beginning of the first white settlement in the county. The city was chartered in 1859. It is the commercial centre of an agricultural region and its industrial plants manufacture dairy products, cement, shoes, valves, caskets and wire. Dixon State (mental) hospital is located in the vicinity. Distinctive landmarks include the Memorial arch, dedicated to its war dead, and, in a small park which marks the site of Dixon blockhouse, a bronze statue depicting a young Abraham Lincoln as a captain in the militia during the Black Hawk War (1832). At the close of the war Jefferson Davis, Zachary Taylor and Lincoln met in the blockhouse that stood near the northern end of the present bridge across the river. For comparative population figures *see* table in Illinois: *Population.* (E. Hg.)

DIYALA (Diala), a river flowing from Iran into Iraq, and a *liwa* (province) in eastern Iraq bordering Iran. The river, called the Sirvan in Iran, rises in the Kurdistan massifs of the Iranian Zagros and flows south-southwestward toward the Tigris, joining it a few miles south of Baghdad. Its total length is about 240 mi. The upper Diyala drains an extensive mountain area of Iran and Iraq and its course is there marked by defiles and precipices. For 20 mi. it forms the frontier between the two countries. It then emerges first into a rolling plateau country forming part of the region known as Assyria and centred on the oil field area of Khanaqin, then through the Jabal Hamrin (the southwestern boundary of Assyria) into the flat Tigris lowlands. There is a difference in level of about ten feet between the Diyala and the Tigris, hence drainage at floodtime is difficult. At low-water sea-

son the entire flow of the Diyala is led off through six major irrigation channels fed by a weir. A large dam, under construction in the early 1960s, at a defile known as Darband-i-Khan, was designed to augment greatly the already considerable irrigation potential of the entire lower basin.

DIYALA PROVINCE consists essentially of the cultivated basin of the lower Diyala, together with portions of higher unused land to the northwest and southeast. Pop. (1960 est.) 349,678. Area 6,078 sq.mi. The main crops are cereals—barley and wheat with rice increasingly important toward the Tigris. The chief town is Baqubah (pop. [1957] 18,547) about 31 mi. N.N.E. of Baghdad on the left bank of the Diyala river. It serves as a market for agricultural commodities and itself produces dates and citrus fruit. Through it runs the main highway from Baghdad to central Iran.

(W. B. Fr.)

DIYARBAKIR (formerly DIYARBEKIR; from *diar*, "land," and *Bakr; i.e.*, Abu-Bakr, the caliph), chief town of the *il* of the same name in southeast Turkey, stands 110 mi. E.S.E. of Malatya on a basaltic plateau on the right bank of the Tigris, which there flows in a deep open valley. The town is still surrounded by the black basalt walls which gave it the name of Kara or Black Amid; they are imposing on the west, facing the open country, but almost in ruins where they overlook the river. A mass of gardens and orchards covers the southwestern slope. Pop. (1960) 79,888.

The streets are narrow, badly paved and dirty; the houses and shops are low, mostly of stone, sometimes of stone and mud. With the post-World War II increase of population, the city expanded outside the walls, with wide streets and concrete buildings. The bazaar is a good one, and gold and silver filigree work is made, peculiar in character and design. Fruit is good and abundant, for the rich volcanic soil is well watered from the town springs. The size of the melons is specially famous. To the south the walls are about 40 ft. high, with towers rising to 500 ft. On the north is the Harput gate, on the west the Rum, on the south the Mardin and on the east the Yeni Kapu or New gate. The Great mosque, Ulu Jami, formerly a Christian church, occupies the site of a Sassanid palace and was built with materials from an older palace, probably that of Tigranes II. The churches of greatest interest are those of SS. Cosmas and Damian (Jacobite) and of St. James (Greek).

The summer climate is excessively hot and unhealthful. Winters are frequently short but severe. The town is supplied with water both by springs inside the town and by aqueducts from fountains at Ali Punar and Hamervat. The principal exports are wool, mohair and copper ore, and imports are cotton and woolen goods, indigo, coffee, sugar and petroleum. Cereals, cotton, tobacco, rice and silk are produced. An exceptionally rich copper mine exists at Maden; galena mineral oil and silicious sand are also found. Virulent scorpions abound.

In the 20th century Diyarbakir was one of the most flourishing cities of Asia. It is at the head of navigation of the Tigris, which is traversed downstream by keleks or rafts supported by inflated skins. There are good roads to Aleppo (Syria) and Iskenderun on the Mediterranean and to Samsun on the Black sea by Harput, Malatya and Sivas. There are also routes to Mosul (Iraq) and Bitlis. Railroad service to Diyarbakir from Ankara was inaugurated in 1935.

Diyarbakir became a Roman colony in A.D. 230 under the name of Amida. It was enlarged and strengthened by Constantius II, in whose reign it was taken after a long siege by Shapur (Sapor) II, king of Persia. In the later wars between the Persians and Romans it changed hands frequently. Though ceded by Jovian to the Persians it again became annexed to the Roman empire, and in the reign of Anastasius I (502) was once more taken by the Persians. It was taken in about 638 by the Arabs and afterward passed into the hands of the Seljuks and Persians, from whom it was finally captured by Selim I in 1515. Subsequently it remained under Ottoman rule.

DIYARBAKIR IL is one of the largest provinces in southeastern Anatolia. Pop. (1960) 401,884. Area 5,928 sq.mi. It is located in front of the large curve of the southeastern Taurus mountains and occupies a large part of upper Mesopotamia, being separated from eastern Anatolia by the Taurus mountains in the north and from the Mesopotamian plain by the Mardin hills in the south. Its western frontier is marked by the volcanic cone of Karaca Dag. Thus it forms a large depression crossed by the Tigris river.

(N. Tu.; S. Er.; E. Tu.)

DIZZINESS: *see* VERTIGO AND DIZZINESS.

DJAKARTA: *see* JAKARTA.

DJAMBI: *see* JAMBI.

DJERBA, an island in the Gulf of Gabès, Tunisia, lies very close to the mainland. Pop. (1956) 62,445, including about 2,700 Jews living mainly in two villages, Hara-Sghira and Hara-Kebira. Area 197 sq.mi. The island, composed entirely of Quaternary rock, is almost flat and has no surface water. Rainfall is irregular and amounts to about 8 in. a year; it is collected in cisterns for drinking, the water from wells being usually saline. Djerba is joined to the mainland by shoals and by the banks of wadies which dry out at low water, the tides along the Gulf of Gabès having a range of up to 6.5 ft. Olives and palm trees are cultivated extensively and there are some irrigated gardens. The weaving of wool and the manufacture of pottery are in decline, but fishing and diving for sponges flourish. Many single men emigrate temporarily to the mainland. The principal town is Houmt-Souk.

Djerba, the "land of the lotus-eaters" of the ancient geographers, has from Carthaginian times been renowned for its dry cultivation of trees, especially olives, and for its fish. There are remains of four Roman settlements. Djerba was conquered by the Arabs in 655 and became a dependency of Kairouan and Tunis (*q.v.*). It was occupied by the kings of Sicily 1148–60, 1284–1335 and 1383–92, being in the intervals a dependency of Tunis. In 1511 and again in 1560 the Spaniards tried unsuccessfully to take the island. In the 17th century Djerba was finally connected to Tunis but retained a certain autonomy. (J.-J. Ds.)

DJIBOUTI (JIBUTI), the port and capital of French Somaliland, Africa, lies on the southern shore of the Gulf of Tajura, about 150 mi. S.W. of Aden. The population, 36,190 (district) at the 1960 census, included a variety of ethnic and linguistic groups: Afar (Danakil); Isa, Gadabursi and Isaaq (Somali); Arabs, Jews and Indians; and French, Greeks and other Europeans (about 4,000). The town is built on level areas, plateaus, linked by jetties: Djibouti plateau, containing Menelik square and the government palace; Serpent plateau; and Marabout plateau. It has a prosperous appearance with its white buildings, old and modern, and its laurel avenues. Adjoining the mainland, the picturesque native quarter, containing the well-known camel market, was being modernized in the mid-20th century. The underground stream of Ambuli supplies the town with water.

The harbour is landlocked and capacious, and the port has been considerably developed since World War II; it covers 160 ac. and has been dredged to a depth of 40–65 ft. There are several berths, with nearly one mile of quays, modern port equipment, a coal depot for 30,000 tons and oil storage. The only significant local industry is the production of salt from the sea. The economic life of the town, and of the territory, depends on the port's use as an entrepôt and as a refueling and supply station for shipping. The number of ships calling at Djibouti has steadily increased with its postwar development. It became a free port in 1949 and since that year its currency has been the Djibouti franc, freely convertible to the U.S. dollar. The Franco-Ethiopian railway, 487 mi. long, opened in 1917 and linking Djibouti and Addis Ababa, carries much of Ethiopia's merchandise. Djibouti owes its creation to Léonce Lagarde, the first governor and founder of the Côte française des Somalis. It became the capital in 1892.

DJOKJAKARTA: *see* JOGJAKARTA.

D LINES, in spectroscopy (*q.v.*), the pair of lines, characteristic of sodium, in the yellow region of the spectrum. Their separation is too small to be detected with a spectroscope of low resolving power, hence to Joseph von Fraunhofer (*q.v.*) they appeared as a single line. This line was the fourth prominent absorption line in the sun's spectrum, starting from the red end, and he accordingly designated it by the letter D. It was subsequently resolved into two components, D_1 and D_2, corresponding to wave lengths 5895.93 and 5895.97 Å. (10^{-8} cm.) respectively.

An emission line appearing in the chromosphere, D_3 of wave length 5875.62, has since been discovered. This line is caused by helium (*q.v.*).

DLUGOSZ, JAN (JOHANNES LONGINUS) (1415–1480), Polish historian and diplomat, was born at Brzeznica in 1415. After studying at the University of Cracow (1428–31) he entered the service of the bishop of Cracow, Zbigniew Olesnicki, and eventually became the head of his chancery. Appointed canon of Cracow (1436), Dlugosz proved a capable administrator of the episcopal estates and a trustworthy negotiator. In 1449 he brought back from Rome a cardinal's hat for Olesnicki and was thereafter entrusted with a succession of missions on behalf of church and state. In the conflict over the part to be played by the church in state affairs and, after Olesnicki's death, over the nomination of bishops, Dlugosz upheld his patron's theocratic views and paid for his attitude by a period of disgrace (1461–63). Unlike Olesnicki, however, Dlugosz had from the start supported King Casimir IV in his Prussian policy, assisting him in the negotiations with the Teutonic Order before and during the Thirteen Years' War (1454–66) and at the peace negotiations. His relations with the king having gradually improved, Dlugosz was charged with the education of the royal princes in 1467. The preparation of official dossiers and the impact of humanism awakened his interest in history. His *Liber beneficiorum ecclesiae Cracoviensis* is a primary source for economic history; the monumental *Historia polonica* in 12 volumes, begun *c.* 1455, completed shortly before his death (in Cracow, May 19, 1480) and first published in full in 1711–12 (2 volumes), though often tendentious, compares favourably with similar contemporary works.

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DMOWSKI, ROMAN (1864–1939), Polish statesman who played a major part in his country's resurrection after World War I and whose policy brought him into conflict with Pilsudski on two important issues, was born on Aug. 9, 1864, at Kamionek, near Warsaw, the son of an impoverished country squire. He studied natural sciences at Warsaw university (graduating in 1891), but interested himself in politics and from 1887 was a member of the secret Polish Youth association "Zet," which sought to restore a united, independent Poland. In 1895, with Zygmunt Balicki (1858–1916) and Jan Ludwik Poplawski (1854–1908) he founded in Lwow, in Austrian Poland, the influential *Przeglad Wszechpolski* ("All-Polish Review"). In 1897 the secret National league (founded in 1893), to which Dmowski belonged, became the National Democratic party, which openly opposed both internationalist socialism and loyalist conservatism in all Poland; and Dmowski's ideas, expressed in *Myśli nowoczesnego Polaka* ("Thoughts of a Modern Pole," 1903), were to be its inspiration. In May–July 1904, during the Russo-Japanese War, he visited Tokyo to oppose Jozef Pilsudski's attempt to get Japanese help for an insurrection in Russian Poland. In Nov. 1905 he told Count Witte, the Russian prime minister, that only the establishment of an autonomous state could counteract the revolutionary movement in Poland.

Becoming the leader of the National Democratic party, Dmowski controlled the elections for the three Russian dumas and sat in the second and in the third, in which he held the balance between the Russian parties and tried to interest the government in winning over the Polish nation. In *Niemcy, Rosya i kwestya polska* ("Germany, Russia and the Polish Question," 1908), he defended the thesis that Germany threatened both the Polish and the Russian nations, but that the behaviour of the tsar's government in Russian Poland assisted Germany. Pilsudski, on the other hand, seeing in tsarist Russia the main obstacle to Poland's independence, was prepared to lead a Polish force to fight on Austria-Hungary's side against Russia. As a result of the two splits in the National Democratic party (1908 and 1911), a progressive opposition against its program grew up, and at the elections to the fourth duma (Oct. 1912) Dmowski lost his Warsaw seat.

When World War I broke out Dmowski was visiting Germany. He was interned for two weeks in Stettin (Szczecin) but was released and returned to Warsaw via Stockholm and St. Petersburg. In May 1915 he was invited by the Russian government to take part in a conference charged to discuss the principles of autonomy for Poland. Dmowski was pressing Russia to proclaim as a war aim the restoration of the Polish state, including the German and Austrian parts of it, to be united with Russia by a common crown, but the Russian ministers would not commit themselves. In summer 1915, however, when German and Austrian armies occupied all Poland, Dmowski concluded that his country's future lay with the western Allies and left for London, whereas Pilsudski continued for a time to co-operate with the Austrians. On Jan. 18, 1916, in Paris, in a memorandum to A. P. Izvolski, the Russian ambassador, Dmowski called for a completely independent and united Poland; in *Problems of Central and Eastern Europe*, privately printed in London in July 1917, he recommended the restoration or formation of national states between Germany and Russia. In autumn 1917 he formed in Paris a Polish National committee. Next autumn, in the U.S., he handed President Wilson a memorandum on the future frontiers of Poland.

In Jan. 1919 the government of restored Poland, with Pilsudski as the head of state, appointed Dmowski first Polish delegate to the Paris peace conference. The struggle for a politically and economically sound Polish-German frontier became his main task and in this he was opposed by David Lloyd George, the British prime minister, who never found time to talk to him privately. However, Dmowski's hour of triumph came on June 28, 1919, when he signed the treaty of Versailles.

Dmowski returned to Poland in May 1920. Once more he opposed Pilsudski, who was trying to bring into being a federal state combining Poland, Lithuania, Belorussia and Ukraine. Dmowski recommended instead a policy of incorporating only parts of the historic eastern provinces into a unitary Polish state. Dmowski sat in the constituent *sejm* until 1922 and was minister of foreign affairs for a few weeks at the end of 1923, but afterward kept aloof from active politics. He wrote four more political books, of which *Polityka polska i odbudowanie państwa* ("Polish Policy and the Restoration of the State," 2nd ed., 1926) is the most important. He died at Drozdow on Jan. 2, 1939. (K. SM.)

DNEPRODZERZHINSK (formerly KAMENSKOYE), a town of Dnepropetrovsk *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., stands on the high right bank of the Dnieper, about 20 mi. above Dnepropetrovsk. Founded as a Cossack settlement about 1750, the town grew from 40,400 in 1913 to 194,000 (1959), a growth based on heavy industry. The large, modern iron and steel plant uses Krivoi Rog ore to produce high-grade steels. There are also rolling-stock works, cement and coke-chemical works and a nitrate fertilizer plant. After 1960 a dam and a powerful hydroelectric station were constructed on the Dnieper there. Most of the population is concentrated in the centre of the city, where the largest factories are located. New development is to the south and southwest. There are a metallurgical institute and a number of technical schools. Railways link Dneprodzerzhinsk to Krivoi Rog and Dnepropetrovsk, and the Dnieper is navigable. The town was occupied by the Germans in World War II from 1941 to 1943. (R. A. F.)

DNEPROPETROVSK, an *oblast* in the east central part of the Ukrainian Soviet Socialist Republic of the U.S.S.R. It is bisected by the Dnieper river (*q.v.*) and is drained by its tributaries—the eastern part by the Samara and Orel and the western by the Bazavluk and Saksagan. Pop. (1959) 2,704,783. The area (12,278 sq.mi.) consists of rolling plains of loess-covered sedimentary rocks, very much dissected by erosion gullies. In the valleys the underlying ancient crystalline rocks outcrop. The soil is the very fertile black earth, originally in grass-steppe vegetation which has been almost entirely removed by the plow. Only on the Dnieper and Samara flood plains are there forest groves, mainly of oak. The climate is continental, with hot summers and cold winters, the latter modified by incursions of warm air from the Black sea, bringing temporary thaws. Rainfall is fairly low, 15–20 in. a year.

The 1959 census classified 1,898,765 of the population as urban. The largest towns are Dnepropetrovsk (660,134), Krivoi Rog (387,579), Dneprodzerzhinsk (194,188) and Nikopol (82,992).

The *oblast*, formed in 1932, is important for its mineral wealth. Around Krivoi Rog are large deposits of some of the richest iron ores in the world, while the Nikopol-Marganets area has one of the two largest manganese deposits of the U.S.S.R. In the east, coal is mined. These minerals are the basis of large-scale heavy industry in the four largest towns, with iron and steel production and a wide range of heavy engineering. Apart from the navigable Dnieper, there is excellent rail and road communication with Moscow, the Donbass (*see* DONETS BASIN) and the Black sea ports. Agriculture is also very important, with greatest emphasis on grain, especially winter wheat, maize (corn) and spring barley; industrial crops (notably sunflowers), fodder crops and melons are also grown. (R. A. F.)

DNEPROPETROVSK, a town and *oblast* centre of the Ukrainian Soviet Socialist Republic of the U.S.S.R., formerly known as Yekaterinoslav and renamed in 1926 for the Ukrainian Bolshevik Petrovski, stands on the high right bank of the Dnieper river (*q.v.*), almost opposite the confluence with the Samara and at the point where the river alters its course from a southeasterly to a southerly direction. The river there has been considerably widened by the construction of the Dnieper barrage (Dneproges) at Zaporozhye, about 50 mi. downstream. Newer suburbs of the city have spread on to the left bank. Pop. (1959) 660,134.

The town was founded in 1787, in the settlement of the newly acquired Right Bank Ukraine under Catherine the Great. From 1796 the town was known as Novorossiisk until 1802, when its old name was restored and it became the centre of a government (province). Despite the bridging of the Dnieper in 1796 and the growth of trading functions in the early 19th century, the town remained small (1844, pop. 8,604). In the 1880s railways were built, linking the town to Odessa, the Donbass (*see* DONETS BASIN) and Moscow, and industrialization commenced (1884, pop. 45,000). Since the Revolution, the town has grown very rapidly into one of the largest industrial cities of the U.S.S.R. With iron ore from nearby Krivoi Rog, Nikopol manganese, Donbass coal and power from Dneproges, a huge iron and steel industry has developed. Castings, plates, sheets, rails, tubes and wire are produced. Large engineering industries are associated with the metallurgy—making electric locomotives, bridge girders, mining and hydro-technological equipment and other heavy machinery. There are large locomotive and rolling-stock repair shops. By the early 1960s the chemical industry had developed. Other important products are cement and reinforced concrete, paper, joinery, clothing, footwear and foodstuffs.

Dnepropetrovsk has a state university and institutes of mining, agriculture, chemical technology, metallurgy, medicine and railway and constructional engineering; there are a Russian and a Ukrainian theatre and a Philharmonic hall. In World War II the town was occupied (1941–43) by the Germans. (R. A. F.)

DNIEPER (DNEPR; ancient BORYSTHENES), the second longest river (1,420 mi.) of the European part of the Union of Soviet Socialist Republics and the third longest in Europe, drains an area of 194,208 sq.mi. It rises in the Valdai hills, at a height of 722 ft., in a peat bog from which also issues a headstream of the Western Dvina. The Dnieper first flows southward with a sinuous course, between low, swampy banks, in a valley about a mile wide. At Dorogobuzh, the head of navigation, the Dnieper turns sharply westward, past Smolensk to Orsha in the Belorussian Soviet Socialist Republic. In this section it is 45–135 yd. wide, with many sandbanks and with rapids at Kobelyaki. At Orsha, where the river cuts through the Smolensk ridge, it again turns sharply to the south and flows through the very extensive and swampy middle Dnieper lowlands to Kiev in the Ukrainian Soviet Socialist Republic. This part of the river is in the highest degree winding, with innumerable divisions, cut-off lakes and sandbanks. Below Kiev the Dnieper swings to the southeast along the northern side of the Dnieper uplands, where there is, characteristically, a high right bank, in places as much as 300 ft. high, with a low, swampy flood plain on the left backed by terraces. There the river is 200–1,300 yd. wide, again with many sandbanks and islands. At Dnepropetrovsk (*q.v.*) the Dnieper turns south and enters the reservoir of the Dnieper barrage (Dneproges) at Zaporozhye, 56 mi. long, which has drowned the cascade of rapids which formerly interrupted navigation there. Immediately below the Zaporozhye dam is the still larger Kakhovka reservoir, 124 mi. long, completed in 1956. Below the Kakhovka dam, the Dnieper flows west-southwest through extensive sand dunes into the long, shallow Dnieper estuary formed by the drowning of the lower reaches.

The average annual discharge is 57,210 cu.ft. per second, with a marked spring maximum following snow-melt. The average fall of the river is slightly less than 1 in 10,000. Freeze-up begins in the second half of November in the upper course and mid-December in the lower, with ice cover firmly established about two weeks later. Thaw starts in early March in the lower course and early April in the upper. The Dnieper has many large tributaries, notably the Berezina (365 mi. long), Pripyat (Pripet) (498 mi.), Teterev (227 mi.) and Ingulets (342 mi.) on the right and the Sozh (403 mi.), Desna (738 mi.), Psel (501 mi.), Vorskla (307 mi.) and Samara (244 mi.) on the left.

The Dnieper is one of the most famous and important of Russian rivers. On its banks and those of its tributaries stand many of the oldest and historically most important towns—Kiev, the first capital, Smolensk, Mogilev, Chernigov, Turov and Pinsk. The Dnieper was the axis and economic *raison d'être* of Kievan Rus (*see* KIEV); that is, it was the great Baltic-Byzantium trade route "from the Varangians to the Greeks." In the late 18th and early 19th centuries its importance as a routeway was enhanced by canals linking it to rivers flowing to the Baltic—the Berezina, Oginski and Dnieper-Bug canals, the last two using the Pripyat. Of these only the last has been modernized and is still in use. At present the whole system is served by passenger and cargo lines. The Dnieper is of great importance for hydroelectric power. As well as the Zaporozhye and Kakhovka plants, a third has been completed (1959) at Kremenchug, a fourth was constructed after 1960 above Dneprodzerzhinsk and two more were planned at Kanev and Kiev. Power is sent to the Donbass or used in the great industrial areas around Kiev and Dnepropetrovsk. A canal was built in the 1960s to take irrigation water from the Dnieper to the south Ukrainian and north Crimean steppes. (R. A. F.)

DNIESTER (Rus. DNESTR; Pol. DNIESTR; Rum. NISTRU), a river of the U.S.S.R., drains a large part of the Moldavian Soviet Socialist Republic and southwestern Ukraine. Its source is on the north side of the Carpathian mountains in Lvov *oblast* and it drains into the Black sea. Direct distance between source (at 3,000 ft.) and estuary is 410 mi. but because of numerous meanders in the middle and lower courses the river itself is 877 mi. in length. The Dniester and its tributaries drain a long, narrow basin, 27,795 sq.mi. in area but nowhere more than about 60–70 mi. wide, bounded on the north by the Volyno-Podolsk upland, 1,000–1,300 ft. above sea level, and on the south by the Carpathian mountains and Bessarabian upland. There are no long tributaries. In the upper course above Galich, the larger tributaries enter from the Carpathians in the south (Stry, Svicha, Lomnitsa); in the middle course, between Galich and Mogilev-Podolski, they come from the north (Zolotaya Lipa, Seret, Zbruch, Smotrich, Ushitsa); in the lower course they are mainly from the south again (Reut, Byk). In its middle course the river is in a deep valley several hundred feet below the surrounding country in places, in incised meanders. Below Mogilev-Podolski the valley widens to 5–10 mi. and, still meandering, the Dniester flows through an area of lakes and marshes, into the Dnestrovski liman, an inlet about 25 mi. in length and 4–12 mi. wide.

The average discharge is approximately 10,750 cu.ft. per second but the flow varies seasonally, the river being fullest following the melting of the ice which normally covers it for two months (November to January) and, later, following the melting of the snow on the Carpathians. The Dniester is navigable for at least part of the year and small vessels can reach Galich, but the continuity of navigation for larger vessels is interrupted by several rapids. The chief river ports are Mogilev-Podolski, Soroki, Bendery and Tiraspol. The main items carried are building mate-

rials (granite, limestone), nonmetallic minerals (kaolin, gypsum), cereals and timber. There are no large towns on the Dniester itself. Lvov, Ternopol, Stanislav, Kishinev and other towns in the Dniester basin are on tributaries above the main valley. The hydroelectric power station at Dubossary is the only important attempt to utilize the power resources of the Dniester and its tributaries. Fishing is of little importance except near the coast. The Dniester formed the Rumanian-U.S.S.R. border from 1918 to 1940 but is now entirely within the Soviet Union. (J. P. Co.)

DOAB (Urdu/Hindi *do*, "two"; *ab*, "rivers"), a name applied, particularly in West Pakistan, to the stretch of country between any two rivers, as the Bari Doab between the Sutlej and the Ravi, the Rechna Doab between the Ravi and the Chenab and the Sind-Sagar Doab between the Jhelum and the Indus. In India it is often used, ordinarily without qualification, as the proper name for the region between the Ganges and its great tributary the Jumna (formerly also called the Great Doab).

DOBBS FERRY, a village of Westchester county, New York, U.S., located on the eastern shore of the Hudson river opposite the Palisades at the lower end of the Tappan Zee, and about 7 mi. N. of the New York city line. Suburban in character, with many commuters, Dobbs Ferry is known for its fine residential neighbourhoods. (For comparative population figures *see* table in NEW YORK: *Population.*) Among the private schools of Dobbs Ferry are the Masters school, founded in 1877, a college preparatory school for girls, and the Children's Village for emotionally disturbed children.

The original site was a Mohican Indian village. The name is derived either from William Dobbs or his son Jeremiah, of English descent, who operated the ferry to Sneden's Landing across the Hudson in the 18th century. Gen. George Washington established headquarters at the Philip Livingston house, later known as the Peter Van Brugh Livingston mansion, in 1781. There, on July 6, French forces under the comte de Rochambeau rendezvoused with the American Revolutionary army; on Aug. 14, the Yorktown campaign was planned; and, on May 6, 1783, Washington and Gov. George Clinton met with Sir Guy Carleton to arrange for the evacuation of the province by the British. The village was incorporated in 1873 as Greenburgh; in 1882 an act of the state legislature changed the name back to Dobbs Ferry. (M. D. HH.)

DOBELL, SYDNEY THOMPSON (pseudonym SYDNEY YENDYS) (1824–1874), English poet and critic of the "Spasmodic" school, was born April 5, 1824, at Cranbrook, Kent. He was never sent to school or university, as his parents were of independent views. John Dobell, his father, was the author of a pamphlet on government. Dobell inherited their attitude and interested himself in the liberal movement in Europe. To celebrate the revolutionary year 1848—the year of revolutions—he wrote *The Roman* (1850), a long, formless dramatic poem in broken verse. Hailed by the critics, it secured for him the acquaintance of Carlyle, Ruskin, Tennyson and Browning, as well as that of Mazzini and Kossuth. *Balder* (1853), another long poem, was intended as part of a trilogy on the "Progress of a Human Being from Doubt to Faith, from Chaos to Order." It was not appreciated, however, and the other parts were never written. *Balder* was burlesqued by W. E. Aytoun in *Firmilian: . . . a Spasmodic Tragedy* in 1854.

The term "Spasmodic," first applied by Carlyle to Byron, was used in 1853 by Charles Kingsley to describe a group of poets including P. J. Bailey (whose *Festus* [1839] was the immediate forerunner of the group), John Stanyan Bigg, Sydney Dobell and Alexander Smith. Their poems were characterized by unrestrained emotions and chaotic imagery. George Gilfillan in *Galleries of Literary Portraits* (1845–54) did much to further their reputation; and Dobell, in a number of essays collected by John Nichol as *Thoughts on Art, Philosophy and Religion* (1876), expressed their vague aesthetic, based on romantic ideas of association and intuition and rejecting the restraint of form.

Besides his long poems, Dobell wrote a number of lyrics and, with Alexander Smith, a sequence of sonnets on the Crimean War (1855). He died at Nailsworth, Gloucestershire, Aug. 22, 1874.

See Dobell's *Poetical Works*, ed. by J. Nichol (1875). (P. M. Y.)

DÖBELN, a town of Germany which after partition of the nation following World War II became a regional capital in the *Bezirk* of Leipzig of the German Democratic Republic. It is 80 km. (50 mi.) S.E. of Leipzig and 50 km. (31 mi.) W.N.W. of Dresden. Pop. (1961 est.) 29,334. Döbeln is on an island formed by the Freiberger Mulde which divides into two streams on entering the town and joins again upon leaving it. St. Nicholas' church, built in 1485, the town hall dating from the middle ages and an early Benedictine cloister are the main features of interest. Agricultural machinery, metal and tobacco products, soap, sugar, foodstuffs and pharmaceutical supplies are produced in the town. The largest plant is the nationally owned refined-steel works.

DÖBEREINER, JOHANN WOLFGANG (1780–1849), German chemist, played an important part in the development of the periodic system of elements. He was born at Hof an der Saale, Bavaria, Dec. 13, 1780. Apprenticed to an apothecary and self-taught in agriculture and the textile industry, in 1810 he became chemistry professor at Jena and later was supervisor of science instruction. He was a lifelong friend of Goethe. Döbereiner's examination of the properties and atomic weights of the known elements led to the classification of similar elements into Döbereiner's triads. The mean of the lightest and heaviest atomic weights approximated the atomic weight of the middle element in the triad. These relationships stimulated investigations which culminated in the periodic classification of all elements. (For a description of the development of the periodic system, including the contributions of Döbereiner and other workers in the field, *see* PERIODIC LAW, THE: *History of the Periodic Law.*) Döbereiner recommended simple galvanic cells for stoichiometric studies before Faraday. He developed the separation of calcium and magnesium by ammonium oxalate or carbonate in the presence of ammonium chloride. He studied the catalytic action of pyrolusite in the production of oxygen from potassium chlorate; the action of spongy platinum in the ignition of hydrogen and oxygen; and the role of platinum black in the oxidation of alcohol and sulfur dioxide. Döbereiner was made privy councillor and awarded the cross of the white falcon. He died in Jena, March 24, 1849. (V. Bw.)

DÖBLIN, ALFRED (1878–1957), German expressionist novelist, best known for his *Berlin Alexanderplatz* (1929; Eng. trans. 1931), in which he applied the technique developed by James Joyce in *Ulysses* to the life of a Berlin worker. Its realism gives it epic force. Döblin was born in Stettin, Aug. 10, 1878; and after studying medicine in Berlin and Freiburg, practised in Berlin, taking an active interest in the conditions of the poor. He left Germany in 1933, became a French citizen in 1936, went to the United States in 1940 and was later converted to Roman Catholicism. He returned to Germany after World War II and was appointed literary adviser to the French occupation authorities. He died in Emmingden on June 28, 1957. His many novels include *Die drei Sprünge des Wang-Lun* (1915), a novel about China; and *Berge, Meere und Giganten* (1924), a Utopian satire on modern technological society. *Schicksalsreise* (1949) is autobiographical. (H. S. R.)

DOBRICH: *see* TOLBUKHIN.

DOBROVSKY, JOSEF (1753–1829), Czech philologist and antiquary, who was one of the founders of comparative Slavonic linguistics, was born at Gyarmat, Hung., on Aug. 17, 1753. Having intended to go to the east as a Jesuit missionary, Dobrovsky studied theology and oriental languages in Prague. After the dissolution of the Jesuit order in 1773 he devoted the rest of his life to scholarship, enjoying the patronage of enlightened Bohemian noblemen. He was indefatigable in bringing to light and describing ancient Slavonic manuscripts and traveled widely (notably to Sweden and Russia in 1792) in search of them. From textual criticism of the Bible he came to the study of Old Church Slavonic and then to that of the Slavonic languages as a whole. His immense erudition ultimately extended to all fields of Slavonic literature, language, history and antiquities.

In the history of the Czech language Dobrovsky is extremely important. His *Geschichte der böhmischen Sprache und Litteratur* (1792, revised 1818) gave a systematic survey of the earlier monuments of the Czech language, many of which had been neg-

lected or suppressed because of their Protestant religious content during the period of the Counter-Reformation. His grammar of Czech (*Ausführliches Lehrgebäude der böhmischen Sprache*, 1809 and 1819) codified the language and brought order into the usage of the literary language which had come to be neglected in the preceding 150 years. His grammar of Old Church Slavonic (*Institutiones linguae slavicae dialecti veteris*, 1822) laid the foundations of comparative Slavonic philology. He died at Brno, on Jan. 6, 1829. *See* CZECHOSLOVAK LITERATURE. (R. AY.)

DOBRUJA (Rumanian DOBROGEA), a territory of eastern Europe, bounded on the west by the Danube, on the north by the Chilia (Kiliya) arm of the Danube delta, on the east by the Black sea and on the south by a conventional line running from the Danube west of Turtucaia to Ekrene on the Black sea. It is divided politically between Rumania and Bulgaria.

The country consists of low hills, fens and sandy steppes, windswept and drought-ridden, with a fertile corn-growing plateau in the south. Constanţa (*q.v.*) is the chief town.

History.—Greek colonies were founded on the Black sea coast of Dobruja in the 6th century B.C., including Istrus, Callatis (Mangalia) and Tomis (Constanta). In the 5th and 4th centuries B.C. invading Scythians submerged the local Thracian population; hence the names of Scythia Minor and Scythia Pontica. For the Roman occupation of the territory, from 75 B.C., *see* MOESIA. The Romans and their Byzantine successors erected walls for the defense of the area, but it was repeatedly overrun by Goths, Alans and Huns.

In the last quarter of the 7th century the territory, with its mixed population of Slavs and Daco-Romans, was overrun by the Bulgars. The Byzantines recovered it in 1018, but in 1186 it was incorporated in the second Rumanian-Bulgarian empire. Later it was ravaged by the Pechenegs; and in the 13th century it was frequently raided by the Tatars. The name Dobruja probably comes from that of Dobrotich, a petty chieftain of Walachian origin who established himself for a brief period in the 14th century. After the conquest of Bulgaria by the Turks, Dobruja was temporarily, at the close of the 14th century, acquired by Mircea the Old of Walachia in the course of his campaigns against the Turks; but with his final capitulation in 1417 it came under Turkish domination for nearly 500 years.

The treaty of Berlin (1878) assigned all of northern Dobruja, then one of the Bulgarian lands under Turkish suzerainty, to Rumania, in compensation for Russia's reannexation of southern Bessarabia (*q.v.*). By the treaty of Bucharest (1913) which closed the Balkan wars, Rumania secured from Bulgaria a quadrilateral of 2,905 sq.mi. to the south of the frontier of 1878. During World War I, though Bulgaria, as Germany's ally, sought to secure the whole of Dobruja, the treaty of Bucharest (1918) assigned only the southern quadrilateral to Bulgaria; the north was put under a condominium of the Central Powers, who guaranteed Rumania's commercial outlet to Constanta. The treaty of Neuilly (1919) assigned the entire province to Rumania. The Rumanians settled a number of Vlachs from Macedonia in the province, but at the census of 1930 only 19.1% of the population of southern Dobruja was Rumanian, as against 37.9% Bulgarian; for the north, however, the corresponding figures were 64.9% and 10.2%. The rest of the total of 815,475 was made up of Turks and Tatars, Russians, Germans and a few Jews.

Early in World War II Rumania, while still neutral, was forced by the German-imposed treaty of Craiova (Sept. 7, 1940) to return the quadrilateral (southern Dobruja), with a population of 407,500, to Bulgaria. This territory included the ports of Silistra on the Danube and Balchik on the Black sea. Under this treaty an exchange was arranged of the 106,534 Rumanians of the quadrilateral against the 50,000 Bulgars from the north. All the Germans were repatriated to the *Reich*. After the war, the Paris treaty of 1947 confirmed the frontier established by the treaty of Craiova.

Economy.—The Rumanian Dobruja, with an area of 5,969 sq.mi. and an estimated population of 502,674 in 1960, was absorbed administratively into the regions of Constanta and Galati. Cereals and industrial crops are grown, vineyards cover an important area and the reeds in the Danube delta are used for paper production. Merino sheep are bred, and fishing accounts for about 70% of Rumania's total fish output. There are a few iron and copper mines. Since World War II, moreover, considerable industrialization has taken place. There are shipbuilding yards in Constanta; metallurgical works at Medgidia and at Cerna-Vodă; a thermal power plant and a cement factory at Ovidiu; and a sulfuric acid as well as a chemical fertilizer plant at Năvodari. There are also summer resorts on the coast (Mamaia, Eforie, Vasile Roaită and Mangalia) and sanatoria for treatment with radioactive mud. (B. BR.)

DOBSINA (Ger. DOBSCHAU), an ancient iron-mining village, is in the upper valley of the Slana river in southeastern Czechoslovakia, 64 km. (40 mi.) W.N.W. of Kosice. Pop. (1960 est.) 5,000. The settlement, founded in 1326 by immigrant German miners, has maintained a tradition of iron mining and timber working. After World War II a large hydroelectric power station was built there.

The famous ice caves of Dobsina lie about 7 mi. from the village. The entrance to them is approximately 3,200 ft. above sea level on a mass of limestone rock and was discovered by some shepherds in 1870. The huge ice chambers, with a total area of nearly 10,780 sq.yd., have an average temperature of 0.28° C. It is thought that the high altitude of the cave mouth prevents any thawing of the cold air that accumulates in the caves and passages. The fine scenery near the caves is famous.

DOBSON, (HENRY) AUSTIN (1840–1921), English poet and man of letters whose love and knowledge of the 18th century gave his own poetry the graceful elegance of pastiche and inspired his critical studies. Born at Plymouth on Jan. 18, 1840, he entered the board of trade in 1856 and from 1884 to 1901, when he retired, was a principal clerk in the marine department. His first collection of poems, *Vignettes in Rhyme* (1873), was followed by *Proverbs in Porcelain* (1877). In these and in *At the Sign of the Lyre* (1885) he showed the polish, wit and restrained pathos which made his verses popular. The ease with which he handled the artificial French forms—the ballade, the triolet and the rondeau—helped to revive their use in English.

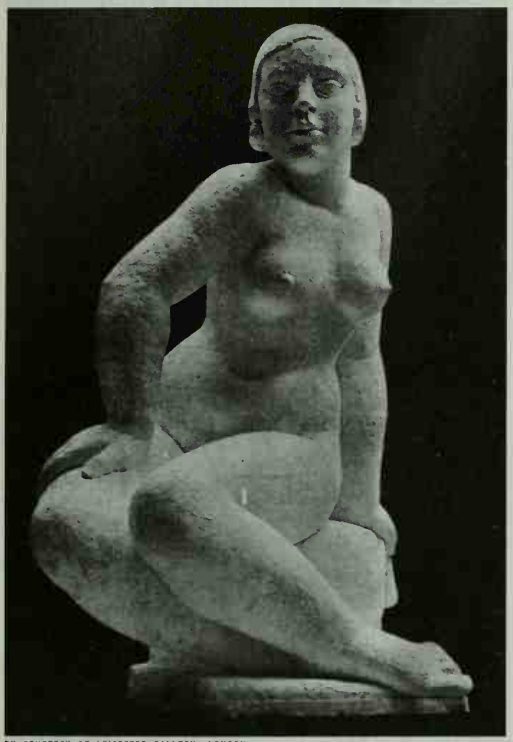
After 1885, Austin Dobson was chiefly occupied with biographical and critical works: books on Fielding, Thomas Berwick, Steele, Goldsmith, Horace Walpole, Hogarth, Richardson and Fanny Burney revealed careful research into 18th-century life and a natural sympathy with its more elegant aspects. Three series of *Eighteenth-Century Vignettes* (1892–96) and *A Paladin of Philanthropy* (1899 and 1901) show his prose at its most delicate. He continued to publish essays, introductions to 18th-century studies and editions of works by 18th-century writers until his death in London, Sept. 2, 1921.

See *Collected Poems* (1923); A. T.-A. Dobson, *A Bibliography of First Editions of . . . Books and Pamphlets by Austin Dobson* (1925) and *Austin Dobson. Some Notes* (1928); *An Austin Dobson Letter Book* (1935).

DOBSON, FRANK (1888–1963), a leading British sculptor, was born in London on Nov. 18, 1888. He studied at the City and Guilds school, London, and worked with the Cornish granite cutters. His early work was geometric and abstract, reflecting the influence of cubism. This revealed in him a concern for volume and space and the relationship of mass to mass which was to earmark all his work. This was combined with a sensitivity for design. From his early abstract forms he turned to a classicism in the wake of Aristide Maillol. Dobson's work, however, retained a degree of geometric abstraction beyond that of the French master. His preference in subjects was symbolical or allegorical, interpreted through the nude female figure. His work showed the use of many materials—white marble, Ham hill stone, Portland stone, bronze, faïence, terra cotta, plaster, silver, glass, concrete. This variety would seem to suggest a greater interest in the material, the revelation of its intrinsic qualities and of its volume, than in the subjective meaning of the sculpture. His portraits include those of Osbert Sitwell (polished brass, 1923), Lydia Lopokova (1924) and Tallulah Bankhead (1927). In later years his forms became more abstract. Dobson was president of

the London group (1923–27) and professor at the Royal College of Art (1946–53). He was elected a member of the Royal Academy in 1953.

Dobson died in London on July 22, 1963.



BY COURTESY OF LEICESTER GALLERY, LONDON

"TRUTH" BY FRANK DOBSON. SHOWN IS PLASTER MODEL FOR FINAL BRONZE CASTING, COMPLETED *c.* 1930

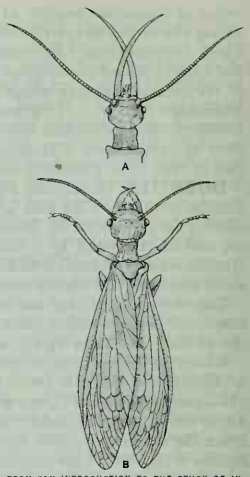
BIBLIOGRAPHY.—Stanley Casson, *XXth Century Sculptors* (1930); T. W. Earp, *Frank Dobson, Sculptor* (1943); F. G. Mories in *Studio*, 135:186 (1948). (I. S. McN.)

DOBSON, WILLIAM (1610–1646), English portrait painter, one of the first distinguished native English painters, was born in London. According to tradition he became Van Dyck's protégé, but this is disputed. He was probably a pupil of Francis Cleyn, a German artist working in London. Dobson's work also shows Venetian influence, doubtless acquired from study of the paintings in the collection of Charles I, for whom he worked at Oxford between 1642 and 1646, after succeeding Anthony Van Dyck as painter to the court. He was buried on October 28, 1646.

BIBLIOGRAPHY.—C. H. Collins Baker, *Lely and the Stuart Portrait Painters* (1912); C. H. C. Baker and W. G. Constable, *English Painting of the Sixteenth and Seventeenth Centuries* (1930); O. Millar, *William Dobson* (1951).

DOBSON FLY. Despite their common name these insects are not true flies (order Diptera), but four-winged, net-winged insects often included in the order Neuroptera but sometimes given separate ordinal rank as the Megaloptera. Along with their smaller relatives, the fish flies, they are members of the family Corydalidae, allied to the alder flies (*see* ALDER FLY), and are found in North and South America, Asia, Australia and Africa. The adults are of medium to large size, some species of the genus *Corydalus*, with a wingspread of about five inches, being among the largest North American insects. The adults are often attracted to lights. The jaws or mandibles are conspicuously larger in the male than in the female, reaching a length of more than an inch in certain species.

Up to 2,000–3,000 eggs are laid in whitish clusters on objects near streams, and the young larvae crawl to the water, developing to maturity there in two or three years. The large (up to three inches long), often blackish larvae, which lurk under stones in rapidly flowing water, have strong biting mouth parts capable of inflicting painful bites on man; and are ferocious predators on other aquatic insects and small invertebrates. Eventually the larvae migrate to wet soil, moss or decaying vegetation near the water and form a pupal cell. The pupal stage lasts only a few weeks at most; the adults then issue from the cell and climb up any available object to allow the wings to dry. The larvae are readily eaten by fish and are used as bait by fishermen, who have applied to them the common name hellgrammite. *See* also NEUROPTERA; INSECT.



FROM "AN INTRODUCTION TO THE STUDY OF INSECTS," © D. J. BORROR AND D. M. DELONG, 1954. REPRINTED BY PERMISSION OF THE PUBLISHERS, HINEHART & COMPANY, INC.

DOBSON FLY (CORYDALUS CORNUTUS): (A) HEAD OF MALE; (B) FEMALE

(F. M. Cr.)

DOCETISM (from Gr. "to seem"), in the early Christian Church, was a theory that Christ, during his life, had not a real or natural but only an apparent or phantom body. It sprang from the same roots as Gnosticism and was characteristically upheld by the Gnostic writers. The origin of the heresy is to be sought in Greek, Alexandrine and oriental speculations about the imperfection or rather the essential impurity of matter. It differed much in its complexion according to the points of view adopted by the different authors. The more thoroughgoing docetists assumed the position that Christ was born without any participation of matter, and that all the acts and sufferings of his human life, including the crucifixion, were only apparent. Marcion, for example, regarded the body of Christ merely as an "umbra," a "phantasma." They denied, accordingly, the resurrection and the ascent into heaven. The milder docetists (to whom belonged such important thinkers as Valentinus and Bardesanes; *qq.v.*) attributed to Christ an ethereal and heavenly instead of a truly human body; they varied in their estimation of the share this body had in the real actions and sufferings of Christ.

Docetism was attacked by all the early antagonists of Gnosticism, especially St. Ignatius. Several passages in the Epistles of John are quoted against it, especially I John iv, 2–3: "By this you know the Spirit of God: every spirit which confesses that Jesus Christ has come in the flesh is of God, and every spirit which does not confess Jesus is not of God."

See also GNOSTICISM.

DOCK, the common name for certain herbaceous plants of the genus *Rumex* (subgenus *Lapathum*), the buckwheat family, Polygonaceae (*q.v.*). Docks are characterized by nonacid-tasting leaves and bisexual flowers, in contrast to the sorrels, which also belong to *Rumex* but have acid-tasting leaves and unisexual flowers, male and female on separate plants. Docks are cosmopolitan plants but are most numerous in temperate regions. About 125 species are known. Twenty-eight species, ten of them introduced from the old world, grow in the United States; eighteen are found in Great Britain.

Docks are annual, biennial or perennial plants with leafy stems. In many species the leaves are wavy along the margins, and the lower leaves are larger than the upper ones. The small red or green flowers are wind-pollinated and are crowded in clusters that

terminate or are scattered along the branches and main stem. Each flower has six sepals, six stamens and an ovary with three styles. The fruiting structures of docks are especially characteristic: the hard, three-angled "seed," an achene, is enclosed by the three inner sepals of the flower that typically enlarge, becoming veiny and winglike as the achene matures, and aid in wind dispersal. A wartlike structure may develop on the midrib of each sepal or of only one or two of them. In certain docks the edges of the sepals bear teeth or bristles. The stem of some species, with its clusters of brown achenes, remains standing throughout the winter.

Giant among the docks is *Rumex costaricensis* of Costa Rica. It may be 20 ft. tall and have a stem 4 in. thick. Some docks are widely distributed weeds, including curly or yellow dock, *R. crispus;* smooth dock, *R. altissimus;* pale dock, *R. mexicanus;* and patience dock, *R. patientia.* The young leaves of several docks, *e.g.,* curly dock and patience dock, may be used for greens. Canaigre or tanner's dock, *R. hymenosepalus,* the most promising tannin-producing plant native to the United States, is found in the southwest. Its tuberous roots contain 25–35% tannin, which, however, is difficult of extraction because of the high percentage of sugar and starch in the roots. Certain cultivated strains of canaigre yield 15–20 tons of roots per acre. Dried roots of *R. crispus* and R. *obtusifolius* constitute the laxative and cathartic drug called rumex. (J. W. Tt.)

DOCK, a basinlike enclosure into which vessels are brought for inspection and repair. Originally, docks were used for many purposes: as dry basins, isolated from water by dikes or other means, they served as a place for building and repairing ships; as wet basins, open to water, they provided berthing space for ships in the normal course of traffic and cargo transfer. The latter function was later rendered by another group of structures especially designed for that purpose and given different designations, such as quay wall, pier and wharf. The term dock is still often used in a generic sense to indicate all water front docking facilities, whether they be dry basin or berthing structures.

HISTORY

The origin of docks dates back to the creation of water transport. The first landing facility undoubtedly was natural—some rocks on a river bank or a strip of beach in a harbour or inlet. Later, with the advent of water craft as an important means of transport in commerce and warfare, landing facilities evolved into special structures. The date and design of the earliest facilities are unknown, but it may be assumed that such structures existed as early as 4000 B.C. in Egypt as well as in Mesopotamia. Memphis on the Nile, Babylon on the Euphrates, and Nineveh on the Tigris were prosperous cities of commerce at that time, and certainly had docking facilities for their galleys and trading boats.

One of the earliest records of dock construction was found on a tombstone in the Nile valley. This is the tomb of Uni, a high dignitary in the court of the great Egyptian monarch Pepi I, who reigned during the 6th dynasty in 3200 B.C. According to the inscription, Uni, whose many titles included that of "superintendent of warehouses and registrar of docks," was given the tremendous job of relocating a pyramid. He had to carry the stonework by boats, and it was necessary first to excavate four dock basins in which to build the flat-bottomed, shallow-draft vessels. While no size of the docks is given, some idea may be had from the dimensions of the boats, which were 60 cubits long and 30 cubits wide, or roughly 110 by 55 ft.

Another interesting account of an early docking facility is given by the Roman historian Appian, who describes the harbour works at Carthage. Built by the Phoenicians during their golden era of commerce in the 5th and 6th centuries B.C., this installation constitutes a marvelous example of engineering, both in concept and execution. It is comprised of two harbours sheltered from the sea by a long, narrow peninsula. The first of these is a rectangular basin at the entrance of the bay, providing docking facilities for boats in commercial traffic. The second, located above the seaport and connected to it by a canal, is an artificial harbour of circular outline. It is this interior harbour that presents some amazingly advanced ideas in both civil and military construction. The saucerlike basin was shaped by digging a circular waterway about 1,000 ft. wide, leaving an island in the centre. A battery of about 220 docks, forming radial niches on both sides of the waterway, provided separate berthing spaces for warships—the multi-tiered rowing galleys of the time. A most impressive feature is the provision of a roof over the docks. This consisted of a masonry vault supported on an ornamental colonnade at the front and by massive fortification walls at the back. The arrangement furnished not only protective concealment for the warships but shelter for the shipyard facilities and operations. Essentially, it may be considered as the prototype of World War II submarine pens built on the northwest coast of Europe.

In general, the structures needed for docking have not materially changed through the ages, although certain supporting facilities have been greatly improved to keep pace with progress in navigation and shipbuilding.

One of the most important factors influencing the dock structure is the depth of the surrounding water. With continually increasing sizes of ships and corresponding increases in their draft, additional water depth has been required at dock sites. In some cases this has been achieved by dredging in front of the dock or the quay wall; in others, the greater depth is obtained by advancing the dock front out from the shore, that is, by building a wharf. In still other cases the structure is projected farther to form a pier. Fig. 1 is the plan of a hypothetical harbour, outlining the general arrangement of docking facilities; the locks shown at the harbour entrance would be unnecessary in locations where tides were not a factor.

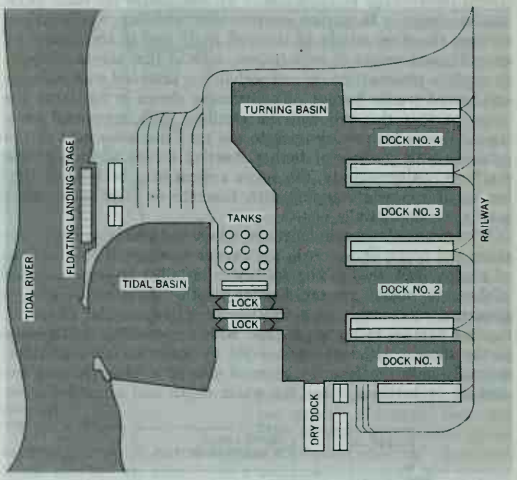


FIG. 1.—HARBOUR INSTALLATION ON A TIDAL RIVER, SHOWING DOCK, CARGO HANDLING AND DRY DOCK FACILITIES; WHERE TIDES ARE OF NO CONSEQUENCE, ENTRANCE LOCKS WOULD BE UNNECESSARY

BERTHING STRUCTURES

Quay Walls.—The quay wall is perhaps the oldest and most common type of water front facility for vessels. It is simply a retaining wall along the shore, topped with a deck or platform, serving both as a barrier to protect the shore and as a ship landing and loading facility. In most cases, it is necessary to place a great deal of earth fill behind the wall in order to raise the deck to the needed height above the prevailing high water level. In addition, it may be necessary to do some dredging in front of the wall to obtain the required water depth.

Until the middle of the 19th century, quay walls were built almost exclusively of stone, a material that produced massive sea walls favoured for their durability and simplicity of erection. However, with the introduction of portland cement, concrete

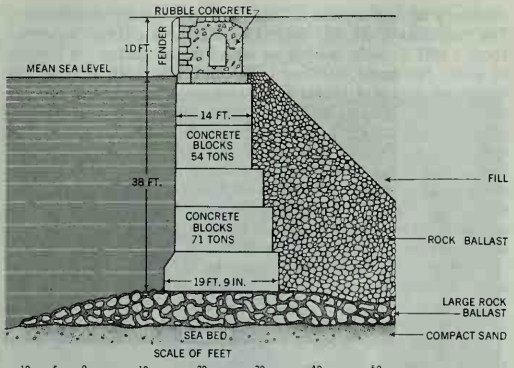


FIG. 2.—QUAY WALLS, VITTORIO EMANUELE III BASIN, GENOA, ITALY

walls, either poured in place or built of precast blocks, came to be used almost universally. The stability of the wall against the lateral force of the retained soil or fill constitutes the main problem in design. In earlier construction, stability was obtained through the sheer weight of the wall itself, and in some cases by an additional weight of rock ballast, such as that shown in fig. 2. In modern construction, lateral stability is achieved with tiebacks and braced trestle frames. The example shown in fig. 3 has the upper part of the wall and the earth-fill deck supported on a timber trestle framework open to the sea; the lower part of the retaining wall consists of timber sheeting driven in back of the platform. Alternatively, the entire system may be built of timber or of concrete framing, with concrete or steel sheet piling used as retaining walls.

Wharves.—At certain locations, where the conformation of the shore and depth of water do not favour economical construction of a quay wall, the landing facility is installed at some distance offshore to obtain greater docking depth. A wharf is such a structure. It consists of a trestlemounted rectangular platform, running parallel to the shore line, with a connecting passageway to the shore. Although surrounded by water on all four sides, normally only the front or seaward side of a wharf is used for docking or berthing, since the water depth and accessibility on

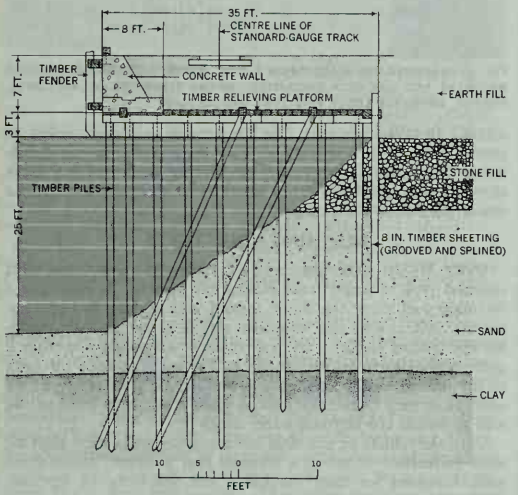


FIG. 3.—QUAY WALL, SAVANNAH, GA.

the other three sides may not be suitable for most vessels.

Wharves generally serve fishing trawlers, pleasure boats and other small craft. For this purpose a relatively small structure is needed, and hence the landing platform has a rather narrow width and a limited berthing length. The entire framing is usually built of timber.

Piers.—Quay walls provide only a limited docking facility, in respect both to landing area and to berthing length, and because of the valuable water front space that they occupy, docking cost at a quay wall is correspondingly high. A more economical expedient is the pier, which, in its simplest form, is merely a platform extending over the water, usually at right angles to the shore line. Functionally, it serves two main purposes, providing a mooring facility for securing vessels and serving as a transfer platform for cargo and passengers.

A pier is composed of two main parts: the deck and its supporting system. The deck is usually built of reinforced concrete, although timber may also be used. The supporting system is an assembly of beams, girders and bearing piles, framed together to form a series of bents or trestles. The framing material may be wood, concrete, steel or a combination of these. In some piers with concrete framing, the deck and the walls are cast together to form an enclosed cellular structure. The buoyancy of such a structure greatly reduces the load on the foundations and, in addition, the interior space can be utilized for storage.

The over-all dimensions of piers vary widely in accordance with function and location, but the trend in modern times has been toward facilities of ever greater capacity. Two examples, both completed in 1961, are the 35th street pier in Brooklyn, N.Y., 175 ft. wide and 1,740 ft. long, and pier 40 on Manhattan island, N.Y., an enclosed, double-deck, concrete structure, 810 ft. wide and 975 ft. long.

The basinlike space between two parallel piers is often referred to by special names. The basin thus formed is called a slip or wet dock, and the quay wall at the shore end is called a bulkhead.

Floating Pontoon Docks.—The so-called floating pontoon docks, of which only a limited number have been built, have the floor pontoon so arranged that it can rise and fall with the water level. The liquid cargo dock of the Allied Chemical & Dye corporation on the Ohio river at Ironton, O., is an example. Completed in 1956, this dock is composed of a bargelike pontoon and two circular walls placed about 110 ft. apart. The walls, formed by steel sheet piling driven to bedrock, serve as an anchorage or mooring device for the pontoon, which floats up and down while engaged to them by means of a sliding arrangement. Access to shore is provided by a trestle hinged at the shore end and resting freely on the pontoon at the other end.

DRY DOCKS

Although many repairs to vessels can be made while the craft is afloat and tied to a pier or quay wall, dry-docking is necessary for major repairs and overhaul. There are also certain inspection and maintenance tasks, such as cleaning and repainting the bottom plating or repairing a propeller, that can be accomplished only by taking the vessel out of water and placing it in an accessible position. Such operations are performed in a dry dock, generally of the stationary type, which is also known as a graving dock.

A dry dock is a rectangular basin dug into the shore and provided with a removable enclosure wall or gate on the side toward the water. Fig. 4 shows the cross-sectional outline of such a dock. The sections of the right wall and the floor slab are typical for the entire dock. The wall section on the left, taken near the dock entrance, contains the pumping equipment. The dock is flooded and drained through a tunnel built in the side wall, with connections to openings in the floor. In some docks the flooding culverts are located across the floor near the entrance; in others, they are carried through the gate.

The depth of the dock basin is about the same as that of the water outside the entrance. When a ship is to be docked, the dock is flooded and the gate removed. After the vessel is brought in and properly positioned and guyed, the gate is placed in its seat and the dock is pumped dry, bringing the craft gradually to rest

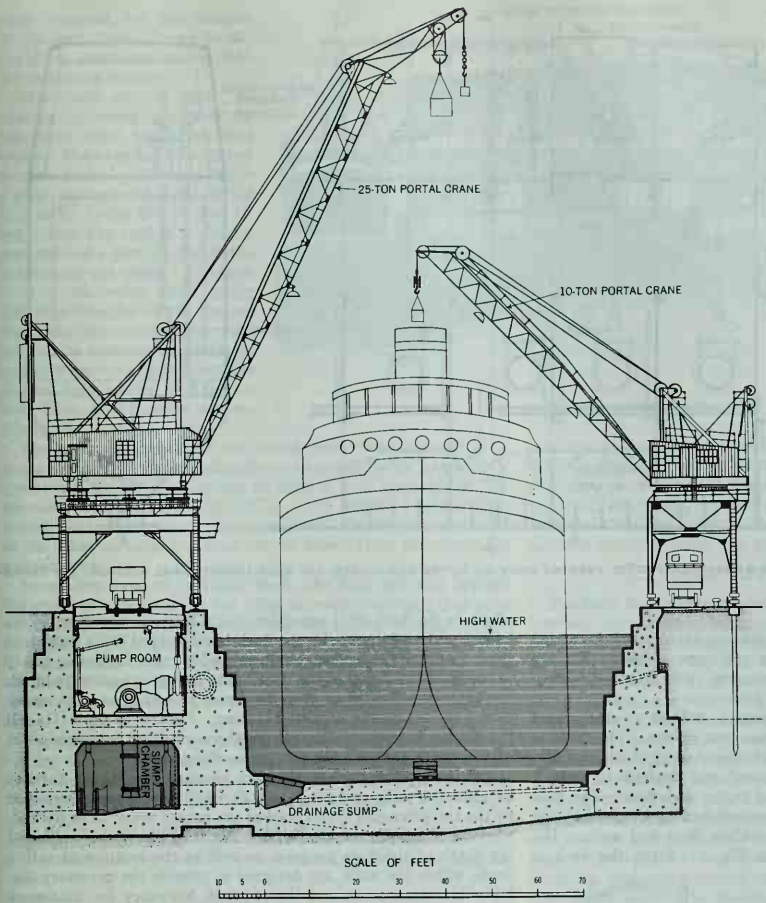


FIG. 4.—CROSS SECTION THROUGH DRY DOCK AT THE KING'S DOCK, SWANSEA, WALES

on supporting blocks anchored to the floor.

The dry dock floor and walls are subjected to various forces under different conditions of loading, but the critical condition occurs when the basin is empty. The unbalanced ground water and soil pressures behind the walls and under the floor tend to bend the walls inward and the floor upward. To sustain these forces, the walls must have sufficient bending strength and, if arranged as simple retaining walls, they must be stable against overturning. The floor, likewise, must have adequate bending strength and, to prevent uplift, the total weight of the dock must be greater than the total forces exerted on its bottom. These requirements generally result in a rather massive framing; deep, wide basins may need a floor slab 20 ft. or more in thickness. In some docks, the ground water pressures in the surrounding soil are reduced, partially or entirely, by lowering the hydrostatic head by means of pumping. In others, some relief against uplift is obtained by using anchorage piles. Piling may also be required where the bearing capacity of the soil is not sufficient to carry the total unrelieved weight of the dock and the load of the ship within.

The construction of a dry dock is a major engineering task. Both the excavation of the basin and the building of the structural lining present difficult problems, arising primarily from severe conditions of underground water. In older installations, in which the basins were relatively small, the dock structure was built mainly of massive stonework or, in a few instances, heavy timber framing, but these materials were displaced by concrete, first in the ordinary mass form and later reinforced with steel. Modern dry docks are considerably larger in size and correspondingly more complex in construction than their earlier prototypes. For example, one of the largest is dry dock no. 6 at the Puget Sound, Wash., naval shipyard. Completed in 1962, this dock is 180 ft. wide, 61 ft. deep and 1,180 ft. long.

Dry Dock Gates.—A dry dock gate is a removable, watertight barrier that serves as the waterside wall of a basin, making it possible to convert a wet dock into a dry dock by excluding outside water after the dock is pumped dry. There have been many forms and arrangements for such gates. In some schemes two leaves have been used to form a mitre-gate, hinged to the side walls of the dock. In others, the leaves roll on a track into recesses in the dock walls. In still others, a one-piece gate is hinged to the bottom sill so it may be lowered to allow a ship to enter. These are all the so-called attached gates. However, the type most commonly used is the floating gate, which is held in its seat when the dock is empty and can be removed simply by floating it out of the way when the dock is flooded with water.

A floating gate is built in the form of a box, and hence such gates are often referred to as caisson gates. Normally they are built of steel and consist of an interior truss work and an exterior shell plate covering. In elevational outline, the gates have a trapezoidal contour, the sloping sides conforming to the inclined faces of the dock walls. The cross-sectional shape of a floating gate is determined by considerations of floatability and stability. It is so devised that the resulting displacement in the prevailing minimum water depths will permit the gate to float. In addition, the gate is ballasted to prevent capsizing.

The interior of the gate is subdivided into a series of compartments, some of which serve as water holds. By means of a pumping system and valves, water can be admitted into or ejected from these compartments, and thus the gate can be placed in its seat or removed from it. The interior arrangement and some of the details and equipment of a typical floating caisson gate are shown in fig. 5. Also indicated in the figure are a set of 30-in. culverts that pass through the gate; these serve as auxiliary inlets for flooding the dock.

In some floating gates, compressed air, rather than mechanical pumps, is used to remove the water from the holds. This method of pumping is particularly adaptable to floating gates built of reinforced concrete; with these, because of the greater draft resulting from their heavy weight, it may be necessary to rotate the gate and place it on its face in order to decrease the depth of the draft in the moored position. Compressed air is utilized also in the operation of flap gates hinged to the bottom seat of the

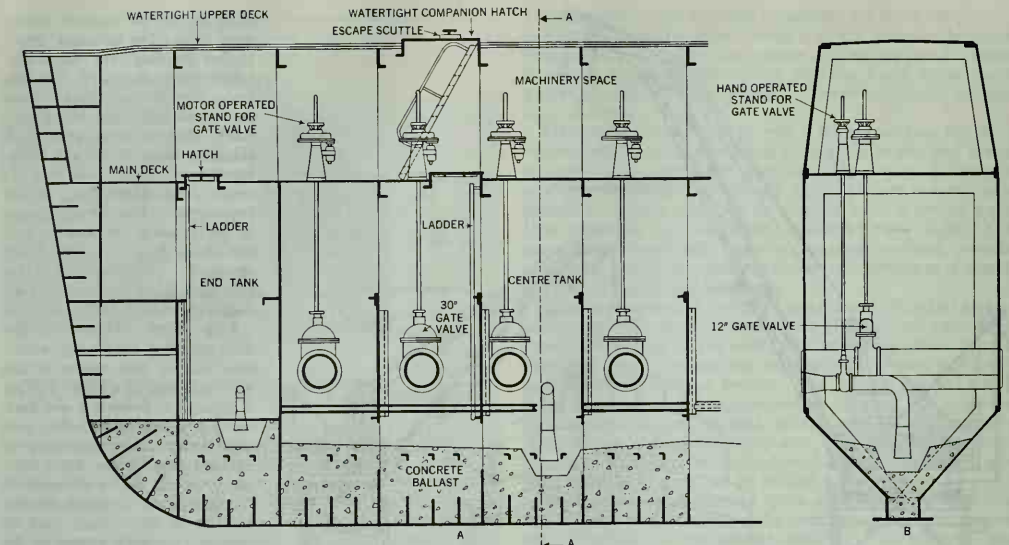
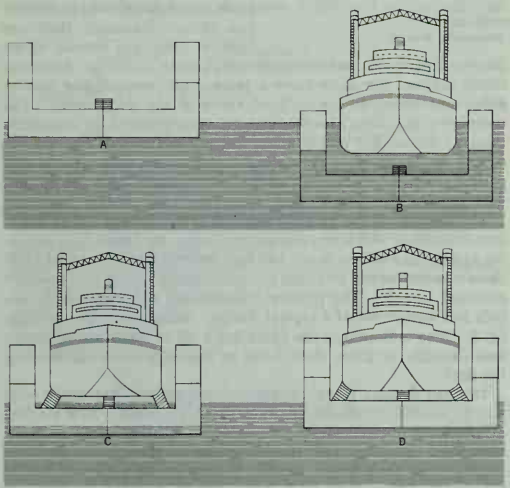


FIG. 5.—SECTIONAL VIEWS OF FLOATING CAISSON GATE STEEL FRAMING SHOWING PIPING AND VALVES: (A) HALF LONGITUDINAL SECTION; (B) TRANSVERSE SECTION THROUGH A–A

dock.

Floating Dry Docks.—While most ship repair work is carried out in stationary dry docks, there are some services that are performed by mobile or floating structures. The principal facility in this category is the floating dry dock.

A floating dry dock is a trough-shaped, cellular structure used to lift ships out of water for inspection and repairs. The docking is carried out by bringing the ship into the channel of the partially submerged dock, which is then raised and drained so that it supports the craft on blocks attached to the dock floor. The raising and lowering of the dock is accomplished by controlling the amount of water ballast within its hollow floor and walls. The sequence of operations is shown in Fig. 6. First, the dock is afloat in its light-draft condition, with little or no water in its ballast tanks. In fig. 6(B) the dock is submerged to its maximum draft by filling the ballast chambers, and a vessel is floating freely in the flooded channel of the dock. The ballast is further reduced, fig. 6(C), the dock floor emerges from the water, and the vessel comes to rest on the support blocking. Finally, in fig. 6(D), all the ballast is pumped out, raising the dock floor completely out of the water and providing a dry working area.



FROM A AMIRIKIAN IN "TRANSACTIONS OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS," 1957

FIG. 6.—OPERATION OF A FLOATING DRY DOCK

The inner dimensions of the dock channel, that is, the distance between the walls and the height above the floor, are determined by the corresponding dimensions of the largest vessel to be docked, allowing a margin for clearance. The breadth of the walls and the depth of the floor pontoon, as well as the location of safety decks within the walls, are designed to provide the necessary stability in submergence and the required buoyancy for maximum lifting power.

A typical floating dry dock is built of steel, with a framing system similar to that of a ship. However, during periods when a shortage of steel has prevailed, both timber and reinforced concrete have been used. The one-piece floating dock of a simple channel shape (fig. 7[A]) is the most prevalent type. Docks such as this have been constructed in many sizes, varying in lifting capacity from 1,000 to more than 10,000 tons. While the majority are built of steel, some docks of 1,000–2,000-ton capacity have been built of timber, and others, of up to 4,000-ton capacity, have been constructed of reinforced concrete.

Floating dry docks ordinarily are operated in sheltered harbours where wave action presents no problem. Under such conditions the structure is subjected mainly to stresses resulting from the docking of ships. However, during the transfer of docks from one port to another, they also sustain stresses from the sea waves. For docks longer than 400 ft. these are much more critical than the docking stresses and require correspondingly heavier construction. As a compromise, large docks are often built in sectional form, thus making it possible to subdivide the structure into a number of relatively short sections that can be towed separately and then reassembled upon arrival at the destination.

Aside from conditions encountered on a sea voyage, a segmental type of a floating dock may be required for two other reasons. First, it may be necessary to break down the dock into smaller components capable of passing through restricted canals or water-

ways. Second, for maintenance of the dock itself, it may be desirable to place one section into the remaining sections.

There are several types of floating dry docks in addition to the basic unit type described above. The so-called ship-shaped floating dock, fig. 7(B), of which a great number were built by the U.S. navy during World War II, has a bow like that of a ship at one end and a gate, hinged at the bottom, at the other. Although it is a somewhat more costly structure than the simple channel dock, the ship-shaped dock contains more usable space inside its walls for service facilities, and the shaped bow makes it easier to tow from one location to another.

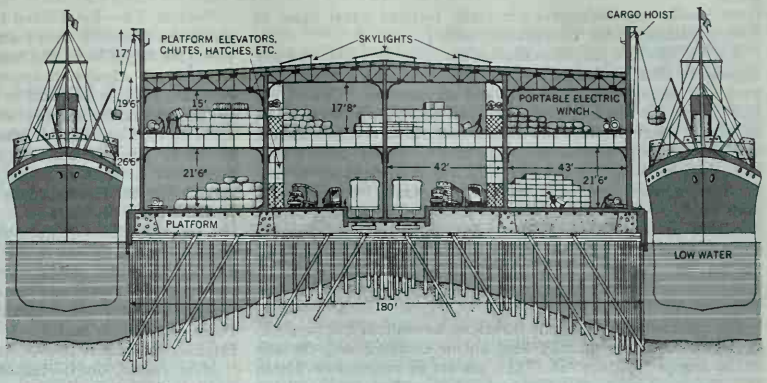


FIG. 8.—SECTION THROUGH CARGO PIER

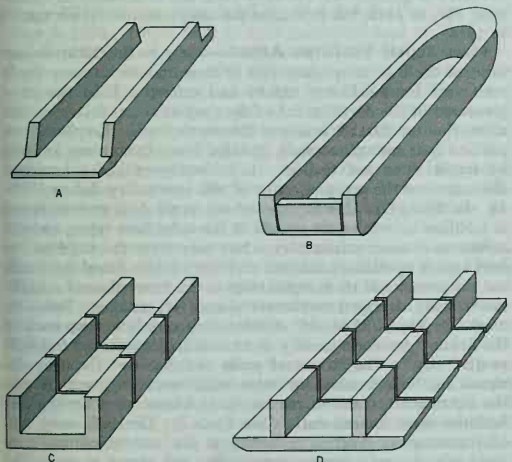
The sectional version of the simple unit dock consists of a series of short, channel-shaped components, each completely operational by itself, connected to form a dock assembly of the necessary over-all length (fig. 7[C]). The length of each section is such that, when turned sideways, it will fit between the walls of the other sections and thus can be raised from the water for maintenance.

In another type of sectional dock, the floor projects beyond the walls on either side in the form of wide pontoons, thus providing more buoyancy and increasing the lifting capacity of the dock (fig. 7[D]). This type was developed during World War II for servicing capital ships at advanced bases; in versions built for the U.S. navy, the length of the sections was held to 80 ft. so that the sections could be towed sideways through the Panama canal.

The pumping system constitutés the main equipment of a floating dry dock. The type and amount of other equipment installed within the structure are determined by the location in which the dock operates and the types of ships it will service.

MARINE RAILWAYS

A marine railway consists of a cradlelike carriage running on rails that extend from the shore into the water. To dry-dock a ship, the carriage is moved to the end of its inclined course, where it engages the submerged hull of the craft; then, after the ship is secured in the cradle, the loaded carriage is pulled out of water by means of a hauling system. For vessels of small tonnage, marine railways render a quick and economical dry-docking service.



FROM A. AMIRIKIAN IN "TRANSACTIONS OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS," 1957

FIG. 7.—TYPES OF FLOATING DRY DOCKS: (A) SIMPLE UNIT; (B) SHIP-SHAPED UNIT; (C) SIMPLE SECTIONAL; (D) ADVANCED-BASE SECTIONAL

DOCK APPURTENANCES

The basic docking structures are fitted with a variety of supplementary equipment. Fittings include the deck fastenings needed for docking and mooring ships, such as bitts, cleats, chocks and bollards to hold mooring lines and winches and capstans for pulling the hauling lines. For protection against impact and abrasion by ships, the decks are edged with timber fenders and, in some cases, with chafing plates. For service and repair work, docks may be fitted with connections for such utilities as electricity, fresh and salt water, steam, compressed air and sanitary sewers.

Weight-handling equipment consists mainly of cranes, generally of the portal type, such as those shown in fig. 4. Cargo-handling facilities may differ widely depending upon the nature of the cargo and the type and location of the dock. The equipment may comprise various types of cranes, hoists, fork lifts, chutes, conveyers, elevators, and other special material-handling devices. In addition, some docks also include warehousing and land transport facilities. A cargo pier equipped with such facilities is illustrated in fig. 8.

See also HARBOURS. (AR. A.)

DOCKYARDS AND NAVAL BASES. Every navy requires shore establishments variously known as dockyards, navy yards and naval bases where repairs can be made, ammunition, fuel and stores supplied, and the needs of the personnel provided for. This is true also for the mercantile fleets that are served impartially by the great commercial ports and repair yards of the world, but the term dockyard is usually applied only to the national establishments for the building and upkeep of warships. In its fullest sense a dockyard is an establishment that builds and equips warships and has complete facilities for docking and repairing them. It is equipped for the installation and repair of armaments and provides facilities for storing and fueling of ships. It also offers training, medical and other services. However, only the few large home dockyards in each country are so completely equipped, and even in these only a small proportion of warships is actually built.

Government dockyards are used mainly for refitting and modernizing the ships serving with the fleets and are also the bases from which new ships are commissioned after being built in private shipyards. Other dockyards have no special facilities for building ships but are equipped to repair and refit various classes of ships. Others that have the status of dockyards are capable only of minor repairs and of supplying stores, ammunition and fuel;

these smaller establishments are really fortified naval bases or fueling stations. (*See* BUNKERING, SHIP.)

A naval base is a shore installation that furnishes direct logistic support to ships of the fleet. It normally includes a naval shipyard and supply depots for fuel and ammunition. One of the most important requirements of a naval base is a protected fleet anchorage where the ships can take on fuel, stores and ammunition and give rest and recreation to the crews. Every dockyard or naval base must be defended by sufficient local defenses to protect it from attack by submarines or torpedo craft, from predatory raids by a few cruisers and from air attack. The security of any dockyard or base, however, must depend, ordinarily, upon the ability of the fleet which it serves to maintain the command of the sea.

UNITED STATES

The continental navy of the American Revolution had no dockyards, and the navy actually went out of existence with the sale of the frigate "Alliance" in 1785. An act of congress of March 27, 1794, provided for six frigates, and these first vessels of the United States navy were built in private shipyards with their future captains superintending construction. The naval committee of the house of representatives recommended acquisition of a navy yard on Jan. 25, 1797. The navy department was established on April 30, 1798; land for six yards was acquired in 1800 and 1801 without express authority of the congress, utilizing part of the funds appropriated for the construction of six 74-gun ships, Feb. 25, 1799; the first direct appropriation, March 3, 1801, was for "completing navy yards."

Five additional navy yards were established prior to 1917–18, and all yards added to their facilities at that time. World War II brought extensions and additions to existing yards and establishment of two new ones; it also brought a change in name from "navy yards" to "naval shipyards."

U.S. Naval Shipyards.—*Portsmouth, N.H.*—This yard was established in 1800 and increased in size in 1866 and later years until it reached 243 ac. It has shipways and dry docks and specializes in building and repair of submarines. Although always known as the Portsmouth, N.H., yard, it is actually across the Piscataqua river in Maine.

Boston, Mass.—Established in 1800, this yard lies between the Charles and Mystic rivers, at Charlestown, on Boston harbour. Area 143 ac. The first dry dock was begun in 1827, completed in 1833. It built many destroyers and escort vessels in World War II. The U.S.S. "Constitution" (*q.v.*) is berthed at the yard, and is open to the public. The South Boston annex, 2 mi. to seaward, was acquired in World War I and increased in area from 106 to 231 ac. in 1942; it has two large dry docks and specializes in cruiser repairs.

New York, N.Y.—Established in 1801 on East river, in Brooklyn, this yard lies between the Manhattan and Williamsburg bridges. Part of the original area was sold to the city of New York in 1890, and the Wallabout market was constructed there. This land was reacquired and additional space was added in 1941–43. There are two large shipways on which battleships have been built, and six dry docks, including two designed for shipbuilding, in which the aircraft carriers "Saratoga" and "Independence" were built. Work was begun in 1941 on a shipyard annex at Bayonne, N.J., in New York harbour. It has a large dry dock and a ship repair wharf, both able to take the largest vessels afloat.

Philadelphia, Pa.—One of the original navy yards was established at Philadelphia, but it was hemmed in and too small by the time of the Civil War. A political fight delayed action but an act of congress of Feb. 18, 1867, authorized acceptance of League Island from the city of Philadelphia, for a new yard. It is on the Delaware river, 100 mi. from the Atlantic, just above the mouth of the Schuylkill river. The old yard was sold at auction Dec. 2, 1875. The shipyard has five dry docks, two marine railways, shipways on which the largest battleships have been built, and modern facilities. The Naval Aircraft factory and testing plants adjoin the yard. Fresh water in the "back channel" provides an excellent mooring space for ships in reserve.

Norfolk, Va.—Established in 1801 at Gosport, in Portsmouth, across the Elizabeth river from Norfolk, this yard occupies a site where the Royal Navy had begun a dockyard before the American Revolution. Always an important navy yard, it was burned on April 20, 1861, in an effort to prevent some of the ships and facilities from falling into the hands of the Confederates, and burned again by the Confederates when they evacuated the yard on May 11, 1862. Area 665 ac. There are seven dry docks, two of them more than 1,000 ft. in length, one large and other smaller shipways. The St. Helena annex of the yard has facilities for the repair of small vessels.

Charleston, S.C.—A navy yard was established in 1901 on the Cooper river, 5 mi. above the junction with the Ashley river. It has dry docks and building ways in its 710 ac., and specializes in repairs to destroyers and mine vessels.

Puget Sound, Wash.—Established in 1891 at Bremerton, across Puget sound from Seattle. It has deep water and is suitable for handling the largest ships. Area 316 ac. It has five dry docks.

Mare Island, Calif.—Established in 1854 across Mare Island strait from Vallejo, Calif., with David Glasgow Farragut as the first commandant. Area 1,500 ac. It has four dry docks and eight shipbuilding ways. It builds and repairs destroyers and submarines.

San Francisco, Calif.—Established in 1940 by the purchase of a private shipyard at Hunter's point, on San Francisco bay, south of the city. It has six dry docks and can handle the largest vessels.

Long Beach, Calif.—Established in 1940, on Terminal Island, San Pedro bay, it has three dry docks and other facilities.

Pearl Harbor, Hawaii.—Established under authority of an act of March 3, 1901, on the island of Oahu, near Honolulu. Area about 700 ac. It has dry docks and repair facilities.

In addition to the 11 naval shipyards listed above, the navy in the early 1960s had a submarine base at New London, Conn., and a destroyer base at San Diego, Calif., which were capable of all kinds of work except major repairs. The United States coast guard, which operates as a part of the navy in time of war, had a coast guard yard at Curtis bay, Baltimore harbour, Md., which did much repair work for coast guard vessels on the east coast. Other repair work for coast guard vessels is done in naval shipyards.

One of the six original navy yards was established at Washington, D.C., in 1800, but it specialized in gun design and construction before the Civil War. As the Naval Gun factory it ceased to work on ships, but in the Washington area the name navy yard persisted in general use. A navy yard was established at Pensacola, Fla., in 1826, but it became the navy's first naval air station in 1914.

Fleet Repair Facilities Afloat.—Early in the 20th century ships of the U.S. navy spent two or three months in navy yards each year for machinery repairs and upkeep. Then the navy pioneered in the development of fleet repair ships, destroyer and submarine tenders, all equipped for repair work. Emphasis was put on repair and upkeep work by ships' crews themselves, assisted by repair ships and tenders. U.S. destroyers and submarines demonstrated the practical value of this new policy during 1917–18. In World War II, many specialized repair ships were equipped in addition to new repair vessels of the older fleet types, and the results were most satisfactory. Not only were the ships of the fleet kept in operating condition with few visits to naval shipyards, but the presence of these repair ships in the forward areas actually saved many damaged combatant ships from sinking. Some remarkable jobs of "first aid" enabled such vessels to limp back to the floating dry docks nearby or to naval shipyards and to "fight another day." The bureau of yards and docks of the navy designed and built floating dry docks which were employed close to the fighting areas and in remote spots where other dry-docking facilities were nonexistent. (*See* DOCK.) The U.S. navy had also made great progress in fueling at sea, and techniques were developed for transferring ammunition and stores at sea. The consequence of all these activities was that ships of the fleet developed a mobility previously regarded as impossible. The service squadrons which operated in the western Pacific including

those which transferred fuel, water, ammunition and stores at sea, added smaller carriers which transferred replacement planes to the fleet carriers.

Construction Battalions and Advanced Bases.—Early in 1942 work was begun on the preparation of advanced bases in the Pacific ocean, at Bora-Bora, Efate and Tongatapu, and the problems encountered resulted in the establishment of the naval construction battalions, nicknamed Seabees (*q.v.*). These organizations had civil engineers and other technicians as officers and were made up of men experienced in or given special training in construction and building work. They erected living quarters and all kinds of other necessary facilities on various Pacific islands, including large repair bases at Espiritu Santo, in the New Hebrides; at Manus, Admiralty Islands; and at Guam.

Naval Air Bases and Stations.—When the United States declared war in 1917 there was one U.S. naval air station, at Pensacola, Fla. Naval air stations were developed at Norfolk, Va., and San Diego, Calif., while seaplane patrol bases were established at seven points on the Atlantic coast. In 1939 there were 11 naval air stations besides 8 air bases for the training of reservists. By 1945 there were about 80 naval air stations, including nearly 40 large stations besides satellite fields. Some of the principal naval air stations in the early 1960s were: Brunswick, Me.; Quonset Point, R.I.; Willow Grove, Pa.; Chincoteague, Va.; Norfolk, Va.; Jacksonville, Fla.; Pensacola, Fla.; Key West, Fla.; Corpus Christi, Tex.; Memphis, Tenn.; Glenview, Ill.; Whidbey Island, Wash.; Alameda, Calif.; Mojave, Calif.; El Centro, Calif.; and North Island, Calif. (*See* also FLEET, NAVAL.)

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GREAT BRITAIN AND COMMONWEALTH

Until the beginning of the 16th century England had no regular establishment for the navy and possessed neither arsenals nor dockyards. The fleet was composed of a few "king's ships" supplemented by ships provided by the seaport towns. These towns were charged with the maintenance of the fighting ships when they were laid up, and there are evidences of dockyards, or of something answering thereto, at the Cinque Ports as early as the 13th century. As the fighting ships developed from the galley to the larger sailing ships there appear to have been depots for both ships and stores maintained at Southampton and Portsmouth, and Henry VII built and completed the first dry dock at the latter place in 1496. Henry VIII in 1509 purchased land at Woolwich and Deptford upon which the building of the first royal dockyards was started, and in 1540 the royal dockyard at Portsmouth was founded around the site of the dry dock of Henry VII. Queen Elizabeth I started the dockyards at Chatham and Sheerness, and both were considerably extended by Charles II after the Restoration. Plymouth, although its ships played so great a part in Elizabethan times, did not become a royal dockyard until 1689, when William III commenced the Plymouth dock at Devonport. The small dockyard at Pembroke was founded in 1814 and was followed by the establishment at Haulbowline (Cobh, Ire.).

Until 1832 the royal dockyards remained under the control of the navy board, which had been founded in 1546 by King Henry VIII. The admiralty was responsible only for the fleet at sea, and this dual control of the navy led to extravagance and allowed mismanagement and corruption which several times came near to bringing about national disaster. With the Reform bill in 1832, the admiralty and the navy office were amalgamated and the present system of dockyard administration came into being. During the 19th century a gradual change came over the dockyards with the transition from sail to steam, and many additions were made to meet the needs of the modern fleet. The most important improvements at any one period were brought about by the Naval Works act of 1895. Defensive harbours were commenced at Portland, Dover and Gibraltar and also dockyard extensions at Gibraltar. At Devonport dockyard the great Keyham extension was started, and new works were begun at Hong Kong and Simonstown, South Africa. At the same time the building of naval barracks at the three home ports began, together with new hospitals at Chatham, Haslar and Haulbowline and colleges at Dartmouth and Keyham.

The growing German menace in the North sea in the opening years of the 20th century compelled the admiralty to seek a new base on the east coast, farther north and easier of approach than Chatham. In 1903 the government approved the creation of a new naval dockyard at Rosyth on the Firth of Forth. Though the outbreak of World War I found this base far from complete, it eventually became invaluable as a first-class dockyard with three big graving docks. Between the wars it was reduced to a care and maintenance basis but rapidly expanded again in 1939. When World War II ended, it was kept in active operation.

In addition to Rosyth, the main British naval bases in World War I were the large dockyards at Portsmouth, Plymouth, Chatham and Malta with smaller establishments at Sheerness, Portland, Haulbowline and Pembroke. There were also dockyards at Gibraltar, Hong Kong, Bermuda, Simonstown and Sydney, Austr., and minor bases at Colombo, Cey.; Wei-hai-wei, China; and Bombay and Calcutta, India. The ports of Harwich, Dover and Immingham acted as bases for light forces, and Scapa Flow, as the main operational base for the grand fleet, was equipped for storing and minor repairs, with Cromarty as a second base.

With the outbreak of World War II all these bases, with the exception of Wei-hai and Haulbowline, which had been surrendered to China and Ireland, respectively, were available as was the great new dockyard at Singapore which had been constructed to meet the Japanese threat. During the course of the war new repair bases manned by the admiralty were set up at Lyness in Scapa Flow; Corpach and Dunstaffnage on the west coast of Scotland; Alexandria, Egy., where a large floating dock was moored; Massawa, the old Italian naval base on the Red sea which was equipped by the U.S. in 1942 but manned from England; Kilindini in East Africa; Durban, S.Af., which possessed the only battleship dock in the Indian ocean; Freetown, Sierra Leone, where a floating dock was put into operation in 1943; Trincomalee, Cey.; and Brisbane, Austr. Ten minor bases were established by Canada on the Atlantic and Pacific coasts to supplement the three main bases at Halifax and Sydney, N.S., and Esquimault, B.C. Facilities were also developed in places where they already existed such as Bombay, Calcutta and Vishakhapatnam, India; Cape Town, S.Af.; Diégo-Suarez, Madagascar; etc.

A new development, known as a floating base or fleet train, was used for the war in the Pacific and enabled the fleet to remain at sea for months at a time. It consisted of floating workshops, storeships and carriers of every kind, vessels which could act as floating docks for minor craft, oilers and amenity ships.

At the end of hostilities the majority of these temporary bases were closed down, but, with the growth of commonwealth navies and the necessity for commonwealth bases and repair facilities to be as widely dispersed as possible, certain developments overseas continued. In South Africa, where the British admiralty retained the use of Simonstown, the Union government established a small dockyard and base for its own navy at East London and took over Salisbury Island in Durban bay. Durban and Cape Town, with an even larger graving dock, reverted to commercial use but could readily be adapted as naval bases of first importance.

Though Canada officially closed down its temporary wartime bases in Sept. 1945, the dock at Saint John, N.B., remained available for vessels up to and including aircraft carriers, while the three main Canadian bases continued to be actively employed. The dockyard and naval base at Auckland, N.Z., was developed to refit ships as large as the latest cruisers, and the dockyard at Sydney formed the main base for the Australian squadron. Brisbane remained a minor base without a dockyard, but, on Jan. 1, 1950, Manus in the Admiralty Islands was commissioned as an advanced Royal Australian Navy base. When the Japanese were expelled in 1944, this island was converted into a naval base for the U.S. 7th fleet, and two huge floating docks, warehouses, machine shops and living quarters were set up. The U.S. disposed of this base in 1947. The dockyard at Bermuda which had served

the navy for many years was officially closed down as uneconomical on March 31, 1951. Singapore continued to develop after it was freed from the Japanese.

In 1957, because of a further need for economy and to meet the reduced refitting requirements of a smaller number of ships, it was decided to close down the dockyards at Hong Kong, Sheerness and Portland. In addition, Malta dockyard was leased to a private ship-repair firm which was to carry out repairs and refits of H.M. ships stationed in the Mediterranean. The dockyard at Simonstown was vacated by the admiralty and handed over to the South African government in 1957, which continued to use it to maintain its expanding naval forces.

Dockyard Administration.—The system under which British dockyards are administered is uniform for all. The control of all dockyards is vested in the controller of the navy (the third sea lord). At the admiralty, under the controller, are the director of naval construction, by whom all ships are designed, and the engineering, ordnance, torpedo, electrical and other technical departments, each responsible for the design of its own material. The director of dockyards, also working under the controller, is responsible for the general management of H.M. dockyards involving the control of large numbers of skilled and unskilled workers. Instructions emanate from the admiralty, the details are left to the dockyard officials, and in practice there is considerable decentralization.

Each dockyard is under the charge of an admiral, commodore or captain according to its size. His deputy as a rule acts as the sovereign harbour master and is responsible for the berthing and moving of ships in the port. The professional dockyard officers are the managers of the constructive, engineering, electrical and civil engineering departments whose names explain their duties. The civil engineering officer is responsible for all buildings, docks, basins, etc. Other dockyard officers are the naval stores officer, cashier, expense accounts officer and medical officer.

It was decided in 1957 that the administration of the naval dockyards should be reorganized on more modern lines, to enable these establishments to carry out more efficiently the repair and modernization of the more complex ships expected to join the fleets. The duties of the senior officers responsible for the management of the dockyards were functionalized. The control of the productive capacity of the dockyards was made the responsibility of a general manager and the activities formerly carried out by the professional managers were put in the hands of production, planning, services and personnel managers.

(S. T. H. W.; G. M. S. S.; L. Ki.)

OTHER COUNTRIES

France.—On the mainland and in Algeria the French coast is divided into four *régions maritimes* with headquarters at the naval ports of Cherbourg, Brest, Toulon and Mers-el-Kebir. The second *région* (Brest) is divided into three *arrondissements*, Brest, Lorient and Lapalisse. Corsica is a part of the third *région* (Toulon). Important naval establishments are at Cherbourg, Brest, Lorient, Toulon (building and fitting out yards) and at Mers-el-Kebir (Algeria), Bizerte (Tunisia), Dakar, (West Africa), and Diégo-Suarez (Madagascar). There are minor bases at Aspretto (Corsica), at Algiers, in the West Indies and at Tahiti and New Caledonia.

Each *région maritime* is placed under the authority of a vice-admiral *préfet maritime*, designated commander in chief in time of war. His authority extends to all territorial forces but not to organized squadrons. Where there is a dockyard the vice-admiral is assisted by a rear admiral "major general," directly in charge of the dockyard. He is also assisted by the *directeurs* of all large departments (naval construction, ordnance, works, medical service, justice, finance) and the heads of coastal defenses, land-based naval aviation, reserve fleet and so on.

The main naval aviation bases are situated at Lorient, Les Mureaux (Paris), Cherbourg, Berre, Hyères, St. Raphaël, Bizerte, Oran, Dakar and Diégo-Suarez.

Germany.—In the Federal Republic of Germany there were in the early 1960s about 150 shipyards for large ocean-going vessels, as well as yards for smaller ships including five graving and many floating docks. The shipyards at Kiel, Hamburg, Bremen, Bremerhaven, Flensburg and Emden were rebuilt after World War II; the naval shipyards are at Kiel, Flensburg, Wilhelmshaven and Bremerhaven.

In the German Democratic Republic merchant ships are built at Warnemünde, Rostock and Wismar; the dockyards at Szczecin and Swinemünde are naval bases for Poland and the U.S.S.R.

Netherlands.—The Netherlands can build the largest merchant ships and all types of naval vessels up to about 10,000 tons. The most important of the 20 or so main shipyards are located along the banks of the Rotterdam seaway and at Amsterdam and Flushing. There are small naval bases at Den Helder, Flushing and Waalhaven (Rotterdam).

Sweden.—The Swedish shipbuilding industry is concentrated at a few large yards, mainly in Göteborg, Malmö and Uddevalla. There are other yards of comparatively minor importance at Helsingborg and Landskrona and in the neighbourhood of Stockholm. There are naval bases at Göteborg, Stockholm and Karlskrona.

Norway.—There are in all 25 Norwegian shipyards capable of building modern steel ships, of which the most important are at or near Oslo and Bergen and at Trondheim, Drammen, Fredrikstad and Kristiansand. The main Norwegian naval bases are at Horten, Kristiansand, Bergen, Trondheim and Ramsundet.

Italy.—The principal Italian shipbuilding yards are at Genoa, Riva Trigoso, La Spezia, Leghorn, Naples, Castellammare di Stabia, Palermo, Taranto, Ancona, Venice, Trieste and Monfalcone. The shipyards that were severely damaged in World War II were all rebuilt. The naval dockyards are at the naval bases of La Spezia and Taranto (the principal yards), Venice, Augusta and Messina in Sicily, La Maddalena and Cagliari in Sardinia, and Naples (secondary dockyards and workshops).

Japan.—By the end of World War II there were five naval bases in Japan, each with a dockyard, at Yokosuka, Kure, Sasebo, Maizuru and Ominato. That at Yokosuka (established in 1866) was the oldest and Kure (1886) the biggest. Though Japan's entire fleet was destroyed during the war, damage to shipyards was comparatively light. In the early 1960s these bases belonged to the maritime self-defense force, but Yokosuka was managed by the U.S. navy, Ominato by the ministry of finance, and the others had been transferred to civilian firms.

Spain.—By 1956 the old shipbuilding yards at El Ferrol, Cartagena and Cádiz had been re-equipped with modern installations for the construction and repair of warships. There were smaller naval bases at Port Mahon (Minorca), Sóller (Majorca), Tarifa, Ríos near Vigo and Las Palmas (Canary Islands). A new naval air base was constructed at Rota near Cádiz in the late 1950s. Merchant ships are built and repaired in private yards at Barcelona, Bilbao, Valencia, Cádiz, Santander, Vigo and Gijón.

U.S.S.R.—Important shipyards exist at Leningrad and Nikolayev with lesser establishments at Kherson, Archangel, Kronshtadt, Sevastopol, Odessa and Vladivostok. As a result of wartime annexations, medium-sized shipyards were added at Tallinn (Estonia), Liepaja (Latvia), Pillau, renamed Baltisk, and Königsberg, renamed Kaliningrad (former East Prussia). Most of the shipyards suffered extensive damage during World War II but later were extensively modernized. The efficiency of Soviet shipyards after World War II was at a very low level but was raised by replanning and re-equipment. As a result of their occupation of eastern Germany and Poland, the Russians profited from the shipbuilding methods and techniques used by these countries.

(X.; L. Ki.)

DOCTOR, the Latin word for "teacher," is the title conferred by the highest university degree. Originally there were three university degrees in European education: bachelor, licentiate (licence to teach) and master or doctor (admission into the teachers' guild). The doctor's degree was first awarded at Bologna in civil law toward the end of the 12th century, then in canon law, medicine, grammar and other fields. In Paris the title master was most common but was interchangeable with the title doctor. English universities adopted the Parisian system but

gradually the superior faculties awarded a doctorate while others retained the title master. In Germany master and doctor were at first interchangeable but the term doctor soon came to be applied to advanced degrees in all faculties. It was the German system that was adopted in most of the rest of the world. The original meaning of the doctorate is best preserved when applied to professors, but the title is now conferred in most fields that require lengthy periods of postgraduate study (*see* UNIVERSITIES; DEGREE, ACADEMIC; MEDICAL EDUCATION).

Doctors of the church are saints whose doctrinal writings have special authority. In the early Christian church there are four Latin or Western doctors—SS. Ambrose, Augustine, Gregory the Great and Jerome—and three Greek or Eastern doctors—SS. John Chrysostom, Basil the Great and Gregory of Nazianzus. To these Eastern doctors Western Christianity adds St. Athanasius the Great. Since the 16th century others have been given the term doctor by proclamation of the Roman Catholic Church. These doctors and the date of their proclamation are: SS. Thomas Aquinas (1567), Bonaventura (1588), Anselm (1720), Isidore of Seville (1722), Peter Chrysologus (1729), Leo I (1754), Peter Damian (1828), Bernard (1830), Hilary of Poitiers (1851), Alfonso Maria dei' Liguori (1871), Francis of Sales (1877), Cyril of Alexandria (1882), Cyril of Jerusalem (1882), John of Damascus (1890), Bede (1899), Ephraem Syrus (1920), Peter Canisius (1925), John of the Cross (1926), Robert Bellarmine and Albertus Magnus (1931), Anthony of Padua (1946) and Lawrence of Brindisi (1959). (V. L. BH.)

DOCTORS' COMMONS, formerly a self-governing teaching body in London, similar to the Inns of Court (*see* INNS OF COURT AND CHANCERY), for practitioners of canon and civil law. Its members held degrees either of doctor of civil law at Oxford or doctor of law at Cambridge and were finally admitted as advocates by the dean of the arches, presiding officer of the court of appeal belonging to the archbishop of Canterbury. Members of the governing body, called fellows, were elected from the advocates by existing fellows. The members practised in the ecclesiastical courts, in the court of admiralty—which together included the courts now comprised by the probate, divorce and admiralty division of the high court of justice—and in arbitrations involving questions of international law.

In 1565 the society leased a site in Paternoster row, near St. Paul's, which served as its headquarters until its incorporation as the College of Doctors of Law Exercent in the Ecclesiastical and Admiralty Courts in 1768, and thereafter until its dissolution in 1858. This event was provided for in the Court of Probate act, 1857, and in the Matrimonial Causes act of the same year; these measures were forerunners of the Judicature act of 1873, which established a single supreme court of judicature, inheriting the jurisdiction of the courts of civil law as well as those of common law and equity, and with a single bar practising before it.

DOCTRINAIRES, the name given to a small group of political thinkers, writers or orators, who exercised a considerable influence in France during the Restoration—more, however, on the development of political ideas than on the course of events. Pierre Royer-Collard (*q.v.*), the most typical of them, had been educated in a school run by the Brothers of the Christian Doctrine, who were colloquially known as "Doctrinaires." This circumstance may have inspired the editor of the *Nain jaune,* who in 1816 was the first to apply the epithet *doctrinaire* to Royer-Collard, but the expression owed its success mainly to the fact that it summed up perfectly the intellectual pride of Royer-Collard and his tendency to present his opinions of the moment as eternal truths. The name was naturally extended to include his friends and disciples, François Guizot, Camille Jordan, Hercule de Sèze, Prosper de Barante, the duc Albert de Broglie, Charles de Rémusat and several others, who had more or less adopted his ideas and his way of expressing himself. The Doctrinaires were never very numerous and a journalist of the period said: "There are four of them, who sometimes boast that there are only three, because it seems to them impossible that there should exist in the world four such powerful intellects, and sometimes claim that there are five of them, but this is when they want to frighten their enemies by their numbers." They at no time formed a political organization or even a school with a well-defined system of thought in common: conscious of being superior minds, they would never have admitted any form of discipline over their political conduct or over their ideas. What they had in common was a certain disdain for the majority of mankind (according to Rémusat "People are divided into those who *understand* and those who *do not understand*") and a way of linking their own political attitudes and certain observed facts to abstract principles (Guizot wrote to a friend: "You have made an admirable choice, like a true Doctrinaire. By following a general idea in your approach to an individual problem you have acted both systematically and empirically at the same time."). They were also in agreement in supporting the political philosophy of the so-called Constitutionalist party in the years 1816–20; *i.e.,* a moderate, constitutional government, based on Louis XVIII's charter.

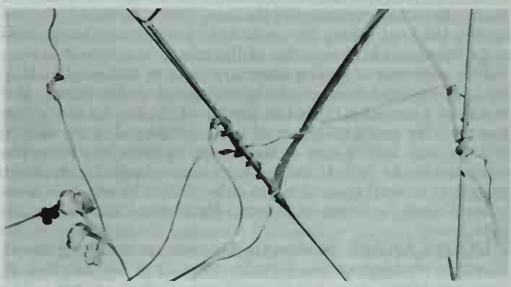
Since the Doctrinaires had provided the Constitutionalist party with its ideological justification, the name Doctrinaires came sometimes to be applied to all supporters of the policy of compromise between the *ancien régime* and the Revolution. In fact, at the end of the Restoration, the Doctrinaires properly so-called were influencing only the small "left centre" group in parliament. By an extension of meaning the word *doctrinaire* has come to be applied, both in French and in English, to a theoretician cut off from the realities of politics.

See Charles Pouthas, *Guizot pendant la Restauration,* ch. 6 (1923); Charles de Rémusat, *Mémoires,* ed. by Charles Pouthas (1958–). (G. DE B. DE S.)

DODD, WILLIAM EDWARD (1869–1940), U.S. historian and ambassador to Germany (1933–37), was born Oct. 21, 1869, in Wake county, N.C. After receiving his B.S. degree in 1895 and his M.S. in 1897 at Virginia Polytechnic institute, he took his Ph.D. in 1900 at the University of Leipzig, where his dissertation was the first of his more than ten books and 100 articles. As professor of history at Randolph-Macon college from 1900 he won national recognition and in 1908 was appointed the nation's first professor of southern history at The University of Chicago. There for a quarter-century his informal lectures and stimulating seminars attracted graduate students from north and south. Alarmed by reactionary and isolationist trends after World War I, he reluctantly turned away from scholarly writing in an attempt, through popular articles and frequent public lectures, to warn the American people of their peril. This led in 1933 to four frustrating years as ambassador to Nazi Germany. Exhausted and ill he returned in 1937 to his farm near Round Hill, Va., where he died on Feb. 9, 1940.

See bibliography of Dodd's publications by Jack K. Williams in *North Carolina Historical Review,* vol. xxx (Jan. 1953). *See* also Avery Craven *et al.,* in *University of Chicago Magazine* (May 1940); Wendell H. Stephenson, *The South Lives in History* (1955). (W. G.)

DODDER, the popular name of the nonchlorophyll-bearing, rootless, leafless, twining parasitic plants forming the genus *Cuscuta,* formerly regarded as representing a distinct family Cuscutaceae but now included in the morning-glory family, Convolvulaceae (*q.v.*). The genus contains over 100 species and is



JOHN H. GERARD

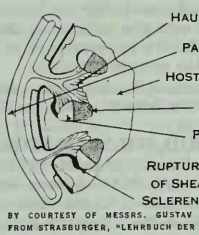
FIG. 1.—DODDER (CUSCUTA), A PARASITIC PLANT WRAPPED AROUND GRASS

widely distributed in the temperate and warmer parts of the earth. Some species are known as scald in England.

The slender threadlike stem is white, yellow or red in colour, bears no leaves and in the seedling stage attaches itself by suckers to the stem or leaves of some other plant around which it twines and from which it derives its nourishment. It bears clusters of small flowers with a four- or five-toothed calyx, a cup-shaped corolla with four or five stamens inserted on its tube and sometimes a ring of scales below the stamens; the two-celled ovary becomes a capsule when ripe. The seeds are angular and contain a threadlike spirally coiled embryo that bears no cotyledons.

On coming in contact with the living stem of a susceptible plant around which it twines, the seedling dodder throws out suckers that penetrate the host, its tissues establishing organic union (*see* fig. 1). By this means water is drawn from the wood or xylem and nutriment from the phloem of the host. The dodder then soon ceases to have any connection with the ground. As it grows, it throws out fresh suckers, establishing itself very firmly on the host plant. After making a few turns around one shoot the dodder finds its way to another, and thus it continues twining and branching until it resembles fine, closely tangled, wet catgut.

The injury done to flax, clover, hop and bean crops by species of dodder is often very great. *C. europaea*, the greater dodder, is parasitic on cultivated and wild hosts in Europe, but is rare in America; *C. epilinum*, on flax, hemp and some other hosts; *C. epithymum*, on various species of clover, alfalfa and other legumes. *C. trifolii*, the clover dodder, damages clover in England.



BY COURTESY OF MESSRS. GUSTAV FISCHER, FROM STRASBURGER, "LEHRBUCH DER BOTANIK"

FIG. 2.—CROSS SECTION OF A WILLOW TWIG SHOWING THE CONTACT OF THE DODDER WITH THE TISSUES OF THE HOST PLANT, WHICH IT FINALLY DESTROYS

In the United States and Canada about 30 species occur, a few of which have been naturalized from the old world. Among the native species are: the love vine (*C. gronovii*), common on herbs and low shrubs in the eastern states and adjacent Canada; the glomerate dodder (*C. compacta*), which forms dense ropes of stems on tall herbs in the central states; and the marsh dodder (*C. salina*), abundant in salt marshes of the Pacific coast, forming golden patches on various saline herbs. All the plants die in autumn but persist by self-sown seeds.

(N. Tr.; X.)

DODDS, ALFRED AMÉDÉE (1842–1922), French general, who took a prominent part in the operations that brought the countries of the upper Senegal and upper Niger under French rule, was born at St. Louis, Senegal, Feb. 6, 1842, a mulatto with some English blood on his father's side. On leaving St. Cyr in 1864, he joined the marine infantry as a sublieutenant. He served as a company commander in the Franco-German War, was taken prisoner at Sedan but escaped and took part in the campaigns of the Loire and of the east. In 1872 he was sent to West Africa; and, except when on active service in Cochin-China (1878) and Tongking (1883), he remained on duty in Senegal for nearly 20 years. As colonel commanding the troops there, he led expeditions against the local tribes, his methods of campaigning being swift and efficient and his knowledge of the country a great aid to him. Taking command of the expeditionary force in Dahomey in May 1892, he occupied Abomey, the native capital, in November; and in a second campaign (1894) he completed the subjugation of the country. He was then appointed inspector general of the marine infantry and, after a tour of the French colonies, was given the command of the 20th (colonial) army corps, becoming inspector general of colonial troops. From 1904 to 1914 he was a member of the Conseil Supérieur de Guerre. He died in Paris on July 18, 1922.

DODECANESE (modern Gr. Dhodhekanisos), a group of islands in the Aegean sea, formally annexed to the kingdom of Greece in 1948. Area 1,051 sq.mi.; pop. (1961) 123,021. The group consists of the southern Sporades (*q.v.*), including Rhodes and Karpathos, with Kastellorizon, and constitutes a nomarchy, the southernmost of the five which make up the *nomos* or department of the Aegean Islands. The city of Rhodes is the administrative centre.

The name Dodecanese means literally "twelve islands" and has been applied at one time or another to groups differently composed and numbering more than 12 islands. This article is concerned with the general history of the Dodecanese group in the modern sense as indicated above. The islands in question are Karpathos (Ital. Scarpanto), Patmos (Patmo) (*qq.v.*), Kasos (Caso), Astypalaia (Stampalia), Lipsos (Lisso), Leros (Lero), Kalimnos (Calino), Nisiros (Nisito), Tilos (Piscopi), Khalki (Calchi), Syme (Simi), with Ikaria (Icaria) until 1912, Rhodes (Rodi) and Cos or Kos (Coo) from 1912 and the outlying Kastellorizon (Castelrosso) before 1912 and from 1923. The Dodecanese, although picturesque and largely mountainous, except for Rhodes and Cos, suffer from deforestation and poor drainage.

In ancient times these islands formed part of the Greek world. Rhodes and Cos (*qq.v.*) have long histories of their own; details are also given under Astypalaia, Karpathos and Patmos. Neither in the Hellenic period, however, nor under the undivided Roman empire can the islands profitably be considered as a unit. Under the Byzantine empire the "theme (province) of the Dodecanese" included not only these islands but also the Cyclades. In the beginning of the 13th century they were the prey of Venetian and Genoese adventurers. A measure of consolidation was achieved in the 14th and 15th centuries, when the knights of St. John of Jerusalem had their headquarters in Rhodes and controlled Syme and the chain of islands from Khalki northward to Leros. Then, in the 16th century, the islands fell one after another to the Turks.

It is to the system of administration evolved by the Turks that the modern connotation of the name Dodecanese owes its origin: the Turks recognized 12 islands, "the Twelve Sporades," as being entitled to a special regime of their own. Whereas Rhodes and Cos, large and economically valuable territories, were reckoned to have been won by conquest and so to be subject to the ordinary rule of the Ottoman empire, the poorer islands, Ikaria, Patmos, Leros, Kalimnos, Astypalaia, Nisiros, Tilos, Syme, Khalki, Karpathos, Kasos and Kastellorizon, having submitted themselves voluntarily to the sultan, were acknowledged to have privileges, ratified by successive firmans, under which they enjoyed administrative, judicial and fiscal autonomy in consideration of the annual payment of a fixed sum, the *maktou*. These privileges were jealously maintained by the islanders, whose delegates insisted on them when Greco-Turkish affairs were being considered by the Great Powers in conference during the 19th century. In 1869, when the Porte, alarmed by Greek Irredentism, decided to integrate the 12 islands within the *il* of the archipelago ("Islands of the White Sea"), assigning Ikaria, Leros, Patmos and Astypalaia to the *sanjak* of Chios and the remaining eight to the *sanjak* of Rhodes, this was declared to be without prejudice to their rights.

Such was the situation prevailing at the outbreak of the Italo-Turkish War. Then, in April and May 1912, Italian forces seized first Astypalaia and then Rhodes, Cos, Lipsos and the remainder of the Twelve Sporades, except Ikaria (which was occupied by Greek forces in the following November) and Kastellorizon (which remained Turkish).

The Italian commanders promised to secure the islanders' autonomy; but when an insular assembly on Patmos proclaimed "the Autonomous State of the Dodecanese" and expressed a desire for union with Greece, the Italians paid no attention except to impose severe penalties on some of the delegates. In the treaty of Ouchy (first treaty of Lausanne; Oct. 15, 1912), the Italian government undertook to withdraw its forces from the islands when the Turks had carried out their obligations in Tripolitania; but this undertaking was not fulfilled.

In the secret treaty of London (1915) the Allies accorded Italy "full possession" of the Dodecanese as one of the inducements for that country to enter World War I on their side. This agreement, however, became of doubtful validity when the United States entered the war in 1917 on the understanding that secret treaties

should not be recognized. On July 29, 1919, an agreement was reached between Eleutherios Venizelos, the Greek prime minister, and the Italian foreign minister Tommaso Tittoni, whereby Italy promised to cede the Dodecanese to Greece with the exception of Rhodes, which was to have "broad local autonomy." By an additional secret accord Italy undertook to permit the inhabitants of Rhodes to decide their own fate in the event of the British government's announcing its willingness to cede Cyprus to Greece, although not until five years should have elapsed. On July 22, 1920, Count Carlo Sforza, Tittoni's successor, denounced this agreement. On Aug. 10, 1920, simultaneously with the abortive treaty of Sèvres between the Allies and Turkey, a new Italo-Greek accord was signed, its terms being similar to those of the previous agreement, with the difference that 15 instead of 5 years were to elapse before the Rhodian plebiscite. To enable Italy to transfer to Greece territory that was still Turkish *de jure*, a special article (no. 122) was included in the treaty of Sèvres, by which Turkey renounced in favour of Italy all rights and titles upon the Dodecanese and Kastellorizon.

In Oct. 1922 the Italian government unilaterally denounced the accord with Greece, despite the protest of Great Britain; and the treaty of Sèvres was never ratified, being overtaken by events, particularly by the Greco-Turkish War in Anatolia. In the treaty of Lausanne (July 24, 1923), which ended this war and superseded the treaty of Sèvres, article 122 was embodied as article 15. Thereon rested Italy's claim to sovereignty over the islands. The Greek government, however, before accepting the treaty of Lausanne, expressly reserved in writing its views on the "determination of the future lot" of the Dodecanese.

Italian rule over the Possedimenti Italiani dell' Egeo, "Italian Possessions of the Aegean," which was administered by the ministry of foreign affairs, lasted until the end of World War II. Firm and efficient, it was distasteful to the inhabitants. Italian became the official language, for education as well as administration; freedom of speech and of the press were restricted; the Orthodox religion, though not actively persecuted, was put at a disadvantage in comparison with the Roman Catholic and Uniate Churches, which had hitherto served inconsiderable minorities. The crowning humiliation came in 1925, when the Dodecanesians were obliged to take Italian citizenship. The upshot of all these measures was to increase substantially the scale of emigration from the islands, especially to the United States. The population fell, under Italian rule, by about 15%.

The Dodecanese (particularly Rhodes and Leros) became important to Italy with the outbreak of World War II, as naval and air bases. Repeated plans to capture the islands were made by the Allies and frustrated: Kastellorizon was briefly occupied by the British in 1941 and Leros and other islands in 1943 after the surrender of Italy; but on both occasions the Axis powers recovered them. The islands finally came into Allied hands after the surrender of Germany in 1945, by which date it was taken for granted that they would be ceded to Greece. After a year under British military administration (in which Greeks increasingly participated), it was agreed by the conference of foreign ministers in Paris on June 27, 1946, that the islands should pass under Greek sovereignty. The decision was confirmed in the Italian peace treaty of Feb. 10, 1947, in which the 14 islands were specified by name. A Greek military administration took them over in April.

As in the case of the Ionian Islands in 1864, the cession was not an unmixed blessing for the inhabitants. By material standards, the Greek administration did not prove to be so efficient as the Italian had been; and since the islands remained poor and infertile, there was still a substantial economic deficit, which the Greek state was hard put to meet in the postwar years of suffering and unrest. The crops (fruit, tobacco, olives, wheat) were insufficient for lucrative export, and the principal nonagricultural occupations of the islanders (fishing, shipping, sponge-diving) had not been much developed. But it was not for the sake of material advantage that the Dodecanesians had sought union with Greece; their case was a striking modern example of the predominance of national sentiment over all other considerations.

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DODECAPHONY, a system of musical composition established chiefly by Arnold Schoenberg (*q.v.*) between 1908 and 1920. The system laid down that the melodic and harmonic elements of a work were to be based on a preconceived succession of the 12 notes in the chromatic scale, not on the traditional principles of tonality. From this succession, called the note-row or note-series, both motives and chords were built. In the strictest forms of dodecaphonic music none of the notes in the series was to be repeated before the remainder of the notes in the series had been sounded. The note-row could be used in its basic form, in its inversion, in a retrograde form and a retrograde inversion. (*See* COUNTERPOINT.) These four forms could also be transposed to any of the 12 degrees of the chromatic scale, thus providing 48 versions of a given row. The system is illustrated in Schoenberg's Suite for Piano, Opus 25 (1923), and was adopted by his pupils Alban Berg and Anton Webern (*qq.v.*). After World War II the system was widely used by composers in many countries in Europe and in the United States. A similar system in which the 12 notes of the chromatic scale were divided into two groups called "tropes" was established by Josef Hauer, who also devised a system of notation on a stave consisting of eight instead of five lines.

See A. Schönberg, *Style and Idea* (1951); J. Rufer, *Die Komposition mit zwölf Tonen* (1952; Eng. trans. H. Searle, 1954).

DODGE, GRENVILLE MELLEN (1831–1916), U.S. civil engineer who was responsible for much of the railroad construction in the western and southwestern states, was born on April 12, 1831, in Danvers, Mass. Educated at Durham (N.H.) academy and Norwich (Vt.) university, where he was graduated from the scientific department, he received a diploma as a military and civil engineer in 1851, at a time when railroad building was commencing in the U.S. on a large scale. He worked first as a surveyor for the Illinois Central railroad and then as head of a survey party in Iowa for the Mississippi and Missouri railroad. He made his home in Council Bluffs, Ia., and at the outbreak of the Civil War he offered his services and those of the Council Bluffs Guards, which he had organized in 1856. He was promoted rapidly to the rank of brigadier general of volunteers and provided valuable service throughout the war in bridge and railroad construction. After the war he served as chief engineer for construction of the Union Pacific railroad, and later held similar posts with the Texas and Pacific railroad and other lines, the facilities completed under his direction totaling thousands of miles. He died Jan. 3, 1916, at Council Bluffs. (W. E. HD.)

DODGE, RAYMOND (1871–1942), U.S. experimental psychologist, one of the most ingenious and productive experimentalists of his generation, was born at Woburn, Mass., Feb. 20, 1871. He received the bachelor's degree at Williams college in 1893 and the degree of doctor of philosophy at the University of Halle in 1896 under Benno Erdmann. After a year as Erdmann's assistant and a year at Ursinus college, Dodge went to Wesleyan university as professor of psychology and then, in 1924, to Yale university and the Yale Institute of Human Relations, retiring in 1936. He died at Tryon, N.C., April 8, 1942.

Dodge is remembered especially for pioneer studies of eye movements in reading and their registration and measurement by photographic methods, and also for having devised during World War I successful methods of selecting and training navy gunners. He experimented also on motor effects of alcohol, vestibular reactions, individual variability and other psychological problems, normal and abnormal. He was editor or associate editor of seven major psychological journals. His writings include *Elementary Conditions of Human Variability* (1926), *Psychological Effects of Alcohol* (with F. G. Benedict, 1915) and *The Craving for Superiority* (1931). Dodge was president of the American Psychological association (1916–17), and chairman of the Division of

Anthropology and Psychology of the National Research council (1922–23), as well as a member of the National Academy of Sciences.

See C. A. Murchison, *History of Psychology in Autobiography*, vol. i (1930). (F. A. K.)

DODGE CITY, a city of southwestern Kansas, U.S., and seat of Ford county, on the Arkansas river, about 150 mi. W. of Wichita. It has railroad shops and farm implement plants and is the supply centre for an agricultural and stock-raising area. The meridian separating central from mountain time passes through it.

Dodge City was settled about 1872 and incorporated in 1875. It was a famous frontier town on the old Santa Fe trail, the rendezvous of picturesque characters, the centre of important freighting lines and headquarters of the cattle business. At the peak, in 1884, herds aggregating 8,000,000 head of cattle passed through from Texas. Large herds of buffalo in the vicinity were ruthlessly slaughtered by hunting parties. The town had a transient and diverse population of cattlemen, adventurers, soldiers, buffalo hunters, homesteaders, gamblers, railroad men and outlaws. Lawlessness and gun fights resulted in the establishment of Boot Hill cemetery, and a succession of marshals and sheriffs, whose fame in the annals of the west has been inordinately enhanced by Hollywood and television. Beeson museum, just outside of Dodge City, has one of the largest collections of cowboy and Indian relics in Kansas. On the river 5 mi. E. of the city is old Ft. Dodge (established in 1864 and named for Col. Henry I. Dodge), an important frontier garrison, now a state home for war veterans. For comparative population figures *see* table in KANSAS: *Population*.

See W. S. Campbell, *Dodge City: Queen of Cowtowns* (1955).

DODGSON, CHARLES LUTWIDGE (pseudonym, LEWIS CARROLL) (1832–1898), was an English mathematician and logician who used his specialized knowledge to carry the art of nonsense to a peak, and who at the same time handled a children's story with none of the moralizing and sententiousness of the early 19th century. He was born at Daresbury parsonage, Cheshire, on Jan. 27, 1832. As a child he was precocious and enterprising, showing a keen interest in the drama, which persisted throughout his life. The first of several manuscript magazines which he wrote and illustrated for his brothers and sisters, *Useful and Instructive Poetry* (1845), contains some curious anticipations of his later work. He spent three years at Rugby school, where he was unhappy, and went to Christ Church, Oxford, in 1851. The death of his mother in the same year profoundly distressed him and may have checked his emotional development, so that his thoughts reverted continually to his happy childhood. He was afflicted with a stammer and was drawn increasingly to the society of children, especially little girls, in whose company he was always at ease. He was nominated to a studentship (or life fellowship) of Christ Church in 1852 and held the mathematical lectureship from 1855 to 1881. Ordained a deacon of the Church of England in 1861, he did not proceed to priest's orders and later considered himself as "practically a layman." He was a painstaking amateur draftsman and became an outstanding photographer of children.

Dodgson's first publication was *A Syllabus of Plane Algebraical Geometry* (1860), and he continued to publish mathematical books, of which *Euclid and His Modern Rivals* (1879–85) and *Curiosa Mathematica* (pt. i, 1888; pt. ii, 1893) may be mentioned. He also wrote anonymously skits on Oxford affairs; *e.g.*, *The Dynamics of a Particle* (1865), *The Deserted Parks* (1867) and *The New Belfry* (1872). But it is on his fanciful works published under the pseudonym "Lewis Carroll"—derived by transposition from his own Christian names—that his reputation rests. Few books have been more often translated than *Alice's Adventures in Wonderland* (1865), which was inspired by his friendship with Alice Liddell, daughter of the dean of Christ Church, and in particular by a trip upriver from Oxford to Godstow with her and her sisters on July 4, 1862. A suggestion of mild impromptu clings to the opening chapters, describing the fall down the rabbit hole and the little door into the garden. As *Alice's Adventures Under Ground*, the book was first written out by hand as a present for Alice and illustrated by Dodgson himself. The original manuscript consisted of 18,000 words only, but on George MacDonald's

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ILLUSTRATIONS FOR ALICE IN WONDERLAND BY SIR JOHN TENNIEL: (TOP LEFT) ALICE "TRIED THE LITTLE GOLDEN KEY IN THE LOCK"; (TOP RIGHT) THE WHITE RABBIT "WITH A TRUMPET IN ONE HAND AND A SCROLL OF PARCHMENT IN THE OTHER"; (BOTTOM) ALICE "SAT DOWN IN A LARGE ARM-CHAIR" FOR TEA WITH THE MARCH HARE, THE MAD HATTER AND THE DORMOUSE

recommendation Dodgson revised and enlarged it for publication. John (later Sir John) Tenniel, under Dodgson's supervision, then prepared the famous illustrations. The first version, *Alice's Adventures Under Ground*, was published in facsimile (1886). The final manuscript of *Alice in Wonderland* has never come to light.

A worthy sequel was *Through the Looking-Glass* (1872), a fantasy based on a chess game. There are many allusions in both books to matters known to the young Liddells. The only other of Lewis Carroll's works to attain comparable fame was *The Hunting of the Snark* (1876), the longest and best-sustained nonsense poem in the English language. His verse was published in *Phantasmagoria and Other Poems* (1869) and *Rhyme ? and Reason ?* (1883), and subsequently in *Collected Verse* (1932). A master of parody, he comes between Edward Lear and Charles Calverley in the tradition of English light verse. The two volumes of his novel *Sylvie and Bruno* (1889 and 1893) proved elaborate failures, yet they are an interesting experiment in the handling of the supernatural, besides introducing the original form of the verse-epigram sometimes called the "Waterford," and immortalized in "The Mad Gardener's Song," beginning "He thought he saw an Elephant." Dodgson died at Guildford, Surrey, on Jan. 14, 1898.

The *Alice* books belong to the rare company of works written for children that appeal equally to young and old. Their characters have become a part of English folklore; quotations from them are commonplaces of speech; and no definition of English humour since they were written has been able to ignore them.

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DODO, the common name for two extinct species of large, clumsy, flightless birds of the genus *Raphus* (or *Didus*). They inhabited the islands of Mauritius and Réunion in the Indian ocean. Together with a smaller bird, the solitaire (*q.v.*), which frequented the nearby island of Rodrigues, they comprise the family Raphidae, believed related to the pigeons (Columbidae). The Raphidae have been extinct since about 1680. The Mauritius dodo (*R. cucullatus*), slightly larger than a turkey, was much the best known of the two species and several were sent alive to Europe. Some of these were at the time preserved in museums, but no complete specimen now exists, only a foot and leg in Oxford. Numerous bones were found in swamps on Mauritius and skeletons were assembled. Detailed paintings from life give some indication of the dodo's appearance. The huge blackish bill terminated in a large, horny hook; the cheeks were partly bare, and the plumage was whitish on the breast and tail and yellowish-white on the wings. The dodo inhabited the forests and is said to have laid one large white egg on a pile of grass. The chief factor that brought about the dodo's extinction was probably the birds' vulnerability to the early settlers and their imported animals, especially the hogs, which fed upon the dodo's eggs and young.

BY COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

RESTORATION OF A DODO

See A. H. Evans' *Birds* and Marquess Hachisuka's *The Dodo and Kindred Birds.* (DN. A.)

DODOMA REGION, TANGANYIKA, established in Oct. 1963, following a reorganization of administrative units in Tanganyika, comprises Dodoma, Mpwapwa and Kondoa districts which previously belonged to the former Central region. It is bounded north and east by Northern (Arusha) region, east by Morogoro region, south by Iringa region and west by Singida region. Area 16,350 sq.mi. Pop. (1957) 514,425. A belt of hills and escarpments, from the Kondoa range to the Rubeho mountains in the southeast, rises 1,500 ft. above the general height (4,000 ft.) of the central plateau to the west (granite) and the Masai steppe to the east. Drainage is partly to the dischargeless Bahi swamp west of Dodoma, but cutting through the hills to the coastal plain are the Mukondoa (Mukondokwa) river, a tributary of the Wami, and the Great Ruaha, which flows through a narrow gorge at the southern boundary of the region. Regional headquarters are at Dodoma (pop. [1957] 13,435), where the main north-south road of Tanganyika crosses the Central railway. The economy is based on livestock products, beeswax, honey, gums and groundnuts (peanuts). Various cereals, beans, onions and oilseeds are among the crops grown. (J. M. KE.)

DODONA, an ancient sanctuary of Zeus in Epirus, contained many remarkable and abnormal features, unlike those of his worship elsewhere. The earliest mention of it is in the *Iliad* (xvi, 234), where its priests are called the Selloi, or, according to a less usual reading of the text, the Helloi. The meaning of the name Selloi or Helloi is unknown, though a connection between Helloi and Hellenes is conjectured. These priests are described as "of unwashen feet, sleeping on the ground." This does not resemble a description of any normal Greek priesthood, nor does it seem appropriate to the clergy of a sky and weather god; it rather suggests worshipers or servants of an earth goddess or of some chthonian power with whom they kept in continual contact day and night. Homer again (*Odyssey* xiv, 327; xix, 296) has the first mention of the oracle at Dodona; Odysseus is reported (falsely) to have gone there "that he might hear the will of Zeus from the god's oak (*drys*) of lofty leafage." In Hesiod there is mention of another sort of tree, the *phegos*, perhaps to be understood as Valonia oak, in the trunk of which, apparently, some person or persons lived. But the reading is not certain and some words are lost. It is certain, however, that the tree (more than one, according to Aeschylus) was reputed to give oracles, presumably by interpretation of the rustling of its leaves and other sounds. The occasional references to actual speech, in Aeschylus and in Apollonius Rhodius, can hardly represent contemporary belief.

Herodotus, but no earlier writer, mentions priestesses, whom he also describes as the actual givers of the oracles, doubtless under some kind of inspiration from the god. Plato classes these women with the Delphic prophetesses as prophesying in an ecstasy, or, as he calls it, madness. The legend Herodotus professes to have heard at Dodona, tracing the origin of their office to the shrine of Amun in Egyptian Thebes, may be largely discounted. Of its real origin nothing is known. A further peculiarity of Dodona was the famous "bronze," a large gong set vibrating at every puff of wind by a scourge held in the hand of a figure standing over it; the persistent ringing passed into a proverb. It does not, however, appear that this had anything to do with the oracle; according to Strabo the gong was an offering from the people of Corcyra.

In Dodona, Zeus had for his consort Dione, not Hera; her name is simply the feminine of his own (stem *Dio-*), and so she may be his original partner, brought with him into Greece. He bore the somewhat puzzling title of Naios, usually connected with *naein*, "to flow"; hence perhaps "Zeus of the spring." The existence of a sacred spring at the shrine is attested by the elder Pliny and some later authors, and is likely enough in itself. But Naios is equally derivable from *naos*, a "temple," though no temple was built at Dodona until the 5th century B.C. There is always the possibility that, as suggested above, Zeus had taken over an older oracle from some deity of the earth and water; he himself seldom gave oracles directly, although it was the orthodox doctrine that those of Apollo ultimately derived from him.

Thanks to excavations on the spot, several examples of inquiries at the oracle are extant. Consultants wrote their questions on lead tablets in such a form that "yes" or "no" was reply enough. Longer answers were sometimes made by the oracle, however (Demosthenes xxi, 53).

See M. P. Nilsson, *Geschichte der griechischen Religion*, 2nd ed., vol. i, pp. 423–427 (1955). (H. J. R.)

DODSLEY, ROBERT (1703–1764), English author and London bookseller who published most of Dr. Johnson's works, and who edited valuable collections of old plays and of poems, was born in 1703 near Mansfield, Nottinghamshire, where his father was master of the free school. He is said to have been apprenticed to a stocking weaver in Mansfield, from whom he ran away, taking service as a footman. In 1729 Dodsley published his first work, *Servitude*, with a preface and postscript ascribed to Daniel Defoe. A collection of short poems, *The Muse in Livery: or, the Footman's Miscellany*, was published by subscription in 1732 and was followed by a satirical farce, *The Toyshop* (1735). With the help of his friends—Alexander Pope lent him £100—Dodsley set up as a publisher at the "Tully's Head" in Pall Mall, London, in 1735. One of his first publications was Dr. Johnson's poem *London*, for which he gave ten guineas in 1738, and he suggested and helped to finance the *English Dictionary*. Pope also made over to Dodsley his interest in his letters. In 1739 his publication of Paul Whitehead's *Manners*, voted scandalous by the house of lords, led to a short imprisonment. Dodsley also founded several literary periodicals: the *Museum* (1746–47, 3 vol.); *The Preceptor: First Principles of Polite Learning* (1748, 2 vol.), with an introduction by Dr. Johnson; the *World* (1753–56, 4 vol.); and the *Annual Register* (1758–), with Edmund Burke as editor. He is, however, best known as the editor of two collections: *Select Collection of Old Plays* (1744, 12 vol.; ed. by Isaac Reed, 1780, 12 vol.; 4th ed. by W. C. Hazlitt, 1874–76, 15 vol.); and *A Collection of Poems by Several Hands* (1748, 3 vol.), which passed through many editions. A collection of his dramatic works and some poems which

had been issued separately were published in two volumes, *Trifles* (1745–77), and this was followed by other poems and plays. His tragedy *Cleone* (1758) had a long run at Covent Garden and was very popular, 2,000 copies being sold on the day of publication. In 1759 Dodsley retired, leaving the conduct of the business to his brother and partner James (1724–97). Robert Dodsley died at Durham on Sept. 23, 1764.

Bibliography.—Dodsley's poems are reprinted with a memoir in A. Chalmers' *Works of English Poets From Chaucer to Cowper*, vol. xv (1810). *See* also Charles Knight, *Shadows of the Old Booksellers*, pp. 189–216 (1865); E. Solly, in *The Bibliographer*, vol. v, pp. 57–61 (1884); Austin Dobson, "At Tully's Head," in *Eighteenth Century Vignettes*, 2nd series (1894); R. Straus, *Robert Dodsley, Poet, Publisher and Playwright* (1910).

DODSWORTH, ROGER (1585–1654), English antiquary, among the first to realize the historical potentialities of contemporary documents, was born at Oswaldkirk, Yorkshire, in 1585. Publishing nothing himself, he amassed transcriptions toward a baronage and formed a collection of sources on monastic history; this was used by Sir William Dugdale (*q.v.*) in his *Baronage of England* (1675–76) and *Monasticon Anglicanum* (3 vol., 1655–73). This last is known under Dugdale's name, although two-thirds of the work is Dodsworth's. On his death in Aug. 1654, 160 volumes of Dodsworth's manuscripts were placed in the Bodleian library, Oxford. Extracts were published by the Yorkshire Archaeological society as *Dodsworth's Yorkshire Notes* (1884 and 1887–93) and by the Chetham society as *Copies of Lancashire Inquisitions Post-Mortem* (1875–76). (J. M. Wi.)

DOG. The dog is the oldest domestic animal. Its remains have been found in Denmark dating from the early part of the Middle Stone Age, in connection with the human culture known as the Azilian. These bones date back to perhaps 6000 to 8000 B.C. Shortly afterward dogs appeared in the Mesopotamian valley and the near east. The evidence is still too incomplete to pinpoint the exact spot where the first dog was domesticated, but it was probably some place in central Europe.

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I. ORIGIN AND HISTORY

1. Ancestry.—All dogs belong to a single species, *Canis familiaris*. Other members of the genus *Canis* include the wolves, coyotes and jackals. The coyotes, which live only in North America, can be eliminated as ancestors of the early European dogs on geographical grounds.

Wolf.—The most likely candidate is the gray wolf, *Canis lupus*, which was originally found over all of Europe, Asia and North America, with a great many highly variable subspecies and local varieties. Wolves are so variable in colour that even individual members of a pack can be easily distinguished; they range from pure black through shades of gray to almost white. The northern wolves are much larger than the southern ones, which makes it probable that dogs came from a smaller central or southern variety.

Jackal.—The other possible candidate, the jackal, is primarily an African animal, although its range extends into Mesopotamia, southeastern Europe and India. Jackals are less social than dogs; they howl in a manner unlike any domestic dog; and have narrow, foxlike heads—factors that make it unlikely that they are ancestors of the domestic dog.

2. Domestication.—After dogs became domesticated, selection by man for various traits of appearance and behaviour began. One trait that distinguishes dogs from their wild relatives is an upturned tail, ranging from a sickle shape to a tight curl. This characteristic, a mutation that probably goes back to the original stock of domestic dogs, points to a common ancestry for all types of dogs. Another feature that distinguishes most dogs from wolves is the smaller, less powerful teeth. There must have been an early artificial selection for those animals that were smaller, less toothy and also more easily tamed and controlled.

3. Distribution and History.—The domesticated dog apparently spread very rapidly all over the world, through both hemispheres and from tropical to arctic climates. When the white men arrived in North America they brought their own dogs, but every Indian tribe already had them. At that time there were at least 20 distinct breeds in North and South America. Most of these have disappeared except for the Mexican hairless and the Eskimo dogs.

In Australia there is the dingo, a separate species from the domestic dog. The dingo, typically a wild animal, is sometimes found semidomesticated in the camps of the aborigines. Its ancestors must have been brought as domestic dogs to Australia by the first immigrants several thousand years ago and later allowed to run wild.

In historical times dogs were found all over Africa. One of the surviving native breeds is the African basenji, still used by the pygmy tribes in equatorial regions. Similarly, dogs lived all over Asia and on most of the oceanic islands.

Most is known about the history of European dogs. From the earliest times traders and travelers not only took their favourite dogs on long journeys but often returned with new and exotic varieties. Dogs were nowhere more cultivated than in England.

By the time John Caius (founder of Caius college at Cambridge) wrote a description of English dogs for the naturalist Konrad von

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"WOMAN'S DAY"

B. J. CYR

TOY BREEDS

Partly because of their small size, toys depend more than any other breeds on the continuing care of man. (Left) Maltese: desired weight under 7 lb.; (centre) toy poodle: height 10 in. or under; (right) papillon: height 11 in. or under. (Standards given for size are those recommended for the male show dog; height always refers to shoulder height. In some breeds only one standard for size has been set as critical.)

Gesner in the 16th century, the English had collected at least six main varieties of dogs—greyhounds, true hounds, bird dogs, terriers, mastiffs and shepherd dogs. The greyhounds, or pursuit dogs, tall, lean and very swift, originally came from Mesopotamia or the near east, where they still survive as the salukis, or gazelle hounds. The true hounds were used for hunting various animals by scent; they had long ears and large baggy lips, as they have today. Caius called them harriers. Modern beagles and foxhounds belong to this group. Bloodhounds were already known in that day. The bird dogs were the water and land spaniels and the related setters. Caius also mentions the "spaniel gentle," probably referring to the ancestors of the modern toy spaniels. Quite different from the above-mentioned dogs were the terriers, which were trained to creep into holes and attack badgers, foxes and other game. Terriers were selected for aggressiveness and were frequently used for dog fights and various sorts of animal baiting. Useful and important dogs in that era were the mastiffs and bandogs, the latter named because they were usually kept on a bond or chain. It is hard to realize that these and most other giant breeds were originally bred for ferocity, being used to protect property and even to fight as war dogs. The shepherd dogs are represented today by the Old English sheep dog and the Scotch collie. Since they were not used by the nobility there are few records concerning them.

A basic group of dogs not mentioned by Caius includes the sled dogs of the Eskimos, found in the arctic in both America and Eurasia. These large curly-tailed dogs, reputedly crossed with wolves, and similar smaller dogs of northern Eurasia are sometimes called the polar or spitz group.

Although the same general types of dogs were found all over the world many less distinct in their physical and behavioural traits have since disappeared. Many ancient breeds have greatly changed or entirely disappeared, but in Iraq are still found two ancient types of dog, the earlier-mentioned saluki and the Kurdish herding dog. The latter is a large breed somewhat resembling the mastiffs and war dogs pictured in Babylonian art in 2200 B.C.

Historical records show that dog breeds have frequently been crossed with each other, so that it is difficult in many cases to determine the ancestors. At any rate, in modern times dogs have become the most variable of domestic animals.

4. Zoological Relationships.—The typical members of the dog family Canidae, order Carnivora, belong to the genus *Canis*, which includes the domestic dog, the closely related dingo of Australia, wolves and jackals. The jackals are sometimes put in a separate genus, *Thos*. More distant relatives in the same family are the foxes, belonging to the genera *Vulpes*, *Urocyon* and *Alopex*. Still more distantly related are the "wild dogs," including *Lycaon*, the African hunting dog; *Icticyon*, the South American bush dog; and *Cuon*, the dhole of India.

All the Canidae have a common ancestor in the Oligocene period.

WALTER CHANDOHA

NONSPORTING BREEDS

This breed category includes such diverse types as the French bulldog (left) and the Lhasa Apso. The French bulldog: weight under 28 lb.; the Lhasa Apso: height 10–11 in.

The "wild dogs" were the first to separate from the wolf line; later the foxes split off. In comparatively recent times the wolves gave rise to the coyotes in America and the jackals in Africa and southern Eurasia. Finally a small race of wolves was domesticated to produce the domestic dog, which in turn gave rise to the dingo in Australia. *See* also CARNIVORE: *Survey of the Order: Dog and Dog Allies (Canoidea).*

WALTER CHANDOHA

TERRIERS

(Left) Border terrier: weight 13–15½ lb. (Right) Bedlington terriers: height 15–16 in., weight about 24 lb.

II. BEHAVIOUR

A. Behaviour Patterns in Dogs and Wolves

Many peculiarities of dog behaviour can be understood only in reference to the lives of their wild ancestors, the wolves. Within recent years the behaviour of wolves in undisturbed wild conditions has been studied scientifically, reducing much of the mythology surrounding them to scientific fact.

1. Territory and Range.—The usual wolf pack has a central headquarters or den. The immediate area around this is defended as a territory and all trespassers, whether wolves or other carnivores, are driven off. In addition, the pack has a wide hunting range, sometimes as large as 40 mi. in diameter. At various points the wolves commonly pass there are "scent posts" where they stop to urinate and defecate. Males lift the leg to urinate and scratch the ground after defecation. Strange wolves passing by will also mark the place in the same manner. The same habits are seen in dogs allowed to run loose in town or country: the tendency to defend the immediate areas around the houses of their owners, but to wander much more widely, marking certain "scent posts" as they go.

2. Group Activities.—Wolves are highly social animals. Sometimes they live in pairs, but the normal group is a small pack of five or six adult animals, males and females together. The cubs produced each year apparently leave the old pack during the next breeding season to found new packs of their own.

The major activity of wolves is hunting. They will eat anything from mice and birds on up, but their major articles of diet are the large herd animals such as deer, in the woodlands, and caribou, in the arctic. They may also be highly destructive to domestic stock in settled areas. In the usual hunt, the pack sets out together but splits up to find game. If one is successful he howls, bringing the others together, and they join to eat the already downed quarry or to make a combined attack on the struggling prey.

Within the pack, wolves are peaceable and highly co-operative animals. While feeding, the wolves observe a dominance order, with the most dominant animal feeding first. Parts of prey animals are often buried or cached, either at the site of the kill or in the vicinity of the den. This presumably saves the food from scavengers. Domestic dogs show the same habits, even attempting to bury such things as dry dog food.

Wolves show the same general types of sounds and communication as dogs—barking when a strange animal approaches the den, yelping in fear or distress, growling when threatening another animal and howling, either alone or, when the pack is together, in unison.

3. Agonistic or Combative Behaviour.—Wolves will attack strange animals unmercifully. Two strange male wolves approach each other stiffly, with tails held erect, and apparently identify each other by sniffing in the tail region. If a fight starts, they rush at each other, snapping and snarling, and the fight lasts until one runs away or submits. The beaten animal will roll on its back, extending its paws, yelping, and protecting its throat by snapping. The winning animal stands over it, growling and threatening. If dominance has already been established, one wolf may indicate this by placing his paws on the other's back and growling while the subordinate animal keeps his tail low. Similar patterns of behaviour are seen in domestic dogs.

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TERRIERS

(Left) Welsh terrier: height 15 in., weight about 20 lb.; (centre) Dandie Dinmont terrier: height 8–11 in., weight 18–24 lb.; (right) West Highland White terrier: height 11 in.

"LIFE," © TIME INC.

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HOUND BREEDS

(Left) Whippet: height 19–22 in.; (centre) Basset hound: height under 14 in.; (right) Otterhound: no definite size standards, but height about 26 in., weight about 65 lb.

4. Courtship and Care of Young.—In courtship wolves show a characteristic pattern of play. They crouch extending their forepaws and cocking their heads to one side, then they throw their forelegs around each other's necks and wrestle. This is followed by running and chasing and eventually mating. Like domestic dogs, wolves show the peculiarity of the sexual tie: after copulation the two animals remain locked together for many minutes.

For the first three weeks or so young puppies are fed exclusively by nursing, but thereafter they begin to take vomited food, with final weaning at about seven weeks of age. Until four to six months of age the young wolf cubs must be fed by vomited food or other material brought to the den. Feeding the young by vomiting occurs in males as well as females and in young unmated animals. Domestic dogs show this pattern more rarely, but vomit readily and, like wolves, frequently eat the vomitus.

B. Specialization of Dog Behaviour

The wolf patterns of behaviour present in all domestic dogs have been accentuated or reduced in different breeds by selection for special purposes. Some of the principal specializations of dog behaviour selected by man are discussed below.

1. Hunting Dogs.—Wolves are generalized hunters, using all possible methods to catch their prey. The hound breeds of dogs have been selected to hunt primarily by scent and are used to find and run down various sorts of land mammals, which leave a continuous trail of scent behind them. Even hounds, however, do not rely entirely on scent but also use their eyes and search the ground in circles. In most cases the trail followed is quite fresh but the bloodhound breed is remarkable in being able to follow a scent many hours old.

A different type of hunting is found in bird dogs. Flying birds leave no continuous scent, and finding them on the ground is a matter of thoroughly covering a large area. When the bird is finally scented, the dog is trained to stop and wait, as in pointers and setters. Other breeds, such as the spaniels, simply flush the birds so that they can be shot. Another problem in bird hunting is to find the shot and wounded birds and bring them back to the hunter. For this job several special breeds of retrievers have been developed, some of which are used for both finding and retrieving.

The spaniels appear to have been the original bird dogs, and tradition says that they originally came from Spain. They were used and selected for various types of hunting in the middle ages. Some were water spaniels, used for retrieving birds from the water. The land spaniels were used in the sport of falconry, being trained to find and flush birds off the ground so that the falcons could attack them. Others were used in setting birds for the net: on finding the birds the spaniel was trained to lie flat on the ground while the net was thrown over him and the birds. This was the original meaning of "setter." Later, when shotguns were developed for use in bird hunting, this behaviour trait was useless, and the setter breeds were then selected for pointing instead. The original pointers were developed about the same time, probably from a mixture of hound and spaniel breeds.

Hunting game on open plains or deserts is not so much a problem of finding the game as of catching it. The various greyhounds have been selected for great speed and running down game of different sorts by sight.

The final part of hunting is the attack on the prey, and the

WALTER CHANDOHA

HOUND BREEDS

(Left) Afghan hound: height about 27 in., weight about 60 lb.; (right) Rhodesian ridgeback (with back ridge of hair growing in reverse direction): height 25–27 in., weight 75 lb.

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WORKING BREEDS

(Left) Bouvier des Flandres ("cowherd of Flanders"): shoulder height 23½–27½ in. (Right) Pull pups: adult height 17–19 in.

terrier breeds have been selected as attack dogs. The fox terriers were used to drive foxes out of their dens, and the larger Airedale terriers were, and still are, sometimes used to attack mountain lions and bring them to bay.

Thus starting with wolves, selection for different types of hunting has produced dog breeds that are faster than wolves (greyhounds), more ferocious than wolves (terriers) and better trailers than wolves (hounds). (*See* HUNTING.)

2. Guard Dogs and Watchdogs.—The tendency of wolves to guard their dens has carried over to dog breeds that guard and protect property. Such dogs have limited uses under modern civilized conditions because the owner is responsible for the damage they do, but almost any breed of dog will still sound the alarm when strangers approach. Breeds such as the German shepherd dog (or Alsatian) and the Doberman pinscher are sometimes used in police work and by night watchmen. Dogs still find certain use in modern warfare, chiefly in night patrols and in scouting and sentry duty.

3. Herding Dogs.—Wolves follow and chase herd animals. In dogs it is a short step from this behaviour to herding. Under primitive conditions herding dogs were used to protect flocks of sheep or goats from predators, and they consequently had to be large and aggressive animals. However, many of the modern shepherd breeds, such as the border collies, are small- or medium-size animals that have been selected for the ability to learn commands and obey them from a distance. Dogs are still used for herding cattle. Most of the animals in actual use are not registered or show animals.

4. Sled Dogs.—One use of dogs that has no counterpart in the behaviour of wolves is as draft animals. With the domestication of larger animals and with modern systems of transport, this use has largely disappeared in most parts of the world but survives chiefly in the arctic sled dogs. Before the white man brought the horse to North America, Indians used dogs to pull their wheelless vehicles (*travois*).

5. Companions and Pets.—An important modern use of dogs is as companions and household pets. Almost every breed of dog has been used for this purpose, but for many persons the ideal household pet is small sized and easily controlled. The various toy breeds have been developed especially as pets.

The popularity of dog breeds varies from year to year and mostly reflects the current taste in household pets. The most popular breeds are therefore usually small or medium sized. Within the last half-century fox terriers, cocker spaniels and beagles have been favourites in the United States, with some of the working and toy breeds such as collies, boxers, German shepherds, Chihuahuas and Pekingese being runners up. Among non-sporting breeds, poodles and Boston terriers have been most popular.

6. Guide Dogs.—Guide dogs for the blind are particularly valuable and devoted companions. Dog and master must go through an intensive period of training in which the dog learns to avoid overhead obstacles, to stop at curbs and to keep the blind person out of the way of traffic. Several breeds have been used successfully as guide dogs, but the German shepherd dog is employed most commonly. (*See* also BLIND, TRAINING AND WELFARE OF: *Dog Guides for the Blind.*)

7. Dogs in Research.—The Russian physiologist I. P. Pavlov began to use dogs for his research on conditioned reflexes, laying the foundation for modern theories of learning in animals and man. Dogs show more heritable variability in behaviour than

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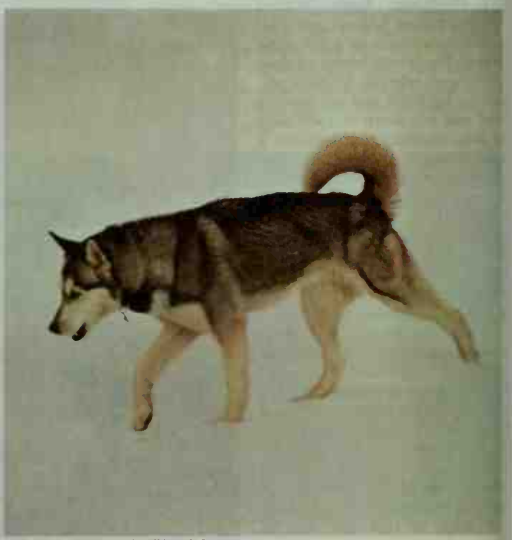

BUSS KINNE—PHOTO RESEARCHERS, INC.

WORKING BREEDS

(Left) Welsh corgi (Pembroke): height 10–12 in., weight 20–24 lb.; (right) Siberian husky: height 21–23½ in., weight 45–60 lb.

any other domestic animal and thus are ideal subjects for the study of the relationship between heredity and temperament. The close social relationship between dogs and man is in many ways similar to the human parent–child relationship, so that dogs can be used to test various theories of child training.

Dogs also have important uses in medical research, and the resulting discoveries have helped to improve both animal and human health. The use of animals in medical laboratories is regulated both by codes of professional ethics and by law, in order to prevent needless suffering. In Great Britain such research is strictly regulated by law and performed only by licensed individuals. (*See* ANIMAL EXPERIMENTATION.)

III. REPRODUCTION

1. Heat or Estrus.—The ancestral wolves do not become sexually mature until nearly two years of age. However, females of most breeds of domestic dogs will show their first heat (or estrus) period before they are a year old and sometimes before six months. There is considerable variation both between breeds and individuals. The African basenji has a seasonal cycle, the females coming into heat in the autumn of each year. A similar cycle is found in the Australian dingo when brought into northern latitudes. Most domestic breeds come into heat at any season of the year, at approximately six-month intervals. The pattern of any individual dog is usually fairly consistent, but longer and shorter cycles are common.

The first sign of estrus in the female is a gradual enlargement of the external genitalia, followed after several days by the discharge of a small amount of blood. At the same time an odorous substance highly exciting to males is secreted in the urine. If the female is not allowed to urinate where males can find it there will be little trouble, but if she is allowed to run freely, males will gather from miles around. Bleeding may continue for a week or more and at its end the female will accept the male. She may be receptive for a few days or as much as two weeks. Ovulation occurs 72 hours before the last point of receptivity. Conception may occur from matings at any time in the cycle, but for maximum fertility the matings should be repeated frequently in order to strike the period of ovulation. Many breeders make a practice of repeating matings every other day throughout the receptive period.

2. Gestation.—The period of gestation is approximately nine weeks counting from the time when the animal is first receptive. The embryos develop quite slowly at first, not becoming implanted until about 21 days after fertilization. The greatest intrauterine growth of the puppies occurs in the last half of pregnancy, during which the female will require an increased and well-balanced diet. Occasionally a female that has not been bred will show a pseudopregnancy, with swelling of the abdomen and enlargement of the mammary glands.

Litter size varies roughly with the size of breed, but there is great individual variation. Some toy breeds rarely have more than one or two puppies, whereas the setters and larger breeds may have eight to ten, with some record litters going much higher. Four to six is a good average; in very large litters the pups are frequently small and weak.

3. Reproductive Capacity.—The reproductive powers of females diminish after five years of age and reproductive cycles usually cease entirely by the age of eight. Males usually remain capable of breeding to a more advanced age, but a male of six years is entering middle age.

Spaying the female (removing the ovaries) or castrating a male (removing the testes) before maturity affects the normal pattern of growth; such animals usually become taller and more obese than the average. Spaying terminates the sexual cycle in the female, but castration may have little effect on the sexual behaviour of an experienced male.

IV. GENETICS AND BREEDING

As stated earlier, the ancestral wolves are highly variable in size and appearance, and their dog descendants are the most variable of domestic animals. Not only are there wide differences between breeds but there is also great individual variability within each breed. At the present time there is little crossing between any two registered breeds, since this is discouraged by most breeders' clubs, but there are historical records of much cross-breeding in the past, and most of the modern breeds have been developed by such early crosses. It should be remembered that no breed is pure in the genetic sense, but is a variable population kept within certain limits by artificial selection.

1. Colour.—There are certain physical characters the inheritance of which is well known and highly predictable in breeding experiments. Most of these are based on genes affecting colour. Only a few of the major colour-influencing genes are described below.

The basic wolf-gray or wild-type coat consists of long guard hairs, banded with black and red, and a lighter-coloured undercoat, which grows heavily in winter and is shed in summer. The colour is distributed in a basic pattern of "countershading": more black hair on the top of the body and more red underneath, becoming almost white on the belly. Thus there are two basic pigments, black and red, with the absence of pigment producing white.

In domestic dogs the original coat has been modified in length, texture, pattern and colour, in a wide variety of combinations. The major series of genes that modify colour is the *A* series. Given in order of relative dominance, these genes are: A^s, coal black; a^y, red, varying from clear red to red with some dark hair (the so-called sable colouring); a^w, the wild type or wolf gray; and a^t, bicolour (black-and-tan), having a clear black on the upper part of the body and clear red below, with red dots over the eyes.

Other genes may influence the *A* series: the recessive *ee* changes all black hair to red, and *bb* changes black hair to brown or liver colour. These pigments may be modified still further by other genes to produce all shades from dark to very light.

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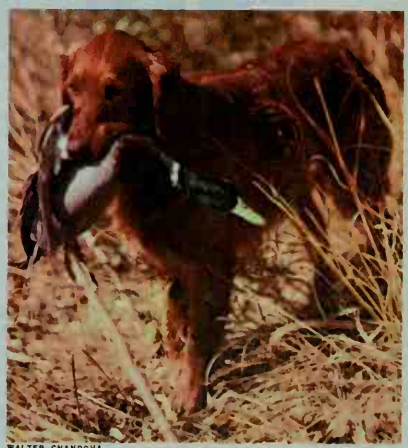

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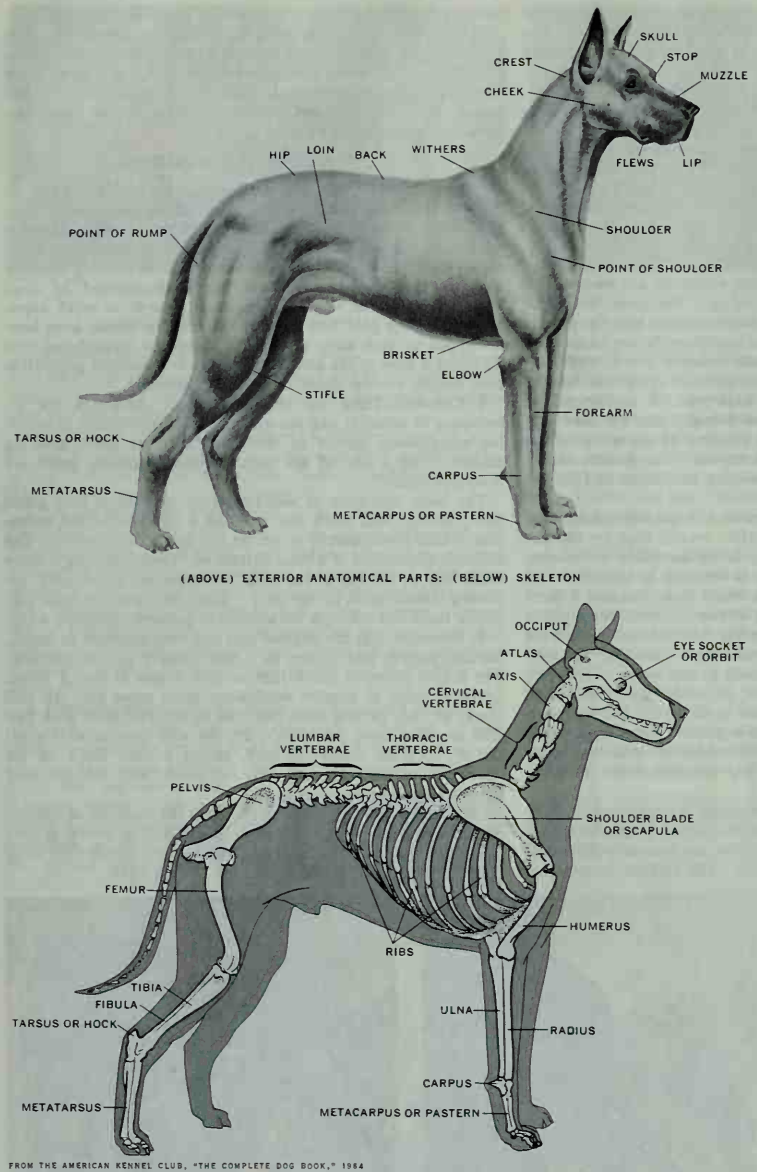
SPORTING BREEDS

(Left) German short-haired pointer: height 23–25 in., weight 55–70 lb.; (right) Golden retriever: height 23–24 in., weight 65–75 lb.



(ABOVE) EXTERIOR ANATOMICAL PARTS: (BELOW) SKELETON

FROM THE AMERICAN KENNEL CLUB, "THE COMPLETE DOG BOOK," 1964

Another important series of genes produces various degrees of white spotting, ranging from small spots on the tail, feet and belly, through piebald (heavy mottling over the entire body) to almost completely white animals, as in white bull terriers. Hair length and coat texture are also influenced genetically, but less precisely than coat colour. In general, short hair is dominant over long, coarse over fine, straight over curly, wire coat is incompletely dominant over smooth, sparse over dense. There are an enormous number of possible combinations, each breed having a limited but often confusing number.

2. Shape and Weight.—In body form there is an ancient mutation for the upcurved tail. This is a physiological trait, since the dog can usually straighten his tail; its inheritance is not well known. There is major mutation for short legs, seen in such breeds as dachshunds and basset hounds; the first-generation hybrids of a mating of a short-legged dog with a normal-legged one have legs that are intermediate in length. The bulldog mutation chiefly affects the head, producing a short and flattened snout accompanied by an undershot jaw. Again, the first generation of a cross between a bulldog and a normal-faced dog has an intermediate appearance. Still another inherited trait is ear carriage, varying from lop ears to erect ones.

One of the outstandingly variable characteristics of dogs is body weight, ranging from as little as 2 lb. in dwarf breeds such as the Chihuahua, to 150 lb. in some of the large breeds such as the mastiff and St. Bernard. Offspring from crosses between large and small breeds tend to be intermediate in size, and the trait is affected by large numbers of genes.

3. Behaviour and Temperament.—The inheritance of behavioural and temperamental characteristics is highly complicated. The behaviour characteristic of a particular breed consists of a combination of several independently inherited traits, each of which is affected by one or two major genes and perhaps other minor ones. For example, the tendency to crouch or sit in cocker spaniels depends on two independent traits: the crouching posture itself and the tendency to remain quiet.

It is very likely that more than one combination of genes will produce a desirable trait in a dog; therefore, two excellent dogs bred together may produce somewhat inferior offspring, and vice versa. Consequently, most successful dog breeders experiment with matings till they come upon those matings that give the highest proportion of desirable progeny. Since dogs are long-lived and often fertile animals, this method of progeny testing can be highly successful. At the same time there are in most pure breeds a large number of undesirable recessive traits of form and behaviour that crop out in certain matings. Many of these are preserved and spread throughout a breed if a champion male carrying an undesirable recessive trait is widely bred to numerous females. Furthermore, many of the traits desired by dog fanciers, such as the bulldog head which would be a physical defect in a wild animal and promptly "selected out" in nature, are perpetuated by man through special care and attention.

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MISCELLANEOUS BREEDS

(Left) Border collie, originally from the border country of Scotland and England: height about 20 in., weight about 50 lb.; (centre) Wheaten terrier, originating in Ireland, is the colour of wheat: height 18–19 in., weight 35–45 lb.; (right) Australian terrier: height 10 in., weight 12–14 lb.

It should be remembered that no trait is inherited as such. Mendelian inheritance transmits the genetic factors, or genes, but the traits themselves have to be developed in the presence of all sorts of varying environmental factors. Even coat colours can be affected somewhat by the environment, and this is much more true of behavioural traits, which are always modified by training and experience.

V. CARE AND TRAINING OF THE DOG

A. Selecting and Training

1. Selecting a Dog.—*Age.*—The ideal time to acquire an individual puppy is between six and eight weeks of age, in order to permit normal psychological development (see *Development of Behaviour* below). Since neither physical nor behavioural development is complete at this time, the best guide to the puppy's future is its parents, and the buyer should if possible select a puppy from known breeding stock. The puppy should be normally plump, lively and free from obvious physical defects and extreme timidity. (For establishing a breeding stock, the prospective owner will often do best by acquiring a pregnant female of proven fertility.)

Sex.—Whether the owner chooses a male or female will depend on his personal preference. Males are usually larger than females, more active and tend to wander more as adults.

Being less in demand, females are less expensive. Sexual cycles can be eliminated by spaying, as noted above in the section *Reproduction.* The most desirable time to spay a female is after the first heat period, as this will assure normal physical development.

Breed.—The choice of breed depends on the use of the dog and, again, on the owner's preference. All dogs require some kind of training and there is no breed that will make a satisfactory animal without it. The hounds and bird dogs are generally quite gentle with children and rarely get into fights with other dogs, but are sometimes a little difficult to housebreak and to prevent from wandering.

Mongrels.—A mongrel, or cur, is a dog of unknown ancestry. First-generation hybrids between two pure breeds show a great deal of hybrid vigour and are usually more healthy and hardy than either parent breed. Their appearance and behaviour traits may be like one or the other parent, or neither. Some dog breeders regularly produce such hybrids for special purposes when the result can be predicted. Crossbred retrievers, spaniels and setters are hybrid types registered by the Kennel Club of England. Crossing between hybrids themselves produces segregation of parental traits in all sorts of unpredictable combinations. If the owner selects such a hybrid of unknown ancestry, he should remember that appearance is no guide to behaviour, nor even to the breed of the ancestors. Nevertheless, such hybrids frequently make attractive and desirable pets, and sometimes become outstanding working or hunting dogs.

2. Development of Behaviour.—The early development of a dog is divided into several distinct periods: (1) neonatal, (2) transition, (3) socialization and (4) juvenile. In the neonatal (newborn) period, the puppy's activity is largely confined to nursing and sleeping. Provided normal maternal care is given by the bitch, little additional care is needed, except to make sure the puppies are kept warm and the mother is well fed. The newborn puppy is blind and deaf and is consequently largely isolated from the external world.

In about 14 days its eyes will open, marking the beginning of the transition period. During the third week the puppy undergoes a rapid change in behaviour and in sensory and motor abilities. Toward the end of the week, when its ears open, the puppy begins to react to sound. At the same time its first teeth appear, and it will attempt to eat solid food if offered.

Meanwhile it has begun to walk instead of crawl and to show social responses to humans and to other dogs. This marks the beginning of the period of socialization. The puppy will now slowly approach a strange person, nosing and wagging its tail. Another social response is playful fighting with its littermates. At any time during this period, which lasts up to ten weeks of age, it is easy to form a close social relationship between a puppy and its owner, the maximum favourable response being obtained between six and eight weeks of age.

By removing a puppy from its litter early in the socialization period all social relationships are transferred to human beings. Emotional disturbance and prolonged yelping is a normal reaction to removal from the litter and can be relieved by fondling and companionship. The puppy soon associates its owner with relief from distress. Adopting a puppy late in the period will throw the balance in the opposite direction, so that the puppy's strongest relationships are with dogs rather than with human beings. In fact, puppies raised in large fields apart from human beings will become almost completely wild by 14 weeks of age. This period is therefore a critical one for determining the nature of social relationships. In addition, the puppy becomes strongly attached to its environment during this period, and it is important that it be introduced into the type of surroundings that will be its future home.

Puppies left in a kennel environment much beyond 12 weeks of age are likely to be permanently shy and timid when brought into

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MISCELLANEOUS BREEDS

(Left) Chinese crested, named for the tuft of hair on its head, is an almost hairless dog: shoulder height about 16 in., weight 20–25 lb.; (centre) Shih tzu, a Tibetan dog: height about 11 in., weight about 16 lb.; (right) Ibizan, rare outside the Balearic Islands and Spain: height about 25 in., weight about 50 lb.

the outside world. From the viewpoint of the dog trainer best results are obtained if the puppy is introduced to its future activity and environment, at least in a simplified form, sometime between 8 and 12 weeks of age.

Following the period of socialization is the juvenile period, lasting up to sexual maturity, usually sometime after six months of age. During this time the puppy is still physically undeveloped and relatively unskilful, so that complex training should not be attempted.

3. Early Training.—Development of the nervous system is largely completed by eight weeks of age. For the household pet the period between 8 and 12 weeks is the ideal time to begin the basic training in such commands as "come," "sit" and "fetch." It is also the ideal time for housebreaking, based on the natural development of behaviour. The puppy has two basic behaviour patterns that can be used in housebreaking. One is a tendency not to defecate or urinate in a sleeping place, so that if shut up in a fairly small box or kennel for the night the puppy will ordinarily not urinate or defecate until morning. The second is the tendency to urinate and defecate in special spots. This tendency appears at about eight weeks of age. Given frequent access to such spots, either on paper in a house or out-of-doors, the puppy will rapidly form habits of using them. It may also be punished for undesirable habits, but the punishment should be mild and immediately associated with the act itself.

4. Training Methods.—Successful training methods vary with the breed of dog and the type of activity desired. Methods that work well with one breed will work poorly with another. For example, mild punishment can easily inhibit undesirable behaviour in many of the shepherd dogs, whereas similar punishment may only stimulate resistance and fighting in the aggressive terrier breeds.

The basis of most training is reward. The trainer should offer reward for desirable behaviour and withhold reward for undesirable behaviour. To be effective the reward must come immediately after the action, so that the dog can form a connection between the two. Good habits formed in this way also help prevent the formation of bad habits, since one interferes with the other. The rewards used vary with breeds and individuals, and the trainer must study the animal to determine which type of prize is most effective. For the hunting breeds food is usually a very strong reward.

Dogs also respond to praise and handling, although some breeds do not enjoy rough petting and restraint. An activity may be rewarding in itself. Hunting breeds such as beagles seem to enjoy hunting for its own sake, irrespective of rewards, and other breeds similarly enjoy other kinds of activity.

Punishment is chiefly useful to inhibit activity and is ineffective otherwise. For example, if an owner repeatedly calls a dog to punish it for misdeeds, the dog will soon learn not to come. A general rule is to use punishment sparingly and only in situations that the dog understands. At the same time it is necessary that the trainer be dominant over the dog; the dog must never be allowed to control the master by punishing him. The dominance relationship is easily established over very young puppies, and is best set up by restraint and handling rather than outright punishment.

One chief difficulty in training a dog is getting him to do a required act so that it may be rewarded. In any complicated training it is best to break down the activity into a number of simple steps. Another useful technique is "forced training," in which the animal is compelled to go through a particular activity and so learn what is required. This is particularly useful in leash training, in which it is easy to guide the dog through the proper behaviour, after which he will usually anticipate the required action without further force being used.

The requirements of city life are such that a dog must be kept under control most of the time. Training of this sort is aimed at preventing the dog from becoming a nuisance to others and at making the dog aware of the dangers of traffic. Obedience training has therefore become highly popular, and special schools for dogs and their owners are found in most cities. The basic training consists of teaching the dog to obey certain elementary commands such as "come," "sit," "stay" and "heel" (to follow closely on the owner's left side). More advanced training includes retrieving, jumping on command and tracking a person.

B. Special Traits

1. Breed Psychology.—The psychology of each breed can be best understood in terms of the work for which it has been selected. Hunting breeds such as hounds have been selected to work independently of human handlers and are therefore somewhat difficult to keep under strict control. They have also been selected to work peaceably in packs or groups; consequently, aggressive behaviour is seldom a problem. The shepherd dogs, on the other hand, have been selected for their ability to learn to work under direction and to form firm habits. It is therefore easy to teach them restraint.

As alluded to earlier, a highly important factor in training is the degree of maturity. Young puppies learn very quickly, but have little persistence and power of concentration. In most breeds there is considerable steadying of these qualities at maturity,

Labrador retriever. The breed, originated in Newfoundland, generally was known as the St. John's dog to distinguish it from the similar Newfoundland dog. The Labrador retriever is bred and trained primarily to retrieve game from water

Pointer. On a partridge hunt the dog has scented game and begun to assume a point, an attitude marked by orientation toward the game, with rigidity of body and horizontal extension of the tail

Weimaraner. A German breed originally valued for hunting hoofed game, the Weimaraner is used mainly to point and to retrieve birds

FIVE SPORTING BREEDS

Spaniels, pointers, setters, and retrievers are popular hunting dogs. Spaniels are relatively small dogs that move well through thick, brushy areas and are adept at flushing game; pointers and setters are bred and trained to locate game and then to hold a "point" until the hunter arrives to flush and dispatch the game; retrievers locate and retrieve game already downed by the hunter

Irish setter. Dogs of this breed are normally trained to work to the gun, and they ordinarily do not cover as much ground as other hunting breeds. Irish setters tend to be temperamental and require patient training

Cocker spaniel. A retriever formerly valued for its deft work in heavy brush, particularly in hunting woodcocks (hence "cocker"). Cocker spaniels are now more prized as pets

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DOG

Bloodhound. A large, powerful tracking hound with an especially acute sense of smell

Dachshund. A dog originally bred to track badgers and invade their burrows, but now kept mainly as a pet

FIVE HOUND BREEDS

Hounds may be divided into three groups: coursing (or sight), tracking (or scent), and miscellaneous. All include hunters. The coursing hounds locate game by sight and then run it down. The tracking hounds rely mainly on their sense of smell to track game; they tend to bay as they hunt

Beagle. A small tracking hound, a natural hunter of hares and rabbits, but also an affectionate pet

Greyhound. A swift coursing hound, with keen sight, used for hunting and racing

Basenji. An African all-purpose hunter. It rarely barks but often gives a peculiar "yodel" when excited

PHOTOGRAPHS, (TOP LEFT, CENTRE RIGHT) "WOMAN'S DAY," (TOP RIGHT) "LIFE" © 1949 TIME, INC., (OTHERS) "LIFE" © TIME, INC.

German shepherd. A versatile breed trained as police, guard, and guide dog

Collie. An alert watchdog and sheepherder

Boxer. Trained for police work and for leading the blind

FIVE WORKING BREEDS

Dogs aid man in many ways, from herding sheep to capturing fugitive criminals. Certain breeds excel at certain tasks, but most of the working breeds exhibit a number of common qualities: strength, endurance, agility, and, preeminently, responsiveness to the commands of their master; they are all companionable pets

Great Dane, largest working breed, with preferred height of 30 in.; a watchdog

Samoyed, native of Siberia. Herder of reindeer, sled dog and hunter

PHOTOGRAPHS, (TOP LEFT) "LIFE" © 1949 TIME, INC., (OTHERS) "WOMAN'S DAY"

DOG

Manchester terriers. These small vermin hunters differ from the toy Manchester terrier in being slightly larger and in having ears that fold forward

Airedale. Largest of the terrier breeds, ideally measuring 23 in. in height at the shoulder

FIVE TERRIER BREEDS

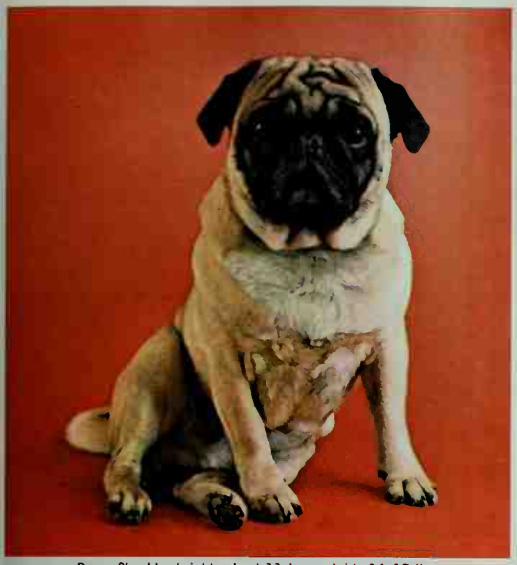
The breeding of terriers has been traced back to medieval Britain, where yeomen exploited these aggressive dogs in their own form of hunting. Later, the gentry adopted the terriers for more elaborate forms of hunting, using them to drive out and kill game denned by hounds

Fox terrier. Named for its ability to attack foxes in their dens

Miniature schnauzer. Favoured as a ratter in its native Germany

Scottish terrier. Believed to be the most ancient of the Highland terriers

PHOTOGRAPHS, (TOP LEFT) WALTER CHANDOHA, (OTHERS) "WOMAN'S DAY"



Pug. Shoulder height: about 11 in.; weight: 14–18 lb.

Chihuahua. Shoulder height: 6–9 in.; weight: 1–6 lb.

Pomeranian.
Shoulder height: 5–7 in.; weight: 3–7 lb.

FIVE TOY BREEDS

Selective breeding has yielded dogs of notably small size classified as toy breeds. A few are described in ancient records and appear to have endured virtually unchanged. Some are derived from larger breeds, but others are unique. Because of their small size they are favoured as house pets.

Yorkshire terrier. Shoulder height: about 8 in.; weight: about 5 lb.

Pekingese. Shoulder height: about 9 in.; weight: to 14 lb.

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DOG

Dalmatian. Formerly bred as a coach dog

Chow Chow. A dog of Chinese origin, having a distinctive blue-black tongue and black-lined mouth

Boston terrier. Derived from dogs bred for pit fighting

FIVE NONSPORTING BREEDS

The historical ancestors of the nonsporting classification of dog were retrievers, bullbaiters, and hunters. Contemporary breeds are sometimes called the companion dogs; they are intelligent and tractable, and are valued as pets

Bulldog. Once a tenacious fighter originally bred for bullbaiting, but now prized as a house pet

Poodle. Mainly a pet today, the poodle occasionally still functions in its original role as a retriever

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sometimes as early as six months but often at a year or more of age. Therefore, it is usually best to attempt complex and difficult training at maturity.

2. Intelligence.—Intelligence can be defined as the ability to solve problems and adapt to new situations. The degree of intelligence shown by any animal depends upon his sensory and motor equipment as well as upon the development of the brain. Dogs have a well-developed cerebral cortex with many convolutions; excellent hearing, being able to distinguish sounds far above the human range, and a highly developed sense of smell. Their vision, however, is considerably inferior to that of human beings, as they lack colour vision and are relatively poor at discriminating form. A dog may not detect a person standing perfectly still downwind, but notices him only when the person moves.

In their motor abilities dogs are good runners but only fair leapers. They have little power of prehension with their paws, and hence are incapable of solving problems involving complex manipulation. Instead they must use their teeth for manipulating and carrying objects.

Judging how intelligent a dog is, either in comparison to other dogs or to other animals, is very difficult. Obviously a dog will be unable to perform as well as a monkey any problem involving complex manipulation or colour vision. For most dog owners, intelligence is measured by the ease with which a dog can be taught. However, this may depend in a large measure on the degree of motivation rather than on any absolute intellectual power. In general, when individual dogs are sufficiently motivated there appear to be no wide differences in intelligence between breeds.

There are big differences, however, in the ease with which breeds and individual dogs will accept complex training. Certain breeds have a high reputation for intelligence of this sort, particularly the shepherd dogs and poodles. These animals have a high capacity for developing motivation and attention toward their handlers, and a similarly high capacity for accepting inhibitory training. Most of the "wonder dogs" famous for their intelligence belong to these groups. A highly trained dog is capable of mastering hundreds of different commands.

At the same time there are definite limitations on canine intelligence. Like other mammals (excluding man), dogs cannot be taught to talk, and indeed learn to "speak" or bark on command only with great difficulty. There is no evidence that dogs are able to recognize the meaning of words when they are used in new combinations (*i.e.*, to understand new sentences), thus the amount of information that actually can be conveyed to a dog is quite limited. A well-trained dog is, however, capable of such attentiveness to his owner's slightest movements and mannerisms that he almost seems to read the owner's mind.

3. Emotions.—Most emotional reactions of dogs are readily understandable to their owners. Growls and snarls are threats, and barking is usually an alarm signal. Rapid horizontal tail wagging indicates a friendly approach and is roughly the social equivalent of the human smile. High-pitched yelping occurs in situations involving pain or terror. The rapid yelps and whines of puppies indicate distress, which may have many causes. Solitary howling usually indicates loneliness or is a reply to another howling dog.

Some other reactions are not so easy to interpret, and can only be understood in terms of the behaviour of dogs toward each other. Jumping up and placing the feet on the master is usually an attempt to initiate the playful fighting so often seen between dogs. A stiff-legged approach with erect and slowly wagging tail indicates aggressiveness and may be followed by an attack. A worried dog holds his ears down, so that his forehead is smooth. An attentive dog often displays a wrinkled forehead, usually the result of the erection of the ears.

The external expression, however, is not always a true guide to internal emotional state. A serious prolonged internal emotional disturbance will often show up in depressed activity and loss of appetite.

4. Abnormal Behaviour; Neuroses.—The owner should be slow to interpret any behaviour of a dog as abnormal, remembering that an animal will adapt to a situation in any way that gives him satisfaction, however bizarre this may appear to the onlooker. Unusual behaviour may also result from organic disease. Any marked changes in behaviour, such as convulsions (often called fits), staggering gait and the like, are usually indications of serious disease and require diagnosis by a veterinarian.

A neurosis may be defined as a kind of behaviour that gives relief from tension without adaptation to the cause of tension. For example, dogs confined to small pens for long periods will often develop the habit of running in circles or jumping from side to side whenever a person approaches. The dog is stimulated to respond to the person, but because of confinement can only make what appear to be useless and inappropriate movements. Likewise, a dog left by itself in a house for long periods will often chew furniture and rugs. This behaviour can be understood as a thwarted attempt to escape.

Neurotic behaviour can be largely prevented by giving the dog an opportunity to satisfy certain basic needs. The two needs most often thwarted are the need for some sort of physical activity (dogs being basically active hunting animals) and the need for social companionship, which can be satisfied by either dogs or people. Dogs adjust fairly well to the absence of opportunity for sexual behaviour, particularly if there is no external stimulation. There is no basic need for aggressive fighting in the absence of external stimulation, and the owner will do well to initiate inhibitory training early in life, remembering that restraint plus rewards are more effective than punishment, which has the effect of actually stimulating fighting.

C. Nutrition and Growth

1. Adult Dogs.—Dogs are basically carnivorous hunting animals, and as such are physiologically adapted for going for long periods without food or water. Many adult dogs can go without eating for a week without serious harm. When food is available, a hungry dog will gulp down large quantities as rapidly as possible.

An adult dog can be fed either once or twice a day. The amount of food needed will depend upon the amount of exercise, but a rough guide is one-half pound of dry dog food or its equivalent for a 20-lb. dog. Smaller breeds generally require more food per pound of body weight than do larger breeds. Pups need more food than mature dogs, especially during the period of rapid growth between six weeks and six months of age. It is easy to overfeed a dog with a good appetite, but this is really a disservice to the animal since, as with man, excessive fat is harmful to health.

Dogs have many individual as well as breed idosyncracies with regard to food. The hunting and working breeds are generally hardy, with good appetites, and do well on almost any balanced diet. In former times they were often fed chiefly on bread and cereal. Some breeds and individuals are much more delicate and require special foods. Professional advice may be needed in some cases. Many dogs will develop special tastes, particularly if they are overfed.

A well-balanced diet for a dog is not too different from that for a human being, except that the dog's intestine is not well equipped for handling roughage, so foods like bran and certain vegetables containing an excess of fibre should be avoided. However, dogs digest bones easily and can live almost exclusively upon fresh ones. Bones sometimes cause trouble though: to be especially avoided are splintery bones, such as those of poultry or chops; large beef bones are safest. Dogs, being able to produce their own vitamin C, have no need for vegetables and fruits, but can eat them if there is nothing else available; they can also readily digest cooked starchy foods. Most dogs, however, prefer meat to any other kind of food.

Most commercial dog foods contain a balanced diet and can be used as a basic element in feeding, supplemented by small amounts of meat and fats. Organ meat (*i.e.*, the liver and other internal organs) is especially nutritious.

2. Puppies.—Puppies naturally have special nutritional requirements. In normal development the young puppy gets all of his food from the mother's milk during the first few weeks of life. The mother then begins to supplement this with vomited food and completely weans the puppies at seven to ten weeks of age. How-

ever, since most mothers cannot feed their puppies adequately by natural means throughout this whole period, food supplementation should begin at about three or four weeks of age, the puppy being fed once or twice a day. The most convenient time for taking a puppy from the mother and one which produces the closest attachment to human beings is, as stated earlier, between six and eight weeks of age, or just before the normal weaning time. Such a puppy can be fed twice a day up to eight weeks and once a day thereafter. More frequent feedings can be given if the owner wishes, but are not necessary.

The best supplement is some sort of mash containing milk and meat. For the best growth of the puppy, the mash should contain large quantities of high-grade protein and also iron, since the mother's milk is deficient in the latter. A puppy's diet should also be supplemented with vitamin D (cod-liver oil is a good source) to prevent rickets. This is particularly important in the large breeds such as the Great Dane. Older puppies can be gradually shifted to the adult diet.

Puppies that must be hand-reared from birth present a different problem. Cow's milk is not a completely satisfactory substitute for bitch's milk, as it contains much less protein and fat and an excessive amount of sugar. The best results are obtained with an artificial bitch's milk. Such puppies need to be fed only three times daily, eight hours apart, up to three weeks of age and twice a day up to eight weeks.

A normal rate of growth is the best indication of good health in a young puppy. For the first three weeks puppies will gain between 50% and 100% of their birth weight each week. Once supplementary feeding is begun they gain weight very rapidly up to four months of age, then more slowly, reaching nearly adult size by six months of age. Thereafter growth is quite slow, the dog reaching full development at approximately two years. The prime of adult life extends through the fifth year; however, many dogs live more than twice this long and some last well into the teens. There are considerable breed and individual differences in longevity.

D. General Care and Hygiene

1. Bathing and Grooming.—A dog may be bathed as often as the owner desires, but it should be remembered that soap removes the natural oil from the hair and skin and may be somewhat irritating to the animal. Thorough rinsing is desirable. The dog itself has no need for bathing and many hunting and working dogs are never bathed. Pregnant females should be bathed prior to parturition in order to remove roundworm eggs from the skin and thus prevent infection of the pups.

The need for grooming varies with the breed. The extremely short-haired breeds never require grooming but most long-haired breeds require brushing to remove loose hair and burrs. Poodles have hair that grows continuously and must be regularly clipped, and wire-haired terriers require special clipping and brushing to keep them in good appearance. A dog that gets little exercise may occasionally need its nails clipped.

2. Exercise and Elimination.—An adult house dog should be let out twice a day, morning and evening, for exercise and elimination. A dog will keep in better health and spirits if given certain regular activity. If the dog cannot be allowed to wander, some task or training should be given for a half-hour or so each day.

3. Symptoms of Ill-Health.—Lassitude and lack of normal appetite are indications of many diseases, and a veterinarian should be consulted in case of any persistent symptoms. A dry nose may indicate a fever, but is not entirely reliable. Temperatures can be checked with a rectal thermometer. A dog's temperature averages higher and is more variable than that of a human being: the range is from 98° to 105° F., but temperatures above 102° F. may indicate fever. A continuous discharge from the eyes or nose is a serious symptom that may indicate distemper. Continuous headshaking or carrying the head to one side may indicate an ear infection. Lameness or limping can occur from a variety of causes, such as cuts or thorns in the foot, sprains, hip displasia and arthritis. "Skidding" in a sitting position indicates some irritation of the anal area and may be caused by an infected anal gland or by parasites. Vomiting is a normal pattern of dog behaviour and is not a serious symptom. Foaming at the mouth and excessive salivation is one symptom of rabies, but also occurs in other conditions. In case of any serious symptoms the owner should consult a veterinarian immediately.

E. Diseases and Parasites

1. Canine Distemper.—One of the most important diseases of domestic dogs is canine distemper. This is an air-borne, highly infectious virus disease that attacks the nervous system. It runs a long course, with a high proportion of fatalities. The disease can be prevented by inoculation with an attenuated virus. This should be given (combined with a similar vaccine against infectious hepatitis) at nine weeks of age and, to maintain protection, yearly thereafter.

Puppies nursing on immune mothers are protected by the antibodies obtained in the mother's milk for a few weeks after birth and can be successfully vaccinated only after these antibodies have disappeared. (*See* Distemper, Canine.)

2. Infectious Canine Hepatitis.—This disease attacks the liver primarily. The early symptom of high fever resembles that of distemper but the disease, which is often fatal, runs a much shorter course. It is transmitted by contact through urine, hence is less infectious than distemper. However, many dogs are carriers, spreading the disease long after they have recovered. As indicated above, it can be prevented by inoculation. (*See* Hepatitis, Canine Viral.)

3. Rabies (Hydrophobia).—Rabies is an invariably fatal disease that is highly dangerous because it can be spread to human beings as well as to other dogs and other mammals. The disease attacks the nervous system chiefly, causing animals to become highly irritable. Infected dogs are so fearless that they bite anything they come across, spreading the disease through the saliva entering the wounds. Many wild animals, such as foxes, provide a reservoir for the disease. In parts of the world where rabies occurs, dogs should be inoculated against it. Both temporary and permanent vaccines are available. (*See* Rabies.)

4. Parasitic Diseases.—*Worms.*—There are many intestinal worms that attack dogs. The most serious one is a variety of Ascaris, a roundworm that can cause a high percentage of fatalities in young puppies. Most puppies acquire considerable resistance to them after three months of age, but the majority of dogs have at least light infections. Females about to be bred should be wormed, bathed and transferred to thoroughly clean quarters. They can also be wormed as late as seven weeks in pregnancy. If this is not done, the puppies can become infected from the mother, even before birth. Puppies can be given a mild worm expellant (vermifuge) if symptoms develop. Other parasitic roundworms that attack dogs include heartworms, hookworms and whipworms.

With the exception of rabies, most diseases of dogs are not transmissible to human beings. A rare exception is a tapeworm, *Echinococcus granulosus,* normally transmitted from dogs to sheep through fecal matter, but which can accidentally be transmitted to human beings, particularly children. The parasite grows as a cyst and may enter the brain or other vital organs and cause severe symptoms. It is found only where dogs have access to the bodies or entrails of sheep and cattle. Other less harmful varieties of tapeworms occur commonly in dogs and can be treated with appropriate vermifuges. Dogs may become infected with these tapeworms by eating fleas and the uncooked bodies of food animals in which the tapeworms spend part of their life cycle.

Mange.—Mange is caused by two varieties of mites that live in the hair follicles. An afflicted dog loses his hair and the affected area is itchy and inflamed. The mites are difficult to kill and successful treatment must be continued over many weeks. An inexperienced person may confuse mange with wet eczema, a more common and less serious ailment. In wet eczema the skin is itchy and exudes serum; there is usually a loss of hair. It is not infectious apparently, but results from irritation from dust and heat. Serious cases require veterinary treatment.

Lice.—Lice spend their entire life cycle on the dog and are transferred to new hosts by direct contact. Successful treatment usually requires two or more applications of some oily substance that smothers the lice, or of an insecticide. The developing lice (or nits) are highly resistant, but adult lice can be controlled readily, even with soap and water.

Fleas.—Fleas present a different problem, since they leave the dog during part of their life cycle in order to breed. Those on the animal can be easily eliminated with commercial preparations (sprays and powders), but their breeding areas must also be eliminated for successful control. Larval fleas live on filth and commonly breed around barnyards or other places where animals deposit feces.

Ticks.—Ticks, which breed in grassy or bushy areas, may attach themselves to a dog as it brushes against the vegetation. Individual ticks can be removed by applying kerosene or some other oily substance to the ticks' bodies.

5. Other Ailments.—Finally, dogs are susceptible to many other less common bacterial and parasitic diseases, which vary according to the life of the animal and the climate in which it lives. Dogs are also subject to constitutional ailments such as heart disease and cancer. Likewise, congenital defects are common, such as crooked legs and cleft palates. As in other traits, dogs show hereditary differences in their resistance to disease, but this trait is greatly aided by good nutrition and proper exercise.

VI. BREEDERS' ASSOCIATIONS AND DOG SHOWS

1. Development.—In western Europe and North America, dog breeding has been highly developed as a pastime and business. Dog shows and systematic attempts to improve and maintain dog breeds originated in the latter half of the 19th century. According to E. C. Ash, the first recorded dog show was held in Newcastle, England, in 1859, and the first large show was held in Chelsea in 1863. About the same time, the showing of dogs became popular in the United States, and by 1880 the annual bench show in New York included about 29 breeds.

As dog shows grew in number, a need was felt for some kind of regulating body. The Kennel Club of England filled this need in Great Britain; it was founded in 1873 and became the supreme governing body of dog breeders' associations in that country. A few years later, in 1884, the American Kennel club was formed, becoming the ruling body of breeders' associations in the United States. Soon thereafter similar organizations were formed in many other countries.

Dog shows are organized by local or national dog clubs. Some dog clubs are devoted to only one breed, whereas others include any breed. Rules for holding shows in the United States are made by the American Kennel club, and in Britain by the Kennel Club of England. According to U.S. rules, in each breed there are five different classes for each sex. Winners of the classes compete against each other and the final winners receive points toward a championship. Finally, champions may compete in a special class for the best of the breed. A good animal may win the best of breed, win best in its group of breeds and finally be honoured as the best in the show. The competition increases with the number of dogs entered and the highest honour is best in a large show. Two of the largest and best-known U.S. shows are those of the Westminster Kennel club, in New York, and the International Kennel club, in Chicago, in each of which shows 2,000 to 3,000 animals may compete. About a dozen British shows attract double this number of entries each year, Cruft's, at London, being the largest.

Although there is a great deal of correspondence and some interchange of stock between British and American breeders, clubs in the different countries set their own standards and rules.

2. Types of Shows.—Show dogs are judged on the basis of breed standards, the various physical characters considered desirable and those considered faults in any particular breed. These standards are not directly concerned with health, vigour or ability to reproduce; in fact, the quality of the show breeds sometimes suffers in these respects. A popular feature of many shows is the obedience trial, in which dogs are judged on performance rather than appearance.

Field trials, held for hunting breeds, give an opportunity for dogs to compete against members of their own breeds in the performance of hunting duties such as trailing, pointing and retrieving. There are also standard field trials for shepherd dogs, in which the dog has to herd a small flock of sheep along a prescribed course, cut sheep out of a flock and drive them in a small pen, all without assistance except from signals given by the shepherd. *See* also FIELD TRIALS.

VII. CLASSIFICATION OF BREEDS

A. ENGLISH AND EUROPEAN

The English classification, revised periodically by the Kennel Club of England, set the standard that other countries have followed, with some modifications. The Kennel club recognizes two major classes of breeds: sporting and nonsporting. Included in the sporting category are hounds, gun dogs and terriers; the nonsporting breeds include working dogs, toys and all other breeds.

Classifications of recognized breeds vary widely in other countries. The French list recognizes, in addition to hunting dogs, watchdogs, running dogs, 17 kinds of shepherd dogs and 24 "ladies' dogs," including toy dogs and lap dogs. The German list emphasizes utility dogs and watchdogs, whereas the Swedish one includes nine different spitz breeds.

B. AMERICAN

The current American classification, devised by the American Kennel club, is more extensive than the English. It lists six groups of breeds and embraces most of the breeds of other countries. A few breeds on the English list are not recognized in America and vice versa. The American Kennel club provides registry service for the more than 100 breeds listed below, with the number still increasing.

1. Sporting Breeds.—These are primarily bird dogs or gun dogs. The basic breeds were the medieval spaniels, from which the modern setters and pointers were developed—the latter with some admixture of hound ancestry. The pointing griffon is a hunting breed developed in the Netherlands. The Weimaraner, an all-purpose sporting dog developed in Germany, is unusual among the sporting breeds in its aptitude for obedience training. All the retrievers are modern breeds, developed in England and North America within the 20th century from various crosses.

Griffon (wire-haired pointing)	Spaniel (American water)
Pointer	Spaniel (Brittany)
Pointer (German short-haired)	Spaniel (clumber)
Pointer (German wire-haired)	Spaniel (cocker)
Retriever (Chesapeake Bay)	Spaniel (English cocker)
Retriever (curly-coated)	Spaniel (English springer)
Retriever (flat-coated)	Spaniel (field)
Retriever (golden)	Spaniel (Irish water)
Retriever (Labrador)	Spaniel (Sussex)
Setter (English)	Spaniel (Welsh springer)
Setter (Gordon)	Vizla
Setter (Irish)	Weimaraner

2. Hound Breeds.—This group includes two main types: (1) sight hounds and (2) scent hounds. The greyhounds are of the first sort, and the closely related saluki and Afghan hound are probably nearest to the original type. Greyhounds and the smaller whippets are now used in dog racing as well as for hunting. The borzoi and Irish wolfhound, as well as the Scottish deerhound, are related animals. The second main type comprises the scent hounds, of which the foxhounds and beagles are excellent examples. The bassett hound, otterhound, bloodhound and harrier are closely related.

Other animals in this group are more miscellaneous. The basenji is an all-purpose hunting dog from Africa, closer to the greyhound type than to any other and now used chiefly as a house pet. The dachshund was originally developed in Germany as a badger hunter, combining the qualities of a hound and terrier; it is now chiefly a house dog. The Norwegian elkhound is an entirely different type of dog from the main types and resembles a small spitz. The Rhodesian ridgeback is a general-purpose hunting dog developed in South Africa and having the peculiarity of permanently erect hair on the shoulders.

Afghan hound	Foxhound (English)
Basenji	Greyhound
Basset hound	Harrier
Beagle	Norwegian elkhound
Bloodhound	Otterhound
Borzoi (or Russian wolfhound)	Rhodesian ridgeback
Coonhound (black-and-tan)	Saluki
Dachshund	Whippet
Deerhound (Scottish)	Wolfhound (Irish)
Foxhound (American)	

3. Working Breeds.—The largest number of these breeds are derived from various sorts of herding and farm dogs: the collie, Old English sheep dog, Shetland sheep dog and Welsh corgi (a cattle dog) from the British Isles, and various others named for the country of origin. The German shepherd (or schäfer) was the common herding dog in that country; the bouvier des Flandres was a cattle dog; the Briard was a herding dog from Brie in France; and the puli, komondor and Kuvasz came from Hungary. The schnauzer and Rottweiler were originally farm dogs in southern Germany.

The second largest group are the guard dogs, again of miscellaneous origin. The large breeds include the mastiff, Great Dane, Newfoundland, St. Bernard and Great Pyrenees. The boxer and Doberman pinscher are somewhat smaller breeds developed in Germany.

Finally there are the sled dogs from various arctic regions: Alaskan malamute, Eskimo, Samoyed and Siberian husky.

Alaskan malamute	Kuvasz
Belgian sheep dog	Mastiff
Bernese mountain dog	Newfoundland
Bouvier des Flandres	Old English sheep dog
Boxer	Puli
Briard	Rottweiler
Bull-mastiff	Samoyed
Collie	Schnauzer (giant)
Doberman pinscher	Schnauzer (standard)
Eskimo	Shetland sheep dog
German shepherd dog	Siberian husky
Great Dane	St. Bernard
Great Pyrenees	Welsh corgi (Cardigan)
Komondor	Welsh corgi (Pembroke)

4. Terrier Breeds.—These are typically dogs of the British Isles, receiving their original name because they were used to attack vermin living in the *terre* or earth. The only foreign breed is the miniature schnauzer, developed as a rat terrier in Germany.

Airedale terrier	Lakeland terrier
Bedlington terrier	Manchester terrier
Border terrier	Norwich terrier
Bull terrier	Schnauzer (miniature)
Cairn terrier	Scottish terrier
Dandie Dinmont terrier	Sealyham terrier
Fox terrier	Skye terrier
Fox terrier (wire-haired)	Staffordshire terrier
Irish terrier	Welsh terrier
Kerry Blue terrier	West Highland White terrier

5. Toy Breeds.—These are very small dogs of various origins. Some are merely dwarf editions of larger breeds, in fairly normal form and proportion. Others have heads of the bulldog type, with short flat noses. Chihuahuas are the smallest breed.

Affenpinscher	Papillon
Chihuahua	Pekingese
English toy spaniel	Pinscher (miniature)
Griffon (Brussels)	Pomeranian
Italian greyhound	Poodle (toy)
Japanese spaniel	Pug
Maltese	Toy Manchester terrier
Mexican hairless	Yorkshire terrier

6. Nonsporting Breeds.—This is a miscellaneous group used entirely for companions and show dogs. The poodles originally came from water spaniels and have a high reputation for trainability and intelligence. They are bred in three sizes: standard, miniature and toy; the toy competes in the toy class (*see* above).

Dalmatians were once used as coach dogs and bulldogs for bull baiting. The chowchow, of Chinese origin, is unusual in having a blue tongue. The keeshond and schipperke are small dogs from the Netherlands and Belgium, and the Lhasa Apso came from Tibet. The Boston terrier is a popular American breed developed from a bulldog–terrier cross.

Boston terrier	Keeshond
Bulldog	Lhasa Apso
Chowchow	Poodle (miniature)
Dalmatian	Poodle (standard)
French bulldog	Schipperke

C. Other Varieties

The Kennel Club of England recognizes the following breeds not found in the American classification: Finnish spitz, Australian terrier, bearded collie, shih tzu, Tibetan spaniel, Tibetan terrier and black-and-tan miniature terrier. Many American breeders have not sought recognition for certain purebred varieties that they have developed. Others have registered their distinct breeds in organizations other than the American Kennel club. There are many special strains of hounds, often originating from certain famous packs and some named after their owners. Among American foxhounds, the Walker, Trigg, July, Trumbo and Birdsong strains are well known, and coonhounds include the Bluetick, Redbone, Plotthound and Treeing Walker varieties as well as the Black-and-tan variety recognized by the American Kennel club.

Other breeds found in various parts of the world include the border collie, Australian kelpie, Australian cattle dog, Drahthaar, Drentsche partrijshond, Catalan sheep dog, Istrian pointer, lurcher, Maremma sheep dog, Portuguese pointer, Portuguese water dog, Rumanian sheep dog, Sealydale, soft-coated wheaten terrier, spinone, Svensk vallhund and many more.

See also references under "Dog" in the Index volume.

Bibliography.—The rules applying to registration and dog shows, up-to-date lists of registered breeds and information about specialty breeding clubs may be obtained from (in the U.S.) American Kennel club, 221 Fourth avenue, New York, and (in Britain) Kennel club, 84 Picadilly, London.

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(J. P. Sc.)

DOGBANE (*Apocynum androsaemifolium*), a North American herb of the dogbane family (Apocynaceae) whose roots contain a mild poisonous principle that formerly found some use in medicine. Called also spreading dogbane, honeybloom, wild ipecac and American flytrap, the plant is native to fields and thickets from Quebec to British Columbia and southward to Georgia, Missouri, Arizona and California. It is a rather slender perennial, one foot to four feet high, with widely branching stems, opposite, oval, slightly pointed leaves and numerous, small, bell-shaped pink flowers, with darker stripes inside, borne in clusters at the ends of the branches. When in blossom, from late June to August, it is a beautiful wild flower. *See* also Apocynaceae.

HUGH SPENCER

DOGBANE (APOCYNUM ANDROSAEMIFOLIUM)

DOGE (from Lat. *dux*, "leader" or "duke"), the title of the chief magistrate in the former republics of Venice and Genoa. His authority, considerable at first, was gradually restricted, though the attendant pomp and ceremony increased. The office disappeared in Venice in 1797 and in Genoa in 1805.

DOGFISH, a name properly restricted to several sharks of the family Squalidae, perhaps because of their habit of hunting and pursuing their prey in packs. The group is identified by the presence of a spine that is at the front of each of the two dorsal fins and by the lack of an anal fin. The common spiny, or piked, dogfish (*Squalus*) is widely distributed on continental shelves and offshore bank areas of all quarters of the earth. It differs from other members of the family in that the teeth of both jaws are alike. Differences between species collected from different areas are so

slight, if at all perceptible, that some authorities believe that spiny dogfish of all regions belong to a single species, *S. acanthias.* Adults average two to three and one-half feet long and weigh about six to ten pounds; the maximum length is about four feet.

Dogfishes congregate in dense schools according to size. They are exceedingly voracious, preying upon all kinds of fish smaller than themselves, as well as on pelagic and bottom-dwelling invertebrates, and even biting their way through the nets of fishermen to seize their catches. As in all sharks, the eggs are fertilized internally. *Squalus* bears its young alive: the females carry the young 18 to 22 months and produce 2 to 11 in a litter. The black dogfish, *Centroscyllium fabricii,* is a related species of the northern North Atlantic, living in deeper water than *Squalus.*

Dogfishes are sold and eaten in many countries. In the United States more than 1,000,000 lb. are marketed annually, much of it under the name "grayfish." The European small-spotted dogfish (*Scyllium canicula*) and the large-spotted dogfish, or nursehound (*S. catulus*), belong to the cat shark family (Scylliorhinidae). They are oviparous: the eggs, enclosed in semitransparent horny cases, have tendril-like prolongations from each of the four corners by means of which they become attached to seaweeds or other fixed objects.

The bowfin, an unrelated American fresh-water fish, is also sometimes called dogfish. The smooth dogfish, *Mustelus canis,* is a wide-ranging Atlantic shark of the family Carchariidae.

See also CHONDRICHTHYES; SHARK. (L. A. WD.)

DOGGER BANK, an isolated shoal in the North sea, about 60 mi. E. of the coast of northeastern England. It rises 70 ft. higher than the surrounding sea floor; is 160 mi. long and 60 mi. wide at the 20-fathom line; and reaches its highest point at its western end, 50 ft. below the sea surface. The bank is a huge moraine consisting in its upper layers of sand, shells and stones, probably laid down during the last glaciation. It is considered that the bank's abrupt western and northern faces mark the limits of the ice sheets at that time. It is a well-known fishing ground. Large amounts of food are available for various species of fish and as a result good quantities of plaice, cod, haddock, turbot, dabs and herring are caught. The origin of the name is obscure, but the Dutch *dogger,* signifying a trawling vessel, was formerly applied to two-masted ships employed in North sea fishing and, by extension, to their crews (doggermen) and the fish taken (doggerfish). Off the south end of the bank an engagement took place between English and Dutch fleets in 1781. There on Oct. 21, 1904, during the Russo-Japanese War, some British trawlers were fired on by the Russian Baltic fleet. A crisis between Britain and Russia followed and the affair was settled by the Russian government paying compensation after the report of an international commission. A naval action was fought near the bank on Jan. 24, 1915, between British and German forces. *See* WORLD WAR I.

See Sir J. S. Corbett, *History of the Great War: Naval Operations* vol. 2 (1921). (A. J. LE.)

DOGGETT (DOGGET), **THOMAS** (d. 1721), English actor and a first-rate comedian, was born in Dublin. He made his London debut probably about 1690 and had his first successes in comedies by Thomas D'Urfey. His Fondlewife in Congreve's *The Old Bachelor,* his Ben in the same author's *Love for Love,* and his Young Hob in his own *The Country-Wake* established his reputation. Anthony Aston, commenting on his comic technique, wrote: "He was the best face painter and gesticular; and a thorough master of several dialects."

In 1709 Doggett became a joint manager (with Colley Cibber and Robert Wilks) of the Drury Lane theatre, retiring from the stage in 1713. In 1716 he founded a prize ("an Orange coloured Livery with a Badge representing Liberty") for the winner in a boat race of six young Thames watermen; the race, the Doggett Coat and Badge, is still run annually. (A. M. N.)

DOGMA, in Christian theology, is a doctrine set down in the deposit of divine revelation and authoritatively defined by the entire church as a truth to be believed and accepted by all orthodox Christians. From this definition it is evident that the meaning and the status of dogma are dependent upon the prior conviction of Christians that the mystery of God had been definitively revealed in Jesus Christ, and that the church, in its response to and responsibility for this revelation, has both the right and the duty to define "dogma" in the formal and ecclesiastical sense of the word.

In this strict sense, it could be maintained that there are only two truly universal Christian dogmas, the doctrine of the Trinity (*q.v.*) and the doctrine of the person of Jesus Christ (*q.v.*), as these were formulated by the ecumenical councils of the early church. Later dogmas, such as transubstantiation, were defined by the Western Church in separation from the East; and still later ones, particularly the infallibility of the pope and the immaculate conception and bodily assumption of the Virgin Mary, were defined by the Roman Catholic Church in separation both from the East and from Protestantism. The dogmatic status of these pronouncements, then, depends upon the prior definition of the church. For Roman Catholic theology, which identifies the Roman Catholic Church as the true Church of Jesus Christ on earth, such pronouncements are as binding as the decrees of the Councils of Nicaea or Chalcedon concerning the Trinity and the person of Christ; for Eastern Orthodoxy and for Protestantism, although for radically different reasons, they are not as binding.

Theological debate over the place of dogma in Christian theology has concentrated upon two closely related questions: the development of dogma and the authority of dogma. Although a dogma, by definition, must be contained in the deposit of revelation, this does not necessarily mean that it must be explicitly formulated in the Bible. Even orthodox theologians acknowledge, for example, that so basic a Christian dogma as the Trinity is not taught in so many words by any individual passage of the Scriptures but is implied by the thought and language of the Scriptures about the oneness of God and about the Father, the Son and the Holy Spirit. Both the challenge of heresy and the church's own theological thought compelled reflection upon the message of the Bible. From this reflection the dogma of the Trinity emerged. Therefore it did not spring up all at once in the church, but developed over a period of several centuries. The claim of dogma to be biblical must be understood this way. Dogma is the official voice of the church in its function as the authoritative interpreter of the Bible.

But if dogma claims to be absolutely binding upon all believers, how can it have a history—that is, be part of the flux and evolution of time? The two most influential answers to that question in modern Christian thought are associated with the names of Adolf von Harnack and John Henry Newman.

Describing dogma as "the work of the Hellenic spirit upon the Gospel soil," Harnack's influential work on *The History of Dogma* was intended to show that dogmas were conditioned by the circumstances of their origin and therefore could not claim universal validity or authority. Harnack concluded that the Protestant Reformation, by subjecting dogma to the Bible, ended the development of dogma, at least in principle, although in practice the churches of the Reformation continued to teach a dogmatic Christianity. According to Newman, however, the development of dogma was the most telling refutation of the Protestant idea that the Scriptures are the sole authority in theology. His *Essay on Development* (1845) was in the presses when he made his final decision to leave the Church of England for Roman Catholicism. In this book he sought to prove that Christian dogmas had developed organically, in a way that was simultaneously faithful to the original deposit of the faith and open to the new questions that arose for the faith, both within and without the church.

A closely related problem is the authority of Christian dogma. As has already been indicated, the solution to this problem depends upon one's definition of the church and of its teaching function. Eastern Orthodoxy finds the teaching function of the church embodied in tradition, which is articulated, but by no means exhausted, by the dogmatic decrees of the ecumenical councils; therefore the authority of dogma is divine. Roman Catholicism also affirms the divine authority of dogma on the basis of tradition and the councils, but it locates the pinnacle of dogmatic authority in the pope "when, carrying out his duty as the pastor and teacher of all Christians in accord with his supreme apostolic authority, he explains a doctrine of faith or morals to be held by the universal

Church" (Vatican council of 1870). Protestantism asserts, in the words of the Thirty-Nine Articles of Anglicanism, that "Holy Scripture containeth all things necessary to salvation: so that whatsoever is not read therein, nor may be proved thereby, is not to be required of any man, that it should be believed as an article of the Faith." Therefore dogma has authority in orthodox Protestantism only on the basis of its claim to be biblical, not on the basis of its being the church's official doctrine. Liberal Protestantism has generally followed Harnack's repudiation of dogma as a vestigial remnant of Roman Catholicism, no longer binding upon Protestant theology. During the middle of the 20th century, the most influential Protestant theologian of the time, Karl Barth, composed his magnum opus under the almost forgotten title of "dogmatics," and *Church Dogmatics* at that. Together with the ecumenical movement and the general rediscovery of tradition in Protestantism, this renewed emphasis gave to the question of dogma a prominence it had not had since before the Enlightenment.

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DOGMATISM is the uncritical acceptance and application of any belief, especially of those ultimate or fundamental beliefs known as principles. The term has been applied by Kant (*q.v.*) to most preceding systems of philosophy because of their alleged neglect to examine "critically" the nature and bounds of human knowledge as a preliminary step to their construction.

DOGON, a people of the Republic of Mali well known for their involved system of metaphysics and cosmogony. There is some doubt about the affinities of the Dogon language, which has been placed in the Mandingo, Voltaic and other language groups. Numbering over 200,000, the majority of them live in the mountains and plains of the Bandiagara district. They are mainly an agricultural people, but their few craftsmen, who are metal and leather workers, form distinct castes. They have no centralized system of government but live in villages composed of patrilineal lineages or extended families, whose head is the senior male descendant of the common ancestor. Each large district has a *hogon*, whose authority is chiefly in the religious sphere, and there is one supreme *hogon* for the whole country. In his dress and behaviour the *hogon* symbolizes the Dogon myth of creation, to which they relate much of their present social organization and culture. Their metaphysical system, which categorizes physical objects, personifies good and evil and defines the spiritual principles of the Dogon personality, is more abstract than that of other African tribes. In conjunction with the myth this system provides the unifying principle in their life, although only a small number of men are fully conversant with it.

Dogon society includes a number of Muslims, proselytized mainly by neighbouring Fulani, but Christianity has made little headway and neither has formal schooling. Dogon youths travel long distances to southern towns. There has been expansion of various food crops, notably onions, for export.

See D. Paulme, *Organisation sociale des Dogon* (1940). (I. C.)

DOG RACING. Dog racing is the racing of greyhounds around an enclosed circular or oval track after an electrically controlled and motivated mechanical hare. The successful use of this artificial lure is made possible by the fact that the greyhound chases his prey by sight rather than by smell. This idea of dog racing was tested in 1909 by Oliver P. Smith, a promoter and greyhound fan, at a track he built in conjunction with Tom Keen at Tucson, Ariz. By 1919 Smith had perfected his mechanical hare and successfully demonstrated it at Emeryville, Calif., and in the next few years other tracks were opened, among them those at Tulsa, Okla., East St. Louis and Chicago, Ill., Erlanger, Ky., and Hialeah, Fla. On Jan. 3, 1925, a track was opened at St. Petersburg, Fla.; the earlier tracks eventually went out of existence, and the St. Petersburg track, later to become internationally known as "Derby Lane," became the oldest greyhound racing track in continuous operation in the world. In July 1926 the sport was introduced in England, where it gained greater favour than in the United States. It later spread to many other countries, including Ireland, France, Italy, China, Czechoslovakia, Australia, Mexico and Cuba.

History.—Dog or greyhound racing was an outgrowth of coursing (*q.v.*), the running or hunting of game by fast hounds. The murals of ancient Greece and Egypt include many figures of hunting hounds of the greyhound type (*see* DOG.). In Great Britain the greyhound has been known for many hundreds of years. The origin of the name is a matter of some conjecture, but it is most probable that it is another form of the words "gazehound" or "greecehound," both names being forerunners of the word "greyhound." The 15th-century *Boke of St. Albans* sets out the requirements of a good greyhound from which comes the rhyme:

The head like a snake
The neck like a drake
The foot like a cat
The tail like a rat
The side like a bream
The back like a beam

The greyhound was the badge of King Henry VII and is the badge of the queen's messengers. The coursing of dogs existed in the reign of Queen Elizabeth I, and the National Coursing club was formed in 1858. The Greyhound Stud book was initiated by the club in 1882, a separate Irish Coursing club stud book in 1923, and the National Coursing Association (U.S.) Greyhound Stud book in 1906.

"Coursing by Proxy" was introduced at a meeting held in England at Welsh Harp, near Hendon, Middlesex, in 1876 and described in the *Times* (Sept. 11, 1876). The course was a straight one of 400 yd., and, by means of a windlass, the "hare" was pulled along a rail laid in the ground. Two hand-slipped greyhounds raced at a time. This was the first known occasion on which greyhounds ran after an artificial lure, as previously greyhounds were used exclusively for coursing. Several meetings were held, but because the course was straight the fastest—but not necessarily the cleverest—greyhound always won and the owners lost interest. Fourteen years after the Welsh Harp meeting, a patent for a circular greyhound racing track was taken out in the United States. The idea was not put into actual practice because the inventor could not find anyone to back him financially, but his invention is the basis of the modern sport.

Little further interest was taken until the Emeryville, Calif., track was opened in 1919. The sport became popular there, and other tracks were opened in different parts of the United States. Charles Munn, a U.S. sportsman, went to England and showed pictures of this new sport to Brig. Gen. Alfred C. Critchley, who at once realized the possibilities of such a venture. These two pioneers founded the Greyhound Racing association, built a track at Belle Vue, Manchester, and on July 24, 1926, just 50 years after the Welsh Harp venture, greyhound racing's success story began. The racing of the greyhounds and the opportunities it afforded for betting attracted large numbers of spectators.

Numerous companies were formed in 1927 to promote this sport and on Jan. 1, 1928, the National Greyhound Racing club was formed and all reputable promoters in the country agreed to accept its rules and jurisdiction in the same manner as the Jockey club's rules control horse racing. At the same time, the National Greyhound Racing society was formed from the managements that accepted the supervision of the National Greyhound Racing club.

After those early days the National Greyhound Racing society

BY COURTESY OF THE NATIONAL GREYHOUND RACING SOCIETY OF GREAT BRITAIN

GREYHOUNDS RACING ON A TRACK

became the body officially recognized by the government in all matters affecting greyhound racing. In 1932 the bookmakers objected to pari-mutuel machines or totalizators (*see* HORSE RACING AND BREEDING) on greyhound racecourses and a court judgment was obtained specifying that totalizators, other than those on horse racecourses, were illegal. The society contended that this was unfair to a rapidly growing greyhound racing public and gave evidence before a royal commission then established. The Betting and Lotteries act of 1934 finally legalized greyhound totalizators and put the sport on a firm and officially recognized basis although confining racing to 104 days a year. These days of racing are not necessarily the same all over the country but are fixed individually by the local licensing authorities; *i.e.*, county and county borough councils.

The total number of persons who attend greyhound racing in Great Britain is estimated to be about 15,000,000 a year.

Method of Racing.—There is a limit of not more than 8 races at each meeting, although on four specially appointed days in the year there can be 16 races. These days must be fixed by the local licensing authority in consultation with the racecourse concerned. In accordance with the rules of the National Greyhound Racing club the races to be run must not be less than 230 yd. or greater than 1,200 yd., and it is usual for flat and hurdle races to be run over varying distances. Not more than six greyhounds run in a race and the owner of the winner is entitled to the prize money, which can be as high as £3,000 for the Greyhound Derby classic race at White City, London. The greyhounds, each wearing a distinctive coat, are placed in separate divisions of the starting box or trap. As the electrically propelled artificial hare, which runs around the inner or outer circumference of the track on a concealed mechanism, flashes past the starting trap, the dogs are released simultaneously by the opening of the front of the trap. To ensure a fair race, control of the speed of the hare is most important. If the leading dog is allowed to gain too much ground to the hare he may run out after it at the bends, allowing the other dogs to come between him and the rail and so gain the advantage. The finish of the race is photographed automatically, and the photograph is used to confirm the judges' placing in the order of finishing. Most races are held at night, under lights. From the form shown by the dogs in trials and races, the racing managers grade their performances and enter the dogs in races with others of equal or comparable merits to ensure as close a race as possible.

Stewards are appointed by the National Greyhound Racing club to supervise all races and trials at all tracks licensed by the club and to maintain the general integrity of greyhound racing. The stewards note the running and times of greyhounds as compared with previous performances. If they are not satisfied with the running of any greyhound they can call for the advice of the veterinary surgeon and, if necessary, hold an inquiry. The result of the inquiry and the stewards' decision is reported to the stewards of the national club. They have power to warn off, suspend or fine any owner or trainer found guilty of any malpractices and, indeed, any other official who deals with racing can be dealt with likewise.

Health.—When the Animal Health trust proposed the formation of a canine division, members of the National Greyhound Racing society guaranteed £70,000 to ensure the establishment of the research centre. The society also makes an annual contribution of £5,000 to the trust.

Veterinary research stamped out distemper and hard pad in greyhounds, invented a special technique to insert a plastic "bone" in the hind leg of a greyhound (which afterward won more races) and devised the "tired heart" operation which foreshadowed similar advances in human surgery. In this field of research Great Britain gave a lead followed by other countries.

There is a veterinary surgeon at every track. No dog is allowed to race unless it has been examined and certified fit; *e.g.*, if its weight varies by more than two pounds from its last trials or racing weight, a greyhound may not race. The veterinary surgeon is there to make quite sure that the entrants for every race are in perfect condition.

Security.—The precautions taken against substitution of one dog for another in a race provide an example of the care taken at tracks licensed by the National Greyhound Racing club to ensure that no loophole is left for criminal ingenuity. Greyhounds running at licensed tracks must be registered with the club. The form of application for registration has to be filled in with an array of measurements, markings and other points which make future identification of the greyhound certain beyond doubt. This information is transferred to the individual greyhound's identity and race record card, familiarly known as its "passport," which must precede the greyhound to every racecourse at which it is running. Every time it runs, the identity of the greyhound is checked against its "passport" to prevent substitution.

OTHER COUNTRIES

United States.—The first greyhounds that provided the nucleus and foundation of the coursing and track stock were brought to North America from England and Ireland by early settlers. Coursing and greyhound racing is confined, in the main, to Florida (which has the most tracks), Massachusetts and the western states.

After the successful demonstration of Smith's mechanical hare in 1919 the sport progressed remarkably, particularly in Florida, Massachusetts, Arizona and Oregon. All major tracks are members of the American Greyhound Track Operators association, and all greyhound racing is held under the supervision of the State Racing commissions, whose representatives supervise the racing, kennels, etc. Practically all track surfaces in the United States are comprised of sand and loam as opposed to the grass surfaces of England and Ireland. The sand and loam are sifted so that the particles are small enough to avoid injury to the greyhounds' feet.

Florida was the first state to legalize greyhound racing, in 1931, after which the state derived considerable income in taxation from it. This income came from a percentage of the "handle" (the money wagered on each race), a percentage of the paid admissions, and occupational licence fees collected from all employees. Florida's experience prompted other states to legalize the sport; these included Arizona, Arkansas, Colorado, Massachusetts, Montana, Oregon and South Dakota. In each of the states in which the sport has been legalized it has become an important source of tax revenue.

The breeding of the greyhounds is extremely important, and there are many full-time breeders who devote their time to ensuring a good blood line for future champions. The registration of greyhounds is with the National Coursing association and the American Kennel club. A dog must be at least 12 months old before his racing career commences as compared with 15 months in Great Britain. A certificate of identification must be granted before the dog can race and this is presented to the racing commission of the state and racecourse concerned before the dog is raced. In addition, the final certificate of identification and "Bertillon" card, which show all the features of the greyhound in the same way as the British identity book, must be produced. The method of racing is very similar to that of Britain, although the number of greyhounds in a race is generally eight and a nightly program or meeting consists of 10 or 11 races. Entries for the various races are determined principally by a grading system that is more or less standardized in the various states, the dogs being classified on the basis of their records in previous races. There are usually six grades, ranging from young greyhounds that are just starting their racing careers and have never won a race, to the outstanding stars of the track. The standard size of the modern track is $\frac{1}{4}$ mi., with the major portion of races run over $\frac{5}{16}$ or $\frac{3}{8}$ mi., the entries passing the grandstand and finish line and then circling the track to complete the distance. Earlier in the history of the sport many of the major races were at $\frac{7}{16}$ and $\frac{1}{2}$ mi. Some feature events are still extended to these distances. The rules under which the dogs race resemble those of the National Greyhound Racing club in Great Britain in principle, although the British rules are more easily enforceable. Betting on races in all the states is by the parimutuel (totalizator) system.

Ireland.—Ireland is noted for the breeding and racing of greyhounds and is the main source of supply for other countries, although England and the United States have built up breeding lines.

In the Republic of Ireland a government board was established to control greyhound racing. Northern Ireland racing is held principally in Belfast, which is also noted for its sales of greyhounds.

Australia.—Greyhound racing is legalized in the states of New South Wales and Tasmania with bookmakers and totalizators. In Queensland and Victoria the sport is illegal but coursing is allowed. Control of racing in New South Wales is semiofficially vested in the Greyhound Racing Board of Control of New South Wales Ltd., but its powers are restricted to a general overseeing of greyhound racing. The Australasian and New Zealand Greyhound association controls the racing of greyhounds and issues a yearly stud book.

Continental Europe.—Greyhound racing in Spain is modeled on the British system and the ruling body is the Federación Española Galguerra, which is equivalent to the National Greyhound Racing club and National Coursing club. The meetings are usually of 12 races with five or six dogs competing in each race. Racing also exists in several other European countries, *e.g.*, Belgium, France and the Netherlands, but only in a minor degree.

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(F. J. U.; N. E. B.)

DOGS, ISLE OF, a district of east London, Eng., on the north bank of the Thames, forming the southern extremity of the metropolitan borough of Poplar (*q.v.*). It is enclosed on three sides by a bend of the Thames formed by Limehouse, Greenwich and Blackwall reaches, and includes Millwall (with Millwall dock) on the west and Cubitt Town on the east; the West India docks across its northern end make of it almost an island. Greenwich tunnel (built in 1902) for pedestrians passes under the river there. The whole district is occupied by docks, riverside works and houses for the workers. The origin of the name is not certain; until the 16th century, the area was known as Stepney Marsh; the present name may have originated as a nickname of contempt. It may also be a corruption of the "Isle of Ducks" and there is a story that the royal kennels were once there when the court was at Greenwich.

DOG SLED RACING. Contests of speed between teams of dogs which haul sleds is fairly popular in the snowier regions of North America. Teams are made up from purebred Siberian huskies and Alaskan Malamutes and, when in racing condition, can average 12 to 14 m.p.h. The teams, usually consisting of five, seven or nine dogs, are driven in the "gang hitch,"—a single leader with the rest of the team in pairs. Control of team is by voice, although drivers may carry whips limited to a three-foot length. In open country, point-to-point races are held. In more populated areas, back roads form the locale with races varying in length from 12 to 30 mi. Races are run on a handicap basis, with prizes for the handicap winner and the elapsed time winner. The largest U.S. organization devoted to dog sled racing and the improvement of sled dog breeds is the New England Sled Dog club, organized in 1924. (H. P. D.)

DOG STAR: *see* SIRIUS.

DOG'S-TOOTH VIOLET, any plant of the genus *Erythronium* of the lily family, Liliaceae (*q.v.*), comprising about 20 species, almost all of which are native to North America. They are low herbs with unbranched stems that spring from deep corms and bear near the surface of the ground a pair of unequal leaves, often mottled with dark splotches, and large, nodding, lilylike, mostly solitary flowers on slender stalks.

The best-known representative in eastern North America is the yellow dog's-tooth violet (*E. americanum*), known also as yellow adder's-tongue and trout lily, with yellow flowers, three-fourths inch to one and one-half inches long, on stalks six inches to eight inches high. This handsome spring wild flower is native to moist woods from Nova Scotia to Minnesota and southward to Florida and Arkansas. The similar but smaller white dog's-tooth violet (*E. albidum*), called also fawn lily, with white flowers, occurs in low woodlands from Ontario to Minnesota and southward to Kentucky and Texas. A conspicuous species in the Rocky mountain region, forming an almost continuous cover in many alpine meadows just after the snow is gone, is the large-flowered *E. grandiflorum*, with flower stalks 8 to 16 in. tall, bearing one to five yellow flowers 1 to 2 in. long. *E. montanum*, common in alpine meadows in western North America, is a smaller plant with white flowers. Many species are cultivated in England, where those from western North America do better than in the eastern states of the U.S. All prefer coolness and moisture. *E. americanum* grows well in moist sites in wild gardens. Undisturbed it makes large patches in a few years.

J. HORACE MCFARLAND COMPANY
DOG'S-TOOTH VIOLET (ERYTHRONIUM AMERICANUM)

The European dog's-tooth violet (*E. dens-canis*), a delicate spring-bloomer with rose-purple flowers, is planted in borders and rockeries. (N. TR.; X.)

DOGTOOTH, in architecture, a band decoration of adjoining, projecting triangles, called, from its saw-tooth shape, in French, *dent de scie*. Early examples of this decoration were found in Syria and in the Mesopotamian valley; *e.g.*, in the palace front at Rabbath-Ammon (built either in the last eight years of the Sassanian dynasty or in the early part of the Mohammedan rule), where it was used on arch moldings; and in a highly decorative form, in the palace of Machitta of the 8th century. It was found widely during the Romanesque period throughout Europe, where it is thought to have been introduced by the crusaders from the east. It was particularly common in Norman work in France and England, appearing as the chevron (*q.v.*) and zigzag. It often appears in arch moldings as a series of projecting pyramids, the sides decorated with foliage. To its supposed resemblance, in this form, to a dog's-tooth violet, some people incorrectly attribute the origin of its name.

DOGUBEYAZIT, a border fortress of eastern Turkey, chief town of an *ilce* (district) of the same name, lies 150 mi. E. of Erzurum, close to the frontiers of the U.S.S.R. and Iran. It looks across a marshy plain to the great cone of Ararat at a general altitude of 6,000 ft. Pop. (1960) 6,772. Its site is very old (there are cuneiform inscriptions on neighbouring rocks), being that of the ancient Armenian town of Pakovan. The great trade route from Trabzon through Erzurum into northwest Iran crosses the frontier at Kizildize a few miles to the south. A knoll above the town is occupied by the half-ruined fort or palace of former governors, which was built for Mahmud Pasha by a Persian architect and is one of the most beautiful buildings in Turkey. It contains two churches and a monastery, the Kasa Kilissa, famous for its antiquity and architectural grandeur. The cuneiform inscriptions are on the rock pinnacles above the town, with some rock chambers, indicating a town or fortress of the Vannic period. Destroyed during the 19th-century Turko-Russian campaigns and World War I, Dogubeyazit was restored by the Turks. It is one of the leading trading centres for animal products, which are the chief source of income in the region. (N. TU.; S. ER.; E. TU.)

DOGWOOD, the name applied to about 45 species of shrubs, small trees and a few herbs belonging to the genus *Cornus* of the family Cornaceae (*q.v.*). Except for a single Peruvian form, the group is restricted to the temperate regions of the northern hemisphere. Dogwoods contribute but little to the world's timber supply, but those with crowns of attractive leaf mosaics, showy inflorescences, brightly coloured fruits and twigs of many hues are numbered among the hardiest and most universally used of the woody ornamentals.

Nearly 20 species of *Cornus* are indigenous to North America, six of which occur on the Pacific rim. The most striking are the flowering dogwood (*C. florida*) of eastern United States, and the Pacific dogwood (*C. nuttallii*) of the west coast. Both are small,

shapely trees featuring lustrous green leaves and tiny, four-parted, yellowish flowers borne in heads subtended by four (rarely five) large snowy white bracts with pink or reddish tips followed by clusters of small, brilliant red, fleshy fruits (drupes). The inflorescences, with subtended bracts, appear in great profusion in advance of the leaves and are often two to five inches across.

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FLOWERING DOGWOOD (CORNUS FLORIDA)

Horticultural varieties of the flowering dogwood in common use include var. *rubra,* with deep pink floral bracts; var. *xanthocarpa,* with yellow fruits; var. *pendula,* with pendulous branchlets; and var. *pluribracteata,* with eight to ten or more floral bracts. The sapwood of the flowering dogwood (*C. florida*) is very resistant to wear and is used almost exclusively in the production of shuttles and spindles for mills.

Unlike other species, Pacific dogwood commonly blooms twice during the growing season. The second complement of blossoms appear as the fruits from the first are maturing. During this period the tree is especially attractive with its white flowers and crimson fruits set in a sea of lustrous green foliage. Other noteworthy American dogwoods include the spreading and shrubby red-stemmed dogwood (*C. stolonifera*); pagoda dogwood (*C. alternifolia*), a tree with alternate leaves; and silky dogwood (*C. amomum*), another spreading shrub with purple stems and silky pubescent leaves.

The common European dogwood (*C. sanguinea*) is widely used in decorative plantings. Its principal distinguishing features include small ovate leaves, loose clusters of purplish-black fruits, and dark-red stems. The Cornelian cherry (*C. mas*) of Europe and Asia produces succulent, edible, scarlet fruits which are often made into preserves. Several horticultural varieties of this species together with others of the Asiatic white dogwood (*C. alba*) feature variegated leaves splotched with white, yellow and even pink. Bunchberry (*C. canadensis*), and Lapland cornel (*C. suecica*) are two boreal, nearly prostrate, herbaceous species. The former occurs transcontinentally from Newfoundland to Alaska; the latter is a circumpolar form which in some regions extends beyond the Arctic circle.

Most dogwoods are prolific annual seeders. Seeds sown in cold frames shortly after their maturation in the fall germinate in the spring in greater numbers than those merely held in cold storage through the winter months. The softwooded species, such as *C. alba* and its allies, are easily propagated from cuttings of mature shoots and by layering. Several horticultural forms and varieties are also perpetuated by twig grafting.

Dogwoods attain maximum development on rich, moist loams, but may be successfully grown in most common garden soils. A few species thrive better in shade; those with variegated foliage should be planted in the open for best results.

Insect pests of dogwoods include wood borers, cambial miners, twig girdlers, bud and twig gall-forming insects, and sucking insects such as the white fly and San Jose scale. The incidence of attack of some of these is often severe, but rarely do the activities of any one of them result in the total destruction of the host. Those with sucking mouth parts can usually be controlled by spraying with pyrethrum-soap solutions or oil emulsions. Stems damaged by borers and miners should be removed and burned, preferably before leaf emergence in the spring. Numerous leaf-spotting fungi, some of which cause early defoliation, can be kept under control by spraying with Bordeaux mixture at intervals of two or three weeks soon after the leaves are fully formed.

(E. S. Hr.)

DOHERTY, CHARLES JOSEPH (1855–1931), Canadian minister of justice from 1911 to 1921, was born in Montreal, Que., on May 11, 1855, and educated at St. Mary's college and McGill university. He was called to the bar in 1877, became a king's counsel in 1887, taught civil and international law at McGill university for 20 years and was a judge of the superior court of Quebec, 1891–1906. He was elected to the house of commons in 1908 as Conservative member for St. Anne's-Montreal, and with the Conservative victory of 1911 became minister of justice in the Borden government, a position which he held until he was defeated in the election of 1921. He was one of the three supporters of the Union government elected in Quebec in 1917. He accompanied Sir Robert Borden to the meetings of the committee on imperial defense in London in 1912 and to the Paris peace conference of 1919, and was one of the Canadian representatives at the first assembly of the League of Nations in 1920. During World War I he was active in the recruitment of the Irish Canadian Rangers. He was appointed to the imperial privy council in 1920. He died at Westmount, Que., on July 28, 1931. (M. E. P.)

DOHNÁNYI, ERNŐ (Ernst von Dohnányi) (1877–1960), Hungarian composer, pianist and conductor, principally known for his "Variations on a Nursery Song" for piano and orchestra, was born at Bratislava (Pressburg) on July 27, 1877. He studied at the Budapest Royal academy under István Thomán for piano and Hans Koessler for composition, and also took some lessons from Eugen d'Albert. His first piano quintet aroused Brahms' admiration in 1895, and he had further successes with his first symphony (1897) and first piano concerto (1899). As a pianist he traveled widely and by 1905 was reckoned one of the first ten pianists in the world. He taught at the Berlin *Hochschule* (1905–15) and gave the first performance of his "Variations on a Nursery Song" (1914) in Berlin on Feb. 17, 1916. He returned to Hungary and became conductor of the Budapest Philharmonic society (1919), professor (1928) and director (1934) of the Budapest academy and director of the Hungarian radio (1931). After 1945 his influence under the prewar regime was held against him, and in 1948 he left as a political exile, his music being banned in Hungary for more than ten years. He taught in Argentina and from 1949 was composer-in-residence at Florida State college, Tallahassee. He was active as a pianist until the end of his life, but his output after 1930 was only sporadic. The style of his music was late romantic and conservative, and after 1910 he occupied only a minor place among his contemporaries as a composer.

His works include the ballet *Der Schleier der Pierrette* ("The Veil of Pierrette," 1910); the operas *Tante Simona* (1913), *A Vajda tornya* ("The Tower of the Voivod," 1922) and *Der Tenor* (1929); three string quartets and three symphonies. He died in New York city on Feb. 11, 1960. (Co. Ma.)

DOHRN, ANTON (1840–1909), German zoologist and founder of the marine laboratory at Naples, Italy, born at Stettin (Szczecin, Pol.) on Dec. 29, 1840, studied under E. H. Haeckel at Jena, and made embryological and morphological researches in many animal groups. Working at Messina, Sic., in the 1860s he saw the need for a large international centre for research on marine organisms and realized his ideal in the zoological station at Naples, to found which he gave his own fortune. The first building was opened in 1874 and was further extended in succeeding decades. To help maintain the laboratory he included an aquarium to attract tourists, initiated the system of grants from governments, universities and scientific societies to support research "tables" and promoted the supply of specimens for teaching purposes. During 35 years under Dohrn's direction the zoological station, with its unrivaled library, was visited by leading scientists from all countries and it largely influenced the course of biological research in that era. It became a model for similar laboratories in other countries. Besides the station's *Mitteilungen* and the *Zoologischer Jahresbericht,* Dohrn also started the famous series of monographs on the *Fauna and Flora of the Gulf of Naples.* He died at Munich on Sept. 26, 1909. (F. S. Rl.)

DOISY, EDWARD ADELBERT (1893–), U.S. biochemist, was awarded jointly with Henrik Dam of Denmark the Nobel prize in medicine and physiology for 1943 for research into and discovery of vitamin K. Born at Hume, Ill., on Nov. 13, 1893, he was educated at the University of Illinois and Harvard uni-

versity, where he received the Ph.D. degree in 1920. He served on the faculty of Washington university school of medicine, St. Louis, Mo., 1919–23; during that period he collaborated with Edgar Allen, then embryologist in the department of anatomy, on the refinement of a bio-assay technique to locate and measure the activity of estrogenic hormones. That accomplishment paved the way for notable progress by them and others in the field of sex hormones. Doisy also developed improved methods for isolation and identification of the diabetic hormone, insulin. In 1923 he was appointed professor and in 1924 director of the department of biochemistry of St. Louis university. He made important contributions to the knowledge of vitamins and antibiotics, and in 1955 the university's department of biochemistry was renamed the Edward A. Doisy department in his honour. He wrote on blood buffer systems, sex hormones, vitamin K and antibiotic compounds in professional journals. He published with Edgar Allen and C. H. Danforth *Sex and Internal Secretions* (1939).

(P. A. Sr.)

DOLCI, CARLO (Carlino) (1616–1686), Italian painter, who was one of the last representatives of the local Florentine school, was born in Florence on May 25, 1616. He studied with Jacopo Vignali, a follower of Guercino. At a time when other Florentine painters migrated to Rome, the centre of monumental baroque painting, Dolci remained in Tuscany and developed his manner out of the native traditions of Florence. He rarely left Italy, but in 1672 he went to Austria to paint Princess Claudia Felice, the daughter of Anna dei Medici. The figures in Dolci's dramatically concentrated compositions are typically rendered in half length, and often convey a marked element of sentiment. His easel paintings, especially his madonnas and saints, are his most notable works.

Without possessing much genius or invention, Dolci produced highly wrought pictures extremely attractive to some tastes. Refinement of detail, soft colour and livid shadows often characterize his paintings. Among his students was his daughter, Agnese Dolci, who is supposed to have copied many of his paintings. He died in Florence on Jan. 17, 1686.

DOLDRUMS, an area or belt of calms or very light winds in certain equatorial regions, especially over the oceans. In the days of sailing vessels these areas were avoided, if possible, by mariners lest they find themselves becalmed for days or weeks, feeling uncomfortably warm in the still, humid air, losing time and consuming provisions and water. *See* Wind; Tropical Storm: *Origin.*

(H. R. B.)

DOLE, SANFORD BALLARD (1844–1926), president of the Republic of Hawaii (1893–1900) and first governor of the Territory of Hawaii (1900–03), was born in Honolulu on April 23, 1844, the son of American Protestant missionaries. He spent two years in the U.S., from 1866 to 1868, attending Williams college (Williamstown, Mass.) and studying law. He then returned to Hawaii to become one of its leading lawyers, a member of the legislature from 1884 to 1887 and a leader in the reform movement which brought about adoption of the constitution of 1887. Also in 1887 he was appointed an associate justice of the supreme court of Hawaii, an office he held until the monarchy was overthrown in 1893 by a revolution of which Dole himself was a leader. In 1894 he was elected by the constitutional convention as the first president of the Republic of Hawaii. While accepting leadership in this republican government, he preferred a regency headed by Princess Kaiulani, heir apparent. With firmness and wisdom he guided the republic through a difficult period, suppressing revolutions and stabilizing the governmental machinery. When President Cleveland demanded the restoration of Queen Liliuokalani to the throne Dole refused to yield, claiming that Cleveland was without authority to act. In 1898 he went to Washington in the interests of annexation to the U.S., and when that event took place in 1900 Dole was appointed by President McKinley as the first territorial governor. In 1903 he became U.S. district judge of Hawaii and in 1909 was reappointed to a second term. At its expiration in 1915 he retired to private life in Honolulu, where he died on June 9, 1926. *See* also Hawaii: *History.*

(E. M. Da.)

DOLERITE: *see* Diabase.

DOLET, ÉTIENNE (1509–1546), French humanist, scholar and printer whose *Commentarii linguae Latinae* was a valuable 16th-century contribution to Latin scholarship, was born at Orléans, Aug. 3, 1509. After studying at Paris, Padua and Venice, he settled in Toulouse. His quarrelsome temperament, unrestrained enthusiasm for Renaissance learning and anticlericalism involved him in personal and public controversies: he was banished from the university, and moved to Lyons, where for a time he suffered imprisonment for the justifiable homicide of a painter called Compaing, but was released by royal pardon. An ardent Ciceronian, he answered Erasmus' attack on slavish imitations of Cicero's style with a *Dialogus de imitatione Ciceroniana* (1535), and in 1536 published the first volume of his *Commentarii;* the second followed in 1538. This work was dedicated to Francis I, who gave him permission to set up as a printer. His first publication, *Cato christianus,* was a profession of his creed as a Christian moralist. It was followed by works which showed the catholicity of his literary appreciation and the unorthodoxy of his attitude to the church: translations and editions of classical authors, of treatises by Erasmus, and of the New Testament and Psalms, as well as works by Rabelais. He was thrice accused of atheism and imprisoned: in 1542, in 1544 on the double charge of having published Calvinistic works and a dialogue by Plato denying the immortality of the soul, and in 1546. He was finally condemned by the theological faculty of the Sorbonne, and burned at the stake at Paris, Aug. 3, 1546.

Whether Dolet was a Protestant or an anti-Christian rationalist and freethinker is debatable. He was condemned by Calvin as well as by the church, but he published many religious books and repeatedly advocated the reading of the Scriptures in the vernacular. It seems likely that his fate was the result of his capacity to make enemies rather than of his opinions, although he is often described as the "first martyr of the Renaissance."

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DOLGELLAU (Dolgelley), an urban district and the county town of Merioneth, north Wales, is 10 mi. E. of Barmouth by road. It stands on the south bank of the river Wnion a mile above the estuary head of the Mawddach river and under the shadow of Cader Idris (2,927 ft.). Pop. (1961) 2,267.

The town, a huddle of gray stone buildings, has narrow winding streets radiating from its centre, Eldon square. A seven-arched bridge over the Wnion dates from 1638. The boys' grammar school was founded in 1665 and St. Mary's church was rebuilt in 1716 round the original 13th-century structure. The building comprising the county hall and assize court dates from 1825.

Three important highways meet there: from Cheshire and Merseyside; from the English Midlands and central and south Wales; and from southwest Wales and the Cardigan bay area. Thus Dolgellau is one of the chief gateways of the Snowdonia National park. A branch line links the town with the main railway system.

Merioneth, being mountainous, has the highest proportion of sheep in Wales, and Dolgellau was once noted for the manufacture of a woolen cloth known as "webs." Early in the 19th century this trade declined but Dolgellau remains one of the chief markets for Welsh Mountain sheep. Most of the inhabitants speak both Welsh and English.

(A. M. Re.)

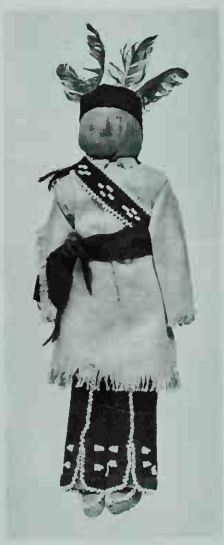
DOLGORUKI (Dolgorukov), a Russian princely family, descended from Rurik. In the 17th century there were four branches of it. Two members of the eldest branch, Yakov Fedorovich (1639–1720) and his brother Grigori (1656–1723), both diplomats, were personal friends of the emperor Peter I. Yakov's nephew, Vasili Lukich (1670–1739), also a diplomat and later a member of the supreme privy council, wanted the emperor Peter II to marry his niece Ekaterina Alekseevna (1712–45). After Peter's sudden death (1730), Vasili produced a letter, purporting to be Peter's last will, appointing Ekaterina his successor. When Vasili had to abandon his scheme, he supported the election of Anna Ivanovna to the throne on "conditions" leaving the real

Egyptian wooden doll with hair made of clay beads, found at Thebes. Probably Middle Kingdom

Etruscan jointed doll of terra cotta. 700–600 B.C.

Greek terra-cotta doll from Corinth known as a dancing doll. The arms and legs are secured to the body with metal pins. 5th century B.C.

Eskimo ivory doll representing a shaman (priest or sorcerer); Point Barrow, Alaska. About 1850



Cornhusk doll made by the Seneca tribe, New York. Late 19th century

Beaded buckskin doll of the Blackfoot Plains Indians, Montana. About 1900

DOLLS OF THE ANCIENT WORLD AND NORTH AMERICA

BY COURTESY OF (TOP LEFT) THE TRUSTEES OF THE BRITISH MUSEUM, PHOTO BY JOHN R. FREEMAN & CO. LTD.; (BOTTOM) MUSEUM OF THE AMERICAN INDIAN; PHOTOGRAPHS, (TOP CENTRE) COLLECTION OF THE NEWARK MUSEUM; (TOP RIGHT) JOHN R. FREEMAN & CO. LTD., © ENCYCLOPÆDIA BRITANNICA

DOLL

Jumeau bisque doll with unglazed head and body; French. 19th century

Early English wooden doll. 17th century

Doll dressed in local straw plait; English. Exhibited at the Luton plait exhibition, 1878

English boy doll with wax head, bust and limbs, stuffed cloth body and wool suit. Thought to have been made by the Montanari family. About 1860

"Letitia Penn," the earliest known play doll in the U.S. 1699

German child doll in French dress with bisque swivel head, composition body, ball joints and sleeping eyes; made by Simon and Halbig. About 1900

EUROPEAN AND U.S. DOLLS

BY COURTESY OF (TOP CENTRE) VICTORIA AND ALBERT MUSEUM; (BOTTOM CENTRE) THE HISTORICAL SOCIETY OF PENNSYLVANIA; PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT AND RIGHT) JACK SKEEL; (TOP RIGHT) W. H. COX, LUTON. ALL PHOTOGRAPHS EXCEPT TOP CENTRE AND BOTTOM CENTRE © ENCYCLOPÆDIA BRITANNICA

power to the supreme privy council. Anna subsequently repudiated the conditions and banished Vasili and other members of his family first to Siberia, then to the Solovetski monastery. Finally the charge of forging Peter II's will was revived, and Vasili, with Ekaterina's brother IVAN ALEKSEEVICH (1708–39) and two other Dolgorukis, was beheaded in Novgorod on Nov. 19 (new style; 8, old style), 1739.

Among the members of the third branch the most prominent was VASILI VLADIMIROVICH (1667–1746), a general who plotted against Peter I and also against Anna Ivanovna. He was twice deported and deprived of his titles and twice restored to them. Other members of this branch were: VASILI MIKHAILOVICH (1722–82), the general who conquered Crimea in 1771; PETR PETROVICH (1777–1806), a favourite of the emperor Alexander I and an opponent of Adam Czartoryski; and PETR VLADIMIROVICH (1807–68), who was deported from St. Petersburg to Vyatka for publishing in Brussels, under the pseudonym of Comte Almagro, *Notice sur les principales familles de la Russie* (1843; Eng. trans., *A Handbook of the Principal Families in Russia,* 1858). He left Russia in 1859 and published *La Vérité sur la Russie* in 1860. He died in Bern, Switz.

DOLICHOCEPHALIC, having a relatively long head. In anthropology it denotes a cephalic index of 75 or less (*see* CEPHALIC INDEX; CRANIOMETRY). In obstetrics the term is applied to a head that is temporarily elongated, usually by molding from a long and hard labour. (F. L. A.)

DOLL (*cf.* Norse *daul,* Saxon *dol,* old German *doche,* Latin *puppa*) is a child's toy, modeled, however crudely, on the human form, and perhaps the oldest plaything of mankind.

Ancient World and Europe.—No dolls have been found in prehistoric graves, probably because they were made of such perishable materials as wood and fur or cloth. From Babylon there is a fragment of an alabaster doll with movable arms. Dolls dating from 3000–2000 B.C., carved of flat pieces of wood, geometrically painted, with hair made of strings of clay or of wood beads, have been found in Egyptian graves. Ancient Greek clay dolls, meant to be dressed, often have arms and legs secured to the body with metal pins. Other Greek dolls, such as those found at Corinth and dating from about 500 B.C., may have had religious meaning. In ancient Greece and Rome marriageable girls consecrated their discarded dolls to Venus or Diana. Dolls were buried in children's graves in Egypt, Greece and Rome; dolls have even been found in early Christian catacombs, and in southern United States glass doll houses with dolls and toys sometimes are still placed on the graves of children. Ancient rag or stuff dolls also have been found; one Egypto-Roman doll (*c.* 300 B.C.) is stuffed with papyrus. Dolls crocheted of bright wool, and others, with wool heads, clothed in coloured wool frocks, dating from about A.D. 500, have been found in Egypt. Dolls dating from the middle ages are little known. Clay horses and knights have been found and small figures made of tin and glass. Simple clay dolls with a depression in the breast to hold a christening coin may have been godparents' gifts. Crèches with carefully modeled figures of the Holy Family, the Magi and shepherds were set up in homes and churches, as they are today. Elaborated during the Renaissance, these reached a zenith in the 17th and 18th centuries in southern Europe. Protestant Europe, during the same period, developed very elaborate doll houses. As early as 1413 there were *Dochenmacher* or dollmakers in Nürnberg, which from the 16th to the 18th century was the leading manufacturer of dolls and toys. Paris was another early mass producer of dolls, making chiefly fashion dolls; as early as 1391 the queen of England ordered fashion dolls from France, and Isabella, queen of Spain, received a life-sized fashion doll from Anne of Brittany in 1496.

Doll heads were made of wood, terra cotta, alabaster and wax, the last a technique perfected in England by Augusta Montanari and her son Richard (*c.* 1850–87), who introduced the first infant dolls. About 1820 glazed porcelain (Dresden) doll heads and unglazed bisque heads became popular. A French bisque doll made by the Jumeau family in 1862 had a swivel neck; the body was of kid-covered wood, or kid stuffed with sawdust, a type of manufacture that remained common until it was supplanted by molded plastics. Socket joints, movable eyes, dolls with voices and walking dolls were introduced in the 19th century, as well as paper-doll books and dolls of India rubber or gutta-percha. The period from 1860 to 1890 was the golden age of the elaborately dressed Parisian bisque fashion dolls and the smaller "milliner's models."

America.—The oldest American dolls are possibly those found in Aztec graves, such as those near the pyramids of Teotihuacán. In the early colonial period stuff or rag dolls predominated. About 1820, china doll heads were imported from Europe; clothes were made from native fabrics. Ludwig Griener took out the first American dollmaking patent in 1858; his specialty was finely modeled papier-mâché dolls with glass eyes.

Among American Indian dolls, Kachina dolls, made by the Hopi in Arizona, Zuñi in New Mexico and, in a derived form, by the Pomo of California, are pre-eminent. At annual Kachina ceremonies these small figures are given to children by masked adults, impersonating legendary, supernatural Kachinas, who bring the people's prayers to the gods. The dolls are carved from cottonwood or cactus root, painted in symbolic colours and dressed traditionally. The Hopi recognize over 200 Kachinas, including 30 official, or Mong, Kachinas. The dolls are not toys but sacred objects for the children to study. Dolls of bone, walrus ivory and mammoth teeth are made by Eskimos and northern Indians; dolls of the Keres Indians of Laguna and Cochiti are rounded or flat billets identical in form with the prayer sticks used in ceremonial offerings. The beaded buckskin dolls of the Plains Indians and others probably reflect white influence.

Asia and Africa.—In Japan, dolls are also more often festival figures than playthings. A bride takes her doll collection to her new home. At the girls' festival dolls representing the emperor, empress and their court are displayed; girls from 7 to 17 visit each other's collections and refreshments are offered, first to their majesties, then to the guests. This ritual, over 900 years old, may reflect an early scapegoat rite. A primitive Japanese doll, of shaved willow stick with paper clothes and shavings or strings for hair, no doubt descends from willow sticks set up near streams in annual purification ceremonies. Korean children make similar dolls of bamboo sticks, with long grass hair. A scapegoat doll, treated as if alive, was formerly given to Japanese mothers to ward off evil from their children. Japanese boys have an annual doll festival, from the first May after they are born until they are about 15 years old. Warrior dolls, weapons, banners and legendary figure groups are displayed to encourage chivalrous virtues; and some modern dolls are even attired as football players. In Korea, for the children's festival, a paper image of a woman is made with a clay base to stand erect. In Japan the corresponding toy, identified as the Buddhist Daruma, is bought by boys at a temple. The face is painted and in place of eyes are white paper disks, upon which black dots are inked if the god answers a prayer. In China, this toy is fashioned to teeter like a drunken actor.

In India elaborately dressed dolls were given to child brides by both Hindus and Muslims. In Baghdad dolls are considered unlucky; little girls must improvise their own dolls of pillows and blocks of wood. In Iran they are fashioned of folded cotton. In Syria girls of marriageable age hang dolls in their windows.

In Africa, among the Fingo of the Orange Free State, every grown girl is given a doll to keep for her first child; on its birth, the mother receives a second doll to keep for the second child.

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DOLLAR, ROBERT (1844–1932), Scottish-born U.S. lumberman and shipowner, was born in Falkirk, Scot., on March 20, 1844. In 1856 his family emigrated to Ottawa, Ont., where he began as a lumber camp chore boy at the age of 13 and rose to be foreman of a camp at 22. His own first logging venture in 1872 failed during the depression of 1873, but a second in 1876 became

successful. He moved his operations to Marquette, Mich., in 1882, and then in 1888, the year he became a naturalized U.S. citizen, to San Francisco, Calif. Because it was difficult to get shipping, he bought his first steam schooner in 1892, and built up his fleet when the Alaskan gold rush created a demand for charter boats. In 1901 he entered the China and Japan trade. He became an esteemed unofficial adviser to the Chinese. He was in China when the empire fell and the republic was founded in 1911–12, and he recommended U.S. recognition. He gave more than $1,000,000 to build churches, schools and Y.M.C.A. buildings in China. During World War I he secured a U.S. shipbuilding contract for the Chinese government, built the ships and purchased them from the U.S. after the war. He also bought nine troop transports in 1923 and established the first regularly scheduled round-the-world cruise service. He wrote *Memoirs*, 4 vol. (1917–28), and *One Hundred and Thirty Years of Steam Navigation* (1931). He died at San Rafael, Calif., on May 16, 1932.

DOLLAR, a small burgh of Clackmannanshire, Scot., lies 13 mi. E.N.E. of Stirling by road at the foot of the Ochil hills. Pop. (1961) 1,955. The fine buildings of the well-known academy founded by John McNabb date from 1818. Castle Campbell, a stronghold of the Argylls from the late 15th century, stands in the romantic Dollar glen, 1 mi. N.

DOLLAR, originally a silver coin that circulated in many European countries, and in the 20th century the standard monetary unit in the United States, Canada and certain other countries. The Spanish peso, or piece of eight, which circulated in the Spanish-American and English colonies, was known as a dollar by the English-speaking peoples, although the term does not seem to have been in use among the Spanish-speaking peoples. Familiarity during colonial times with this coin resulted in the official designation of the United States monetary unit as the dollar. In 1782 Gouverneur Morris (*q.v.*) made a report to this effect to the congress under the Articles of Confederation. The dollar was established as the nation's monetary unit by the Coinage act of April 2, 1792. Other countries also chose the dollar but their monetary units are not identical with the U.S. dollar. Canada adopted the decimal system of coinage in 1858 with the dollar as the unit of account. As monetary arrangements differ from country to country and change from time to time, "dollar" has a wide range of meanings.

The word itself is a modified form of the Germanic word "thaler," a shortened form of "Joachimst(h)aler," a 16th-century silver coin intended to be the equivalent of the gulden, a gold coin. The Joachimst(h)aler was first struck in 1519 under the direction of the Count of Schlick, who had appropriated a rich silver mine discovered in St. Joachimsthal (Joachim's dale), Bohemia. The coin bore an effigy of St. Joachim. It was also known as the "Schlickenthaler." Many of these coins were struck and they were current in Germany from the 16th century onward. Thaler as a name for a silver coin became general, with various modifications such as daler, dalar, daalder, tallero, etc. Only in 1873 was "thaler" replaced by "mark" as the name of the German monetary unit.

The United States dollar (symbolized $) was defined in the Coinage act of 1792 as either 24.75 gr. (troy) of fine gold or 371.25 gr. (troy) of fine silver. Provision was made for a one dollar silver coin with a bullion content slightly less than that of the Spanish dollar, or peso, as well as for small denomination silver coins and for $2.50, $5.00 and $10.00 gold coins. Thus, from the outset the United States dollar was not simply a silver coin. Rather, the dollar was the unit of account and was given physical embodiments in both gold and silver coins of various denominations. The first actual coinage occurred in 1794. The silver dollar continued in use, but after 1873, when the United States abandoned bimetallism (*q.v.*) in favour of the gold standard, it had the status of a token coin; *i.e.*, a coin worth more as money than as metal. In 1853 small denomination coins had become tokens.

In the U.S. monetary system "dollar" is used in several senses. By law it is the name of the unit of account. A dollar also is a legally specified weight of gold: from 1934, $15\frac{5}{21}$ gr. (troy), .9 fine. As such, it does not circulate. Day-to-day money payments are made with coins, with various types of paper money and with checks drawn against bank deposits. As a unit of account the dollar provides the means by which values are expressed. It is in dollars that prices are quoted, accounts kept, debts contracted and calculations of incomes and costs performed.

Fundamentally the purpose of connecting the dollar to gold is to assure that the buying power of the dollar relative to that of other currencies will remain reasonably stable. Economic distress results when prices in general rise or fall rapidly, or, in other words, when the value of money decreases or increases. On many occasions money that was not effectively linked to gold depreciated seriously. The United States had such an experience during the American Civil War. Germany in 1923, Hungary in 1945 and China in 1949 provide further examples. However, some nations, notably Sweden in the 1930s, demonstrated that an irredeemable paper currency may retain stability in its value. Moreover, when costs are inflexible downward, a nation suffering from pressure on its exchange rate may be able to maintain a higher level of production and employment by way of depreciation of an irredeemable paper currency than by following a policy of monetary contraction with a redeemable currency rigidly tied to gold.

Throughout U.S. history the dollar has been defined in terms of gold (and silver also prior to 1873). Except during the period from 1861 to 1879, and again from 1933 to 1934, this definition has been meaningful. Prior to March 6, 1933, free coinage of gold together with redemption of paper money in gold coin accomplished this. Beginning on Jan. 31, 1934, government purchase and sale of gold in uncoined form at a fixed price served the same purpose. The practical effect of either of these arrangements is that a dollar of circulating money is kept at the same value as the physical quantity of gold specified as constituting a dollar. Of necessity, if circulating money does not itself consist of full weight gold coins, a limit must be placed on the number of circulating dollars which may be created. Otherwise, equivalence cannot be maintained. A system of reserve requirements ultimately based on the nation's stock of gold bars serves to fix an upper limit to the circulating medium. Purchase and sale of gold connect circulating dollars to the gold dollar.

A relatively small number of gold dollar coins was struck, beginning in 1849, but their minute size made their circulation impractical. This coin contained 25.8 gr. (troy), .9 fine gold, which was the gold dollar's weight from 1837 to 1934. On Jan. 31, 1934, the gold in the dollar was reduced to $15\frac{5}{21}$ gr. (troy), .9 fine. In other words, the official price of an ounce of fine gold was increased from $20.66 to $35.00, or, the value of the dollar was reduced from approximately $\frac{1}{21}$ to $\frac{1}{35}$ of an ounce of fine gold. The action was formally taken by means of a presidential executive order issued under terms of the Gold Reserve act of 1934. Until June 30, 1943, further reduction (as well as a slight increase) was permissible, but no further change was made. Also, during 1933–34, gold coins were removed from circulation, title to all monetary gold passed to the government, coins and paper money became full legal tender and gold certificates were called in.

Devaluation (reduction of the gold content of the dollar) was motivated by the desire to raise the price level, which had fallen by March 1933 to approximately half its 1929 level. To the disappointment of those who advocated this step, prices generally did not rise as forecast. Not until early in World War II was the price level restored to the 1929 level. It continued to climb thereafter and at mid-century the U.S. cost of living was roughly twice as high as in 1933.

U.S. experience demonstrated that the gold content of the dollar is not the determining factor governing the purchasing power of the dollar. From 1879 to 1933 prices repeatedly moved upward and downward through a wide range despite constancy in the gold content of the dollar. The rise in prices after 1933 was not simply the resultant of devaluation, but of a host of other factors, many of which outweighed that particular factor.

Many students of money have recommended that the linking of the dollar to gold be retained even if price level stability is not achieved simply and automatically by doing so. They hold that international monetary relationships are more stable when currencies have a gold basis and also that it is desirable to impose an upper limit through gold reserve requirements on the volume of

circulating money. They believe, however, that price level stability would be achieved only by skilful central bank management within a broad framework of measures designed to promote economic stability.

Others have recommended elimination of the linking of the dollar to a fixed quantity of gold. Irving Fisher (1867–1947), the leading advocate of dollar stabilization, in 1913 proposed a compensated dollar whose gold content would be varied directly with the price level. Later Fisher advocated credit control measures aimed at maintaining stability in a selected index number of prices. His general proposals for dollar stabilization gained many adherents, although on matters of detail there was substantial controversy. Almost everyone agrees that stability in the dollar's buying power, if realized, would contribute greatly to economic stability.

In the 1950s the U.S. dollar became the international currency, for more and more countries increased their holdings of dollars as a form of exchange reserve. This development, coupled with the fact that the U.S. balance of payments had turned from surplus to deficit, ushered in a new era. In order to provide essential military and economic assistance, and to maintain effective political and financial leadership in the western world, it became ever more important that the external value of the dollar be held stable and its competitive buying power be maintained. *See* also INTERNATIONAL PAYMENTS. (E. C. Ss.; Jo. M. L.)

DOLLAR AREA, a term applied to the region comprising the United States, Canada and the dollar countries of Latin America. Comparable foreign-exchange areas in other parts of the world are the sterling area, including the United Kingdom and most of the commonwealth countries, and the ruble area, including the Soviet Union, Poland and other communist countries. *See* EXPORTS.

DOLLFUSS, ENGELBERT (1892–1934), Austrian statesman, prime minister from 1932 to 1934, was born at Kirnberg an der Mank in Lower Austria, on Oct. 4, 1892. At Vienna and Berlin in 1919–20 he completed his studies in law and economics. He became secretary of the Peasant federation of Lower Austria and, in 1927, director of the Lower Austrian chamber of agriculture. The Social Christian party delegated him to the commission of the Austrian federal railways whose president he was during 1930. From March 1931 he served as minister for agriculture and forests in the cabinets of Otto Ender and Karl Buresch. On May 20, 1932, he became prime minister. His cabinet included Social Christians, Land Unionists and members of the Home Bloc; it had a majority in the *Nationalrat* and was in a minority in the *Bundesrat* (the upper chamber). In July 1932 the League of Nations granted Austria a loan of nearly £9,000,000, in consideration of which Dollfuss undertook to forgo customs union between Austria and Germany for 20 years. For this the nationalists and Social Democrats unleashed a violent political campaign against him. A formal error in voting procedure in the *Nationalrat* on March 4, 1933, enabled Dollfuss to immobilize his opponents. From then on he became increasingly authoritarian, aiming at domestic peace and freedom from external involvements. In May 1933 he founded the Patriotic Front (*Vaterländische Front*) which, he intended, should gradually replace the political parties. In foreign affairs, Dollfuss enlisted Italy's support against Nazi Germany. At Riccione in Aug. 1933, Mussolini guaranteed Austrian independence, but demanded the abolition of all political parties and a constitutional reform on the Fascist model. In Feb. 1934 fighting broke out in the streets of Vienna between the Socialist and government forces; in the sequel the Social Democratic party was dissolved. On May 1, 1934, Dollfuss proclaimed a new constitution influenced by the papal encyclical *Quadragesimo anno* and based on a system of professional estates. The regime became completely authoritarian. From May 1934 not only did domestic conditions worsen but also the pressure from Germany increased. Dollfuss decided to move against the Nazis; terror and counter-terror amounted to near civil war. On July 25, 1934, Dollfuss was shot during a Nazi raid on the chancellery.

Dollfuss' political views were influenced by Christian Socialist theory, especially the work of K. von Vogelsang. It was characteristic that he attempted to realize in practice the ideas of the *Quadragesimo anno;* but he failed to see that one cannot set up Christian estates in the modern state when estates and a Christian outlook are both lacking. Domestic and foreign difficulties made him compromise with political forces which ultimately he could not control. His connection with the *Heimwehr* (merged with the *Vaterländische Front* in 1934) and the demands of Mussolini drove him to policies which ended in dictatorship. Moreover, he never understood that authority needs to be based on legality: in fighting his political opponents he ignored constitutional principles and so destroyed the base for a sound political development.

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(H. PF.)

DÖLLINGER, JOHANN JOSEF IGNAZ VON (1799–1890), church historian and one of the leading German Catholic theologians who refused to accept the decree of papal infallibility in 1870 and joined the Old Catholics (*q.v.*), was born at Bamberg, Feb. 28, 1799, and ordained in 1822. After teaching church history at Aschaffenburg, where he published his first work, he became professor of canon law and church history at Munich (1826). As a liberal in politics and theology, he was associated with the French Catholic philosopher Félicité de Lamennais and with Gladstone. From 1835 he was a member of the Bavarian Royal Academy of Sciences (president from 1873). He represented his university in the second chamber of the Bavarian *Landtag* and in the Frankfurt national assembly (1848). Though he lost his professorship in 1847, he was given posts that made him second to the archbishop of Munich in the archdiocese, and he was reappointed professor of church history (1849). His historical researches and his belief in freedom of religion brought him into strong opposition to the policy of Pius IX; he disliked the dogma of the immaculate conception (defined 1854), and some of his ideas were condemned by the *Syllabus errorum* issued by the pope in 1864. His opposition to the Ultramontanes (whom his earlier work, *Kirche und Kirchen,* 1861, had supported), unlike that of the French group led by Bishop Félix Dupanloup, was based on modern historical criticism; he was regarded by his contemporaries as one of the greatest historical scholars in Europe. In 1842 he wrote to E. B. Pusey, sympathizing with the Tractarians. When Pius IX proposed to summon a council to define papal infallibility (*see* COUNCIL; VATICAN COUNCILS), Döllinger became recognized as the leader of the opposition in Germany. In 1869 he wrote a series of articles in the *Augsburger Allgemeine Zeitung,* later enlarged, with the help of J. N. Huber, and published as *Der Papst und das Konzil* under the pen name Janus (Eng. trans. 1869). This book was called by W. B. Ullathorne "the greatest and severest attack on the Holy See and the Jesuits, and especially on the policy of Rome, for a thousand years," and Dom Cuthbert Butler (in *The Vatican Council,* 1930) thought it perhaps the most damaging onslaught on the popes ever made. In this book Döllinger showed dislike for the Council of Trent and declared that the decrees of a general council are binding only by subsequent consent of the church. It was placed on the Index of Forbidden Books (1869). After the Vatican council and the definition of the dogma of papal infallibility (1870), Döllinger, who seems to have exaggerated the probable effect of the council on civil affairs, wrote (March 29, 1871) to the archbishop of Munich, "As a Christian, as a theologian, as a historian, as a citizen, I cannot accept this doctrine." He was placed under the greater excommunication (which forbade the faithful to have any dealings with him) and remained under it till his death. He was nevertheless elected rector of Munich university almost unanimously (1871).

The dogmas of the Vatican council, which Döllinger and his friends felt bound to accept, were the infallibility and universal ordinary jurisdiction of the pope; the latter, which is often forgotten, is in practice the more important of the two. These dogmas were to be accepted as having been always the teaching of the church, and the opposition to them was led by professors who had studied the teaching of the church in former ages. Those who were

excommunicated for refusing these dogmas could not be married or buried with the rites of the church, nor could they prevent their children from being taught in school, in Catholic Bavaria, the doctrines which they held to be untrue.

In May 1871 their leaders met at Döllinger's house and decided to organize a congress. Meeting on Sept. 22 in Munich, it was attended by a total of 300 Old Catholics (Altkatholiken) and Eastern Orthodox, Anglican and Lutheran sympathizers. A committee, of which Döllinger was a member, drew up a doctrinal basis and a program for separate organization. Döllinger at first opposed this program, but later associated himself fully with it. That he was definitely an Old Catholic, which has been doubted, is proved by his letter to Pfarrer J. Widmann, Oct. 18, 1874: "I reckon myself as belonging by conviction to the Old Catholic communion, and I believe that it has a higher vocation given to it to fulfil, and that threefold" (protest against the Vatican dogmas, the example of a Catholic church free from error, and the reunion of Christendom). He remained on the list of Old Catholic priests until his death (except between 1878 and 1883, when he removed his name for a time because he did not agree with the permission of clerical marriage). But since the Bavarian government, unlike other German and Swiss governments, did not recognize the Old Catholic confession, he was in a difficult position.

In 1874 Döllinger presided over an international conference of theologians at Bonn, met to discuss reunion between the Old Catholics and the Anglican and Orthodox churches. A basis of agreement between the Anglicans and Old Catholics, on 14 points, very similar to the later Declaration of Utrecht (1889), was carried with but little opposition. Döllinger declared that he and his colleagues did not feel themselves bound by all the decrees of the Council of Trent, and he spoke in defense of Anglican ordinations. He strongly rejected, even as an opinion, the immaculate conception of the Blessed Virgin Mary.

A second conference was held in 1875 at which Döllinger again presided. It was entirely occupied with the *Filioque* clause in the Nicene Creed, and drew up an agreed statement on the subject, which was accepted by both the Orthodox and the Anglicans who were present. In his last years Döllinger and his friend F. H. Reusch collaborated to write *Moralstreitkeiten in der römisch-katholischen Kirche,* 2 vol. (1889), and other works. Döllinger died in Munich on Jan. 10, 1890, after receiving the last sacrament from the Old Catholic priest Johann Friedrich.

Bibliography.—J. Friedrich, *Ignaz von Döllinger,* 3 vol. (1899–1901); J. F. Schulte, *Das Altkatholicismus* (1887); C. B. Moss, *The Old Catholic Movement* (1948). (C. B. Mo.)

DOLLOND, JOHN (1706–1761), English manufacturer of optical equipment, developed achromatic lenses. He was the son of a Huguenot refugee, a silk weaver at Spitalfields, London, where he was born on June 10, 1706. He followed his father's trade, but found time to acquire a knowledge of Latin, Greek, mathematics, physics, anatomy and other subjects. In 1752 he abandoned silk weaving and joined his eldest son, Peter Dollond (1730–1820), who in 1750 had started in business as a maker of optical instruments. His reputation grew rapidly, and in 1761 he was appointed optician to the king. In 1758 he published an "Account of some experiments concerning the different refrangibility of light" (*Phil. Trans.,* 1758), describing the experiments that led him to the discovery of a means of constructing achromatic lenses by the combination of crown and flint glasses. Following the suggestion of Leonhard Euler and the experiments of Samuel Klingenstjerna (1698–1765) Dollond commenced a series of tests on achromatism. Early in 1757 he succeeded in producing refraction without colour by the aid of glass and water lenses, and a few months later he obtained the same result by a combination of glasses of different refrangibilities (*see* Telescope: *Achromatic Telescopes*). Dollond also published two papers on apparatus for measuring small angles (*Phil. Trans.,* 1753, 1754). He was made a fellow of the Royal society early in 1761 and died Nov. 30 of the same year.

DOLMAN, originally a loose outer garment with tight sleeves and open in front, worn by the Turks. The name was also given to the uniform jacket of the Hussars (*q.v.*) which was worn like a cloak with the sleeves hanging. In western European costume the term dolman came to mean a woman's cloak with capelike pieces over the arms instead of sleeves; in modern usage it is applied to a sleeve which is cut to fit a large armhole, so that a dolman sleeve gives the garment a capelike appearance. (M. B. K.)

DOLMEN, the term used for a certain type of prehistoric monument, which usually consists of several great stone slabs set edgewise in the earth to support a flat stone which serves as a roof. The structure was designed as a burial chamber and is typical of the Neolithic period in Europe. The word is Celtic in origin but probably is not Breton; the Welsh equivalent of the word is *cromlech.* Dolmens, although found in covered form as far east as Japan are mainly confined to Europe and northern Africa. There are many examples in the British Isles. *See* also Barrow.

DOLMETSCH, ARNOLD (1858–1940), French-Swiss musician, subsequently acquiring British nationality, a leading pioneer of the recovery of early instrumental music in modern times, was born at Le Mans, France, on Feb. 24, 1858. Dolmetsch's craftsmanship in restoring and making reproductions of early musical instruments, his insistence on source material coupled with an intuitive understanding gave him a remarkable insight into the problems of presenting the music of Bach's generation and earlier in a style of performance forgotten over the breach of at least a century. Since his principles have been so widely accepted, it is difficult to realize how profoundly musicians are indebted to his single-minded genius for the reforms at which he worked in the face of prolonged indifference and misunderstanding.

Dolmetsch studied at the Brussels conservatory and later at the Royal College of Music in London. He was in charge of a department making reproductions of early musical instruments at the Chickering factory in Boston, Mass., from 1905 to 1909 and at the Gaveau factory in Paris from 1911 to 1914. In London he attracted the attention of George Bernard Shaw, who reviewed his concerts with sympathy and enthusiasm. Like Shaw, Dolmetsch was a rebel, a reformer who aroused a response of mingled alarm and fascination. From 1914, however, when he resettled in England, his work met with gradually increasing acceptance; his book, *The Interpretation of the Music of the XVII and XVIII Centuries* (1915 and 1940), confirmed his international reputation. In 1928 the Dolmetsch foundation was organized to support him and to assist in the spread of his ideas. Dolmetsch died in Haslemere, Surrey, Feb. 28, 1940.

See Mabel Dolmetsch, *Personal Recollections of Arnold Dolmetsch* (1958); R. Donington, *The Work and Ideas of Arnold Dolmetsch* (1932). (R. Do.)

DOLOMIEU, DIEUDONNÉ SYLVAIN GUY TANCRÈDE DE GRATET DE (also known as Déodat Dolomieu) (1750–1801), French geologist and mineralogist after whom the mineral dolomite was named, was born at Dolomieu, near Tour-du-Pin, Isère, on June 23, 1750, the second son of François de Gratet, marquis de Dolomieu. He was admitted in his infancy a member of the order of Malta. In his 19th year he killed a brother knight in a duel and was condemned to death, but in consideration of his youth was pardoned after nine months' imprisonment, which he spent in the study of natural sciences. He continued his studies and later gave up his commission in the carabineers and visited Spain, Sicily, the Pyrenees and Calabria, the scientific results being given in a series of important works, including *Mémoire sur les tremblemens de terre de la Calèbre pendant l'année 1783* (1784). In 1789 and 1790 he studied the Alps and described the mineral dolomite in 1791. In 1798 he accompanied Bonaparte's expedition to Egypt. On the way home he was captured and imprisoned at Messina in a pestilential dungeon. Deprived of writing materials, he made a pen from a piece of wood and, with the smoke of a lamp for ink, he wrote his treatise, *Sur la philosophie minéralogique et sur l'espèce minérale* (1801), on the margins of a Bible, the only book he still possessed. Released after the battle of Marengo (1800), he died at Château-Neuf, Saône-et-Loire, on Nov. 26, 1801.

See A. Lacroix (ed.), *Déodat Dolomieu,* 2 vol. (1921).

DOLOMITE, a name applied both to a mineral composed of calcium and magnesium carbonate, and to a rock containing the

mineral as principal constituent. The name, originally *dolomie* (N. T. de Saussare, 1792), is in honour of the French geologist D. G. Dolomieu. The rock is known commercially as dolomitic or magnesian limestone and is used as a source of magnesia, as a refractory and as building stone. For discussion of uses *see* LIMESTONE.

The mineral is a rhombohedral carbonate with a hardness of 3.5–4, varying with direction, and a specific gravity of 2.85 for the pure compound. The rhombohedron, parallel to the faces of which there are perfect cleavages, is frequently the only form present on dolomite crystals, and these crystals often have curved faces and are saddle-shaped.

The calcium and magnesium ions in dolomite have been shown by X-ray diffraction studies to be segregated into separate planes. This arrangement reduces the symmetry relative to that of calcite, and defines dolomite as a separate compound rather than a magnesian calcite solid solution. There may be extensive substitution of ferrous iron, and to a lesser extent of bivalent manganese, in the magnesium positions, giving rise to a variety called ankerite. The dolomite in sedimentary rocks may contain up to 5 mol. per cent $CaCO_3$ in excess of that required by the formula, $CaMg(CO_3)_2$.

Dolomite is found extensively in marbles as well as in talc schists and other magnesium-rich metamorphic rocks. At least some of this dolomite has been shown by textural studies to have formed on cooling from highly magnesian calcite stable at higher temperatures. In high-grade thermal metamorphism, dolomite may dissociate into a mixture of calcite and periclase, which may later alter to brucite and hydromagnesite, and siliceous dolomitic rocks may yield diopside and other magnesium silicates. Dolomite occurs in hydrothermal veins associated with fluorite, barite, calcite, siderite, quartz and various metallic ores, in cavities in carbonate rocks and less commonly as a cement in various sedimentary rocks.

The most important occurrence of dolomite is as a rock-forming mineral in carbonate rocks. In dolomitized limestones, individual dolomite crystals cut across pre-existing fossil outlines and other textural features, and thus in these rocks the mineral is a secondary replacement. Fossil coral reefs are often replaced in this fashion. The thin beds of dolomite, virtually free of fossil remains, which are found associated with beds of anhydrite and halite have been considered to be chemical precipitates. No organisms are known to secrete dolomite. Ankerite, like siderite (*q.v.*), is common in rocks associated with coal beds and shales containing organic matter.

The exact manner of formation of dolomite in sedimentary rocks has been a puzzle for more than 150 years, because it has not been possible to synthesize the mineral under conditions comparable with those prevailing at the earth's surface, and because no present-day dolomite formation in nature was known. Finally in 1957 imperfectly crystallized dolomite was observed forming in South Australia, in ephemeral lakes which were from one-tenth to one-half as saline as sea water, in the vicinity of water plants where pH (alkalinity) was higher than elsewhere.

Among the famous occurrences of dolomite crystals are the Binnental near Brieg, Switz.; Joplin, Mo.; Traversella, Piedmont, Italy; Alston, Cumberland, Eng.; Teruel, Spain; and Brumada, Bahia, Braz.

See also references under "Dolomite" in the Index volume.

(D. L. G.)

DOLOMITES (Ital. ALPI DOLOMITICHE), a mountain group lying in the eastern section of the north Italian Alps, bounded by the valleys of the Isarco in the northwest, the Pusteria in the north, the Piave in the east and southeast and the Avisio in the southwest. It comprises a number of impressive peaks, 18 of which rise to over 10,000 ft. The highest point is the Marmolada (10,964 ft.) whose southern face consists of a precipice 2,000 ft. high. Geologically, the mountains are formed of highly jointed, light-coloured dolomitic limestone, principally of Upper Triassic age. In contrast to other parts of the Alps, the Dolomites have been less violently affected by earth movements; thus the structure is simpler and some plateaus of almost horizontal strata occur. Elsewhere, various forms of erosion have carved the limestone into grotesque shapes; the resulting land forms include jagged, saw-edged ridges, rocky pinnacles, deep gorges, screes of limestone debris and numerous steep rock faces at relatively low levels. Much of the peculiar character of the land forms is related to the permeability of the rock and the resultant absence of surface drainage except in the main valleys. Glaciated features occur at higher levels; 41 glaciers lie in the region. Many of the lower and more gentle scree slopes were once forested; however, only patches of woodland remain, interspersed with grassy meadows. Most of the main peaks were first climbed in the 1860s and '70s by English mountaineers.

The main valleys provide relatively easy access to most parts of the Dolomites. The three main north-south roads use saddles which represent outcrops of softer rocks—Campolongo (6,151 ft.), Cimabanche (5,065 ft.) and Misurina (5,761 ft.). The east-west roads cross the well-known passes of Pordoi (7,346 ft.), Falzarego (6,913 ft.), Tre Croci (5,932 ft.), Sella (7,264 ft.) and Gardena (6,959 ft.). The principal route and tourist centre is Cortina d'Ampezzo (elevation 3,983 ft.), which lies also on a north-south railway. Other resorts are Auronzo, San Martino di Castrozza and Ortisei with its narrow-gauge railway. On the western and southeastern margins, respectively, are located the larger towns of Bolzano and Belluno.

Less extensive areas of dolomitic limestone are to be found in other parts of the Alps. Dauphiné (the home of the geologist D. G. Dolomieu) contains several such areas southwest of Grenoble, all with the characteristic scenery associated with this type of rock. Similar dolomite groups occur in Switzerland (*e.g.*, southwest of Bergün and north of Splügen). (C. EM.)

DOLORES, GRITO DE, the "Cry of Dolores" uttered by Father Miguel Hidalgo y Costilla on Sept. 16, 1810, and generally regarded as the beginning of the Mexican independence movement. Hidalgo, the curate of the parish of Dolores in central Mexico, was involved in a conspiracy against the Spanish government and, when the plot was betrayed, he decided to act immediately. Summoning his parishioners, he cried "Long live America! Long live independence! Death to bad government!" The uprising was premature and Hidalgo was executed but his words lived on. In commemoration, each year on Sept. 16, the president of Mexico shouts them from the balcony of the national palace. *See* also MEXICO: *Colonial Period (1519–1821).* (L. N. MCA.)

DOLORES RIVER. Rising in La Plata mountains in southwestern Colorado, the Dolores river flows through deep canyons until it is met by its chief tributary, the San Miguel river, near the Utah border. Then it flows through Paradox valley northwestward to enter the Colorado river above Moab, Utah.

Melting snow causes a flood flow in spring and early summer, but by midsummer the flow is a trickle. The Dolores and its tributaries irrigate about 60,000 ac. The river probably was named Rio de Nuestra Senora de los Dolores by a Spanish trader named Rivera in 1765. (C. N. C.)

DOLPHIN. The name "dolphin" is often confusing, since it is applied to both an aquatic mammal and a fish. Both kinds of dolphin are known in classical literature, appearing as heraldic figures.

The Mammalian Dolphin.—Several species of whale of the family Delphinidae, especially *Delphinus delphis*, are called dolphin. They are among the many types of the smaller toothed whales, suborder Odontoceti. Dolphins are edible; they inhabit seas and large rivers and rarely exceed 11 ft. in length. They feed chiefly on fish and are mostly gregarious. They show great agility and grace in the water, and often play around ships. The common dolphin of the Mediterranean and Atlantic measures about six to eight feet in length, with a back fin of nine or ten inches. The forehead descends abruptly to the base of the flattened beak, which is about six inches long. The sharp teeth number about 160 to 200 in all. The eyes are of moderate size, the ear aperture is minute and the blowhole crescentic. Dolphins are black above, white below. The female brings forth a single young and is a devoted parent. The bottle-nosed dolphin, *Tursiops* species, has a shorter and more upturned beak.

BY COURTESY OF MIAMI SEAQUARIUM

BOTTLE-NOSED DOLPHINS (TURSIOPS TRUNCATUS) LEAPING FOR FISH IN AN OUTDOOR AQUARIUM

The dolphin has been a well-known animal since ancient times to all who know the sea. It has become more widely familiar to the American public through the popular outdoor aquariums of Florida and California, in which dolphins prove to be astonishingly adaptable, remarkably intelligent entertainers. Because of their intelligence and their ability to communicate with one another through a range of distinct sounds (they also produce supersonic pulses), dolphins have become the object of serious scientific experimentation. The term "porpoise" is often mistakenly applied to dolphins, but correctly refers to similar looking whales of a different family, the Phocaenidae, especially to the genus *Phocaena* (*see* PORPOISE). (*See* also WHALE.)

The Fish Dolphin.—This large oceanic fish, called also dorado, is *Coryphaena hippurus*. Along with the very similar pompano dolphin, *C. equiselis*, it constitutes the family Coryphaenidae. *Coryphaena hippurus*, which has a characteristic shape, tapering from the large head to the slender and deeply forked tail, reaches a length of about six feet. This fish is famous for the rapid changes undergone by its brilliant gold and blue coloration as it dies. It is valued for food. *See* also FISH. (K. P. S.; X.)

DOMAGK, GERHARD (1895–1964), German pathologist and bacteriologist, who was awarded the 1939 Nobel prize for physiology and medicine for his discovery of the antibacterial effects of Prontosil, the first of the sulfonamide drugs. He was born at Lagow, Brandenburg, on Oct. 30, 1895. His studies at the University of Kiel were interrupted by World War I, after which he graduated in medicine in 1921. In 1924 he became a *Privatdocent* at the University of Greifswald. In the following year he received an appointment in the Pathological institute at Münster, where in 1928 he was appointed titular professor of general pathology and pathological anatomy. In 1927 he had accepted a research appointment as director of the I. G. Farbenindustrie (Bayer) laboratory for experimental pathology and bacteriology at Wuppertal-Elberfeld. In the course of a systematic search for new dyes undertaken by Domagk's chemical colleagues Fritz Mietzsch and Joseph Klarer, a number of new azo compounds were synthesized, and the therapeutic properties of these were investigated by Domagk. In 1932 Domagk noticed that one of the dyes containing a sulfonamide group exerted a definite effect on infections in the mouse. This dye, known as Prontosil red, was tried out in clinical practice, and it was successfully used by Domagk himself in treating his own daughter, who had acquired a serious streptococcal infection after being pricked by a needle. Domagk's first published report on the drug's extraordinary powers appeared in 1932 and inaugurated the chemotherapeutic era in medicine.

Following Domagk's acknowledgement of the Nobel award in Oct. 1939, a letter reached the Nobel committee in Stockholm, Swed., in which he declined the prize. It was subsequently revealed that he had signed the second letter under duress when he was in the hands of the Gestapo. In 1947 he visited Stockholm, delivered his Nobel lecture and received the gold medal and diploma, but the prize money had by that time reverted to the Nobel foundation. In addition to his work on the treatment of acute infections, Domagk carried out much research on tuberculosis and cancer. He died in Burgberg, Ger., on April 24, 1964.

(W. J. Bp.)

DOMBES, a historic region of east-southeastern France, once a sovereign principality, bounded on the southwest by Lyonnais, on the west by the Saône river (separating it from Beaujolais), on the north by Bresse, on the east by the Ain river (separating it from Bugey) and on the south by the Rhône (separating it from Dauphiné). It is now included in the *département* of Ain (*q.v.*).

From 1032, when the kingdom of Arles (*q.v.*), of which Dombes was part, passed to the Holy Roman emperor Conrad II, effective authority in the region was exercised by local lords. The seigneurs de Baugé controlled the north, the sires de Villars the south. The north, however, passed to the seigneurs de Beaujeu through the marriage of Marguerite de Baugé and Humbert V de Beaujeu (1218) and thence to Louis II, duc de Bourbon, when he acquired Beaujeu (1400). Louis then bought the south (1402) from the sires de Thoire, who had succeeded the sires de Villars. While French royal authority over the kingdom of Arles depended only on the imperial vicariate (granted in 1378), the Bourbons were now able to form Dombes into a sovereign principality, with its capital at Trévoux.

Seized by Francis I of France after the treason of the constable Charles, duc de Bourbon, in 1523, the principality was restored to the house of Bourbon-Montpensier in 1561. The last heiress of this house, Anne Marie Louise d'Orléans, duchesse de Montpensier (*q.v.*), ceded the principality in 1681, as part of the price for the release of her beloved Lauzun, to Louis XIV's natural son, Louis Auguste, duc du Maine, whose son Louis Charles, comte d'Eu, transferred it to the French crown in 1762.

The sovereign council for Dombes, established by Francis I at Lyons, became a *parlement*. Transferred to Trévoux by the duc du Maine in 1696, it was finally merged in the *parlement* of Burgundy.

Trappist monks, settled in the region under Napoleon III, were largely responsible for draining the unhealthy marshes on the plateau, after which the population was increased by the overflow from Lyons. The principal industry of the region is dairy-farming.

DOMBROWSKI (DĄBROWSKI), **JAN HENRYK** (1755–1818), Polish general, was born at Pierzchowiec, near Bochnia, on Aug. 29, 1755. After service in the Saxon army (1772–92) he joined the Polish. In 1794 he distinguished himself under Tadeusz Kosciuszko in the defense of Warsaw and then led a separate raid against the Prussians in Poznania. After the third partition of Poland (1795) he left for Paris and obtained from the Directory (Oct. 10, 1796) permission to form a Polish legion in Italy. This was approved on Jan. 9, 1797, by the Cisalpine republic. In command of his legion he played an important part in the war in Italy, entered Rome on May 3, 1798, and distinguished himself at the Trebbia (June 17–19, 1799), where his legion suffered great losses fighting against the Russians (*see* FRENCH REVOLUTIONARY WARS). After the peace of Amiens he passed, as general of division, into the service of the Italian republic. Summoned by Napoleon on Oct. 5, 1806, to promote a rising in Poland, he arrived at Poznan on Nov. 6. By the end of the year he had organized seven Polish units and in 1807 he distinguished himself at Danzig and Friedland. In 1809 he served in the Polish campaign in Galicia and in 1812 he commanded one of the Polish divisions of the Grande Armée for the invasion of Russia, being wounded at the passage of the Berezina. He fought at the battle of Leipzig in 1813 and returned to Poland in 1814. He was one of the generals entrusted by the Russian emperor with the reorganization of the Polish army and was made in 1815 general of cavalry and senator of the new kingdom of Poland.

Dombrowski died at his seat of Winnogora, in the province of Poznan, on June 6, 1818.

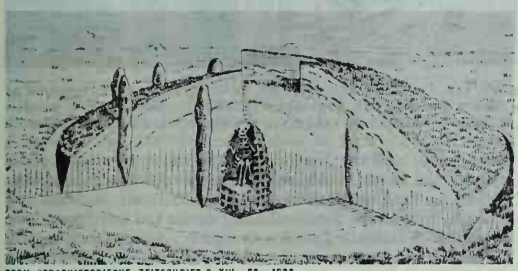
See L. Chodźko, *Histoire des légions polonaises en Italie*, vol. i–ii (1829); A. M. Skałkowski, *Jan Henryk Dąbrowski* (1904).

(St. He.)

DOME, in architecture, an ovoidal or hemispherical vault; or, a vault of polygonal plan that approaches the round dome in shape. (*See* ARCH AND VAULT.) The term has been current in this sense since the 18th century. It derived from the Latin *domus*, "revered house" or "sanctuary" (as did the cognate German *Dom* and Italian *duomo*, "cathedral"), and as late as the 17th century it was applied to guild houses, state houses and the like. This change in meaning is significant, reflecting the gradual loss of what was once a very rich symbolism attached to the domical form. Historically, there are two distinct aspects to the development of the dome: the evolution of symbolic ideas associated with its shape, and the progressive solution in different materials of the problems of roofing a large space without inner supports.

DOMICAL SYMBOLISM

In many primitive societies, the earliest and most prevalent type of constructed shelter, such as the tent, pit house, earth lodge or thatched hut, was more or less circular in plan, and covered with a curved roof of generally domical shape. To this round house type there accrued a wide variety of symbolic associations. An early one was with the death-and-rebirth cycle in nature; fertility rites were conducted in or near the round house in which grain was stored. As a result of the custom of burying the dead in their own houses and conducting propitiatory rites there, the domical shape became associated with tombs, the underworld and the cult of the dead. Very early, too, it acquired celestial significance, becoming, because of its resemblance to the supposed



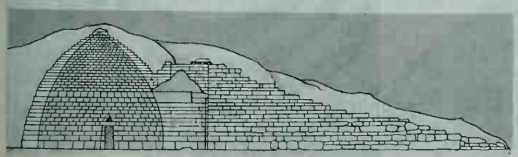
FROM "PRAEHISTORISCHE ZEITSCHRIFT," XIV, 52, 1922

FIG. 1.—DOMICAL NEOLITHIC BURIAL MOUND, THE NETHERLANDS

shape of the sky, a symbol of cosmic forces (the "dome of Heaven") and, by extension, of power generally.

As early civilizations developed, many of them perpetuated the revered domical shape in tombs, temples, shrines or palaces long after their ordinary architecture had become rectangular, with flat roofs or gables. From Shang through Han times in China, the usual tomb was a circular mound, deliberately made to imitate the matted effect of archaic domed house tents. In India, the domed sepulchral stupa (*q.v.*) was venerated long before it became a sacred form of Buddhist architecture. In late Stone Age Europe, tomb barrows often contained actual thatched huts, round and domical, as burial chambers. Stonehenge on Salisbury plain has been interpreted as the surviving core of a huge mound which reproduced on great scale and with cosmic references a revered round house type. In Greco-Roman civilization, the dome occurred often as a tomb form; *e.g.*, the Treasury (tomb) of Atreus at Mycenae (*c.* 1200 B.C.); the tholos (*q.v.*) of Greece, where it symbolized the ideas of death and rebirth in the Greek mystery rites, and the imperial tumuli of Augustus and Hadrian. The dome had celestial significance in round temples, like the Pantheon and the temples of Vesta, and it symbolized the power of the Roman emperors in numerous examples known from literary sources (*e.g.*, the dome over the triclinium in Nero's Golden House).

Diverse and complex traditions of domical ideology developed throughout the ancient world, both east and west. In the late Roman empire domes were used extravagantly to symbolize imperial power and divinity. These connotations were carried, with suitable modifications, into Christian architecture. Examples, especially from the earlier Christian centuries, are innumerable. Over the semicircular apse (*q.v.*) of the basilica (*q.v.*), for instance, there customarily appeared a half dome or conch, which symbolized both celestial power (being very often decorated with an image of Christ in Glory, or Christ Pantocrator) and the tomb of a saint (or many saints) buried under the sanctuary floor below. Most striking of all early Christian domes, perhaps, was that over the church of Holy Wisdom (*Hagia Sophia*) in Constantinople. As the sermon delivered at the dedication of the rebuilt dome in A.D. 561 explained, this dome symbolized at once the glory of God, the power of Christ, the power of the Byzantine emperor and the tomb of Justinian.



FROM SIR BANISTER FLETCHER, "A HISTORY OF ARCHITECTURE"; REPRODUCED BY PERMISSION OF ATHLONE PRESS

FIG. 2.—CUTAWAY VIEW OF THE TREASURY OF ATREUS AT MYCENAE, LATE BRONZE AGE, SHOWING CORBELING

Later medieval architecture in the west made less use of domical buildings than the Byzantines. But in various ways the celestial, sacred, royal and funereal ideas that clustered about the domical shape were preserved; *e.g.*, in domed baptistries, to signify spiritual death and rebirth, in Gothic cathedral vaults painted blue with gold stars, in the ciborium and baldachin over tombs and altars. In Renaissance times an interest developed in the dome as a pure visual form in space, but its original significance persisted. The dome of St. Peter's, in Rome, was completed in 1590 with the intention of symbolizing the glory of God, the power of the Roman pontiff and the tomb of St. Peter below.

Gradually, however, the older symbolic values attached to domes gave way to an emphasis on their exciting visual effects and a vague association with Roman power. In the 19th and 20th centuries, interest grew in the opportunities the dome offered for experiment in new materials and in the creation of great open expanses of interior space.

DOMICAL CONSTRUCTION

A domical shape develops naturally out of many of the pliable materials used for building in primitive societies such as saplings, grass, mud and hides. Conversely, it is an unnatural form in more rigid materials like wood, brick or stone. Yet throughout history domes were built of these materials, often with enormous difficulty. The reason seems to have been that such domes were symbolic; that they resulted less from architectural considerations than from a desire to perpetuate a revered shape in permanent form. Many domes were literally carved out of solid rock; *e.g.*, in some of the tomb chambers in Etruria and the Roman catacombs, and most notably, in the Tomb of Theodoric at Ravenna (*c.* A.D. 526), which is roofed by a single slab weighing many tons, carved into domical shape and set in place like the lid on a pot.

Exactly when, where and how domical construction originated is much debated; it may well have developed independently in several areas. The technique most commonly found in extant early buildings is corbeling. Successive horizontal layers of bricks or stones were built so that each projected slightly beyond the one below, progressively narrowing the interior space until the opening at the top was small enough to be covered by a single slab of stone (*e.g.*, the Treasury of Atreus at Mycenae). It probably developed naturally out of the practice of giving the revered round house a permanent outside envelope of brick or stone. Corbeling was an awkward and none too stable form of construction, however. By comparison, domes in wood had many advantages, and were built much more extensively in early times. Wooden domes were relatively easy to build on a large scale, and when in place, their lightness and interlocked construction exerted little thrust on supporting walls. Although for obvious reasons no ancient wooden domes have survived, there is good evidence that a wooden domical tradition existed in the Roman empire, in India and in Russia, and may have played some part in the development of the Sassanian dome. It was particularly strong in Syria; literary records indicate that large wooden domes were built in that region well into the Christian era—as over the Marneion at Guza (built *c.* A.D. 130 by Hadrian and dedicated to Marnos, a sky god) and the original church of the Holy Sepulchre at Jerusalem (to mark the tomb of the Heavenly Ruler).

Roman.—Gradually, however, both wooden and corbeled domes were superseded by masonry construction, partly because rapid deforestation made wood difficult to obtain, partly because masonry domes were more effective symbols of strength and permanence and partly because the major problems of constructing

(CENTRE LEFT) CARLSON FROM THREE LIONS; (OTHERS) PHOTOGRAPHS BY G. E. KIDDER SMITH

FIG. 3.—(LEFT) ISLAMIC DOMES AND HALF-DOMES OF THE SULTAN AHMED MOSQUE, EARLY 17TH CENTURY, ISTANBUL, TURK.; (CENTRE LEFT) INTERIOR OF THE BYZANTINE DOME OF THE MOTHER CATHEDRAL OF THE ARMENIAN CHURCH, BEGUN 7TH CENTURY, ECHMIADZIN, ARMENIA; (CENTRE RIGHT) RENAISSANCE DOME OF ST. PETER'S, ROME; (RIGHT) BAROQUE DOME OF S. CARLO ALLE QUATTRO FONTANE BY FRANCESCO BORROMINI, 17TH CENTURY, ROME

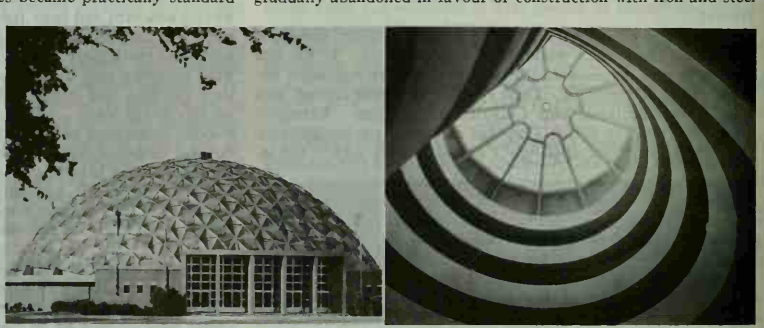
large brick and stone vaults were progressively solved during Roman times. This change may be traced in a few examples. In republican times, the Romans were building a kind of square dome, or cloister vault, ovoid in section and rising equally from all four sides, as may be seen in the extant square bays of the Tabularium, Rome (78 B.C.). Two centuries later, the Pantheon (built under Hadrian between A.D. 110 and 125, diameter about 144 ft.) displayed a masterful command of large-scale domical construction in brick, with an intricate system of built-in relieving arches. The construction was heavy, the only opening being a great "eye" at the top. The Romans solved this problem in later buildings; *e.g.*, the temple of Minerva Medica (actually the *nymphaeum* of the Licinian gardens, *c.* 250), which achieved a daring lightness through use of a structural framework of brick ribs. But they achieved no real solution for the problem of how to make a transition from a square or rectangular ground plan to a circular roof, despite many experiments. An attempt was made in the 3rd century A.D. to put a dome over an octagonal side room in the Baths of Caracalla, by means of corbeling and diagonal arches and niches.

Byzantine.—The next great advance in domical construction was made by Byzantine architects, who developed the pendentive (*q.v.*), and so were able to use the dome over a plan of any shape. The greatest Byzantine dome was that over the basilica-plan church of Holy Wisdom at Constantinople (originally built 532–537 by Anthemius of Tralles and Isidorus of Miletus, restored in 558–562 and later). So skilfully and subtly was the weight of this 100-ft. wide, 180-ft. high dome transferred through pendentives to side walls and buttresses, that on the interior it gave what a contemporary described as the effect of being "suspended on a golden cord from Heaven." Domes became practically standard on Byzantine churches. The only notable further development was to raise the dome on a drum (*e.g.*, the church of St. Theodore, Athens, A.D. 1049). On Byzantine precedent, domed churches were built: in Italy (*e.g.*, St. Mark's, Venice, begun 1063, modeled on the church of the Holy Apostles in Constantinople; S. Antonio in Padua, 13th century); in southern France (cathedral of Angoulême, *c.* 1128, and St. Front, Périgueux, begun 1120 on the plan of St. Mark's in Venice, remodeled by Abadie in the 19th century); in Armenia; in the Balkans; and in Russia.

Islamic.—Muslim builders were under strong Byzantine influence; they used the dome in a lavish form, but on small scale, in Spain and northern Africa and developed it along Byzantine lines in the later architecture of Egypt, in Persia, in India and especially in Turkey. Smaller Islamic domes and half domes were enriched with fantastic stalactite ornament. Sometimes elaborate systems of ribs, or transverse and diagonal arches, replaced the pendentive. In certain examples, as the exquisite Taj Mahal at Agra (1632–50), a bulbous or onion type of dome appeared, which perhaps originated in Islamic Persia.

Renaissance.—Renaissance builders introduced a new conception of the dome as a great sculptured form in space. In order to get the exterior visual effect they wanted without unduly raising the interior dome, they often (though not always) constructed their domes with two or more concentric shells. This principle was begun by Brunelleschi in the dome of the Cathedral of Florence (1420–61, including lantern), and followed by Michelangelo in the dome of St. Peter's in Rome; both have shells connected and strengthened by stone ribs. Often, the exterior Renaissance dome was merely a curved timber roof built over an inner dome of masonry, as in the church of Sta. Maria della Salute in Venice (by Baldassare Longhena, begun in 1631), and St. Paul's in London (by Christopher Wren, 1675–1710). St. Paul's has three shells—the outer timber roof, an inner hemisphere and between them a cone-shaped structure carrying the stone lantern.

Modern.—Renaissance dome-building techniques persisted, with refinements, through the 18th century. Typical is Germain Soufflot's dome of the Pantheon in Paris (1757–1812), which has three stone shells, the outer one thinned to only 19 in. at the base. In the course of the 19th century Renaissance principles were gradually abandoned in favour of construction with iron and steel



(LEFT) AUTHENTICATED NEWS; (RIGHT) EZRA STOLLER, BY COURTESY OF THE GUGGENHEIM MUSEUM

FIG. 4.—MODERN DOMES: (LEFT) GEODESIC DOME OF THE CASA MANANA THEATRE, FORT WORTH, TEX.; (RIGHT) DOME OF THE SOLOMON R. GUGGENHEIM MUSEUM BY FRANK LLOYD WRIGHT VIEWED FROM BELOW, NEW YORK. BOTH BUILT MID-20TH CENTURY

ribs. These were no longer true vaults, but at first they were treated to look like older forms. The dome of the United States capitol (1851–65, by Thomas U. Walter) has its own ribs covered with a masonry imitation of domes like St. Peter's and St. Paul's. Later in the century, iron ribs were displayed with increasing frankness, in domes like those over the court of the Coal Exchange, lower Thames street, London (by J. B. Bunning, 1846–49), the reading room of the British museum (by Sydney Smirke, 1854–57) and the reading room of the Bibliothèque Nationale in Paris (by Henri Labrouste, 1858–68). The primary function of domes like these was to provide a maximum of open interior space, rather than to perpetuate any particular symbolism. Architects could take full advantage of the new opportunities afforded by iron and glass construction for airy and light effects. The purest example of this new kind of domical construction was the dome planned for the Crystal palace (by Sir Joseph Paxton, to house the great exhibition of 1851 in London); although never built, it set a precedent for domical exhibition buildings that persisted into the 20th century. More significantly, it gave a powerful impetus to the wider use of new materials. As the 20th century progressed, the dome became a favourite form for experiments in new materials and new types of construction. Outstanding among these was the casting of domical shapes in concrete by spraying concrete shells over large inflated balloons. Another remarkable type was the geodesic structure, which consisted of a grid of thin aluminum strips or aircraft tubing, intersecting at the mathematically determined centres of equal stress lines on the spherical surface. It created domical structures combining great span and strength with remarkable lightness. A thin concrete dome, spanning 160 ft., was built at the Massachusetts Institute of Technology, Cambridge, Mass., by Eero Saarinen in 1955.

See also references under "Dome" in the Index volume.

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(AN. G.)

DOMENICHINO (DOMENICO ZAMPIERI) (1581–1641), Italian painter and a leading artist of the eclectic school of Rome and Bologna. Born at Bologna in Oct. 1581, he was trained in the academy of Lodovico Carracci, and in 1602 moved to Rome, where he joined the Bolognese artists at work under the direction of Annibale Carracci in the Palazzo Farnese. He was commissioned by Cardinal Agucchi to paint three frescoes in the portico of S. Onofrio. Immediately after he was employed by Cardinal Aldobrandini to decorate a room in the Villa Belvedere at Frascati with mythological frescoes (now in the Lanckoronski collection) and by Cardinal Farnese to paint a chapel in the Badia at Grottaferrata. Both fresco cycles are impregnated with the spirit of Annibale Carracci, though their more classical schemes look forward to the "Scenes from the Life of St. Cecilia" which Domenichino painted in 1615 for S. Luigi dei Francesi. The latter are in some respects his most successful works. In 1614 he executed an altarpiece of the "Last Communion of St. Jerome" (Vatican gallery), based on a painting of the same subject by Agostino Carracci at Bologna; this was looked upon by Nicolas Poussin and later painters as one of the greatest paintings in Rome.

In 1618–19 he executed for Cardinal Borghese the celebrated canvas of "Diana at the Chase" (Borghese gallery, Rome). After the election of the Bolognese Pope Gregory XV (1621), Domenichino was appointed papal architect. Between 1624 and 1628 he was occupied with the frescoed pendentives and apse of S. Andrea della Valle, where the full resources of his mature style are deployed. At this time Domenichino also made studies for the cupola fresco of S. Andrea della Valle, the commission for which was awarded to his rival Lanfranco. Though his work remained in great demand, there was a reaction against the rigid classicism of his style and in the last works which he produced in Rome, four frescoed pendentives in S. Carlo ai Catinari (1628–30) and the "Martyrdom of St. Sebastian" for St. Peter's, now in Sta. Maria degli Angeli, he worked in a broader, less classical style. This closer approximation to the baroque is also apparent in the frescoed "Scenes from the Life of St. Januarius" in the cathedral at Naples, on which Domenichino was engaged from 1631 until his death in April 1641. In Naples his style was less acceptable than it had proved in Rome, and he appears to have been the victim of systematic persecution by local artists, such as Ribera.

Through the 17th and 18th centuries Domenichino's paintings were regarded as second only to those of Raphael, but in the middle of the 19th century he fell from favour, and the importance of his place in the classical tradition has been recognized only in comparatively recent times. His name is associated with the doctrine of eclecticism, whereby a style derived from Raphael was opposed to the realism of Caravaggio. Domenichino's works reveal him as a fresco painter of great distinction and a draftsman of notable purity and skill. He occupies an important place in the history of landscape painting, and his landscapes (of which the most remarkable is a "Landscape With St. John Baptising" in the Fitzwilliam museum, Cambridge) had a profound influence on the classical landscapes of Nicolas Poussin and Claude Lorrain.

See J. Pope-Hennessy, *The Drawings of Domenichino in the Collection of His Majesty the King at Windsor Castle* (1948).

(J. W. P.-H.)

DOMENICO VENEZIANO (DOMENICO DI BARTOLOMEO DA VENEZIA) (active 1438–1461), Italian painter who, though of Venetian origin, worked mainly in Florence. His name appears for the first time in a letter of April 1, 1438, requesting Piero de' Medici to secure him the commission for a painting. According to Vasari (whose biography of this painter is unreliable), Domenico was engaged in Perugia on work for the Baglioni. His first recorded work, however, is a lost cycle of frescoes painted in 1439–45 for S. Egidio in Florence. In 1454 Domenico was associated with Fra Angelico and Fra Filippo Lippi in an assessment of the frescoes by Bonfigli in the Palazzo dei Priori at Perugia, but in 1455 he was once more in Florence. In 1457 he valued an altarpiece painted by Pesellino and Fra Filippo Lippi for the Compagnia della SS. Trinità at Pistoia (now in the National gallery, London). He died in Florence on May 15, 1461.

Two signed works by Domenico Veneziano survive. The first, a much-damaged fresco of the Virgin and Child enthroned with two damaged heads of saints (National gallery, London), formed part of the Carnesecchi tabernacle and is described by Vasari as the first work executed by Domenico in Florence. The second, an altarpiece of the "Virgin and Child with Four Saints" (Uffizi,

ALINARI PHOTO

"VIRGIN AND CHILD WITH FOUR SAINTS," ALTARPIECE BY DOMENICO VENEZIANO FROM STA. LUCIA DEI MAGNOLI, ABOUT 1445. IN THE UFFIZI GALLERY, FLORENCE

Florence), was painted for Sta. Lucia dei Magnoli, probably about 1445. One of the outstanding paintings produced in Florence in the middle of the 15th century, this is remarkable for the soft contours of its figures, its fresh and delicate palette, its mastery of light and its precise and lucid space construction. The predella is now distributed between Berlin, the Fitzwilliam museum, Cambridge, and the National Gallery of Art, Washington. The panels at Cambridge are the most notable surviving examples of the so-called "legitimate construction" described in L. B. Alberti's *Della Pittura*, and the scenes as a whole establish Domenico Veneziano as perhaps the most gifted painter active in Florence at this time. A tondo of the "Adoration of the Magi" in the Kaiser Friedrich museum, Berlin, dates from about 1440. Domenico Veneziano's only surviving portraits are two profile paintings of Matteo and Michele Olivieri (National Gallery of Art, Washington, and Rockefeller collection, New York). The artist's latest work is a fresco of "SS. John the Baptist and Francis" in Sta. Croce, Florence.

See M. Salmi, *Paolo Uccello, Andrea del Castagno e Domenico Veneziano* (1937). (J. W. P.-H.)

DOMESDAY BOOK, or simply Domesday, the original record of William I the Conqueror's survey of England, has proved the most enduring administrative achievement of the middle ages, and is the earliest "public" archive now preserved in the Public Record office, Chancery lane, London, where it is on view to the public. It was undertaken after the king had held "deep speech with his Witan" at his Christmas court in Gloucester in 1085; and was rapidly executed in 1086 by seven or eight panels of commissioners (*legati*), to each of which was allotted a separate group of counties. Each circuit compiled an elaborate account of the royal estates or manors and of those of the king's tenants-in-chief, which was forwarded to the treasury at Winchester. From these vast documents was made, before the king's death in Sept. 1087, a concise summary which is Domesday Book. By contemporaries the whole operation was known as "the description of England," but we learn from *Dialogus de Scaccario* (*Dialogue of the Exchequer*, 1176–79) that the popular name of Domesday—the record from which there is no appeal—was already then in general use.

Form and Content.—Domesday Book includes all the counties of England, except Northumberland, Durham, Westmorland, Cumberland and the northern parts of Lancashire, which were apparently not surveyed. Though invariably referred to as Domesday Book it consists of two volumes which are very different from each other. Volume I (Great Domesday), written in a single distinctive script, contains the summarized record of all the counties surveyed except Essex, Norfolk and Suffolk. For these counties which formed an eastern circuit, the full, unabbreviated return is preserved in volume II (Little Domesday), which for some reason, perhaps the king's death, was never summarized and added to the larger volume. Because of this accident we are much better informed about the economy of East Anglia than of any other part of England, except the southwestern circuit which included Somerset, Dorset, Wiltshire, Devonshire and Cornwall. These counties are duly summarized in volume I, but an early draft of the circuit return, the Exon Domesday, is preserved in Exeter cathedral. Like Little Domesday, which it resembles, it is written by a number of different scribes, though it describes the material at a slightly earlier stage. It also provides an interesting comparison with the summary contained in volume I, and shows us the principles followed in selecting the basic information preserved in the shorter text. Similar surveys were carried out by later kings, but Domesday is unique in discarding all but the vital facts, and so reducing the final record to manageable proportions. It was not too big to be useful in daily administration, and to this fact, no doubt, it owes its preservation.

Collectively, these three manuscripts demonstrate the complexities and difficulties which faced the commissioners whose circuit returns were slowly evolved in successive recensions. The fundamental problem was to reconcile the new Norman conception of a feudal society based on the honour or barony—a complex of estates treated as a unit wherever situated—with the age-long division of England into shires and hundreds, which governed both finance and administration. The dilemma was met by treating each county separately, beginning with an account of the chief town, followed by a numbered nominal roll of the holders of land, from the king downward through archbishops, bishops, earls and barons to the humblest tenants who held in chief of the king. The legal assumption was thus made that every acre of land was held either directly by the king, or indirectly by some tenant-in-chief. All the mesne tenants, those below this rank, were ignored except in so far as they appeared under the fief of a tenant-in-chief. These fiefs are described consecutively, following the nominal roll on the first folio of each county, and consist of long lists of manors or estates, giving the name of the manor and of its holder both "now" (1086) and on "the day when King Edward was alive and dead" (*i.e.*, 1066): its measurement in hides (*c.* 120 ac.): its ploughing capacity: the number of villeins, bordars and cottars, its mills, fishponds, etc., details of subtenures, and lastly its value in pounds. This was considered specially important for it is generally supplied at three different dates—before the Conquest, when the present holder received the manor, and now (1086). No century or country in the middle ages can show any comparable record and contemporary chronicles testify to the resentment which it provoked. For the majority of English villages it is the starting point of their history: also for the towns, for many of which it preserves a record of old customs and services to the crown of immemorial antiquity. Unfortunately it contains no record of London or Winchester (then the capital), though there is some reason to think that they were surveyed.

Method of Compilation.—The serious study of Domesday Book began with the first printing of the text, by royal command in 1783. The work was admirably carried out by Abraham Farley, using special "record" type (which makes it rather difficult to read), and it has never been superseded. There followed in the next generation a volume of indices, a general introduction, and a volume of kindred documents including the *Inquisitio Eliensis* (a private record, compiled by the abbot, of the lands of Ely, all of which lay in the counties of Norfolk, Suffolk, Essex, Cambridge, Hertford and Huntingdonshire) and the Exon Domesday. Finally in 1876 N. E. S. A. Hamilton published the *Inquisitio comitatus Cantabrigiensis* (*The Inquisition of the County of Cambridge*), a document of great importance, being a very early draft of the Cambridgeshire material and demonstrating the actual procedure adopted by the commissioners, whose "terms of reference" are preserved in the *Inquisitio Eliensis*. The method was that of the sworn inquest, by which answers were given under oath to a long list of definite questions. Formal sessions were apparently held in the chief county town, and the facts were supplied by the sheriff, the barons and their subtenants, a jury (half English, half French) from each hundred, while from every village there attended the reeve, the priest and six villagers. The procedure was thus strictly geographical—by shires, by hundreds and by villages—and the Cambridge inquisition actually preserved the information so arranged for that county. But however initially recorded (and practice probably varied from circuit to circuit) the facts were finally grouped in the circuit returns under the names of the king and the tenants-in-chief, and in this form returned to Winchester. The task of king's clerks at Winchester was thus simply to summarize in Great Domesday these huge collections of statistics, by omitting nearly three-quarters of the material submitted to them.

Aim of the Survey.—The motives which prompted the making of the survey were, no doubt, mixed; but the form of our three surviving originals—Domesday Book vol. I and II and Exon Domesday—proves that the basic purpose was to ascertain the extent and value, first, of the king's lands, and secondly of those of the holders of land, *i.e.*, the tenants-in-chief. It could hardly be otherwise in that feudal age when the royal revenue was largely drawn from these two sources. As for the land tax or geld, the reassessment of which was once thought to be the sole object of the survey, the records show clearly that the interest of the commissioners lay rather in achieving a more rigorous enforcement of its collection and in discovering concealed hides. Nor must the importance be overlooked of merely getting the facts down in writing in a hitherto largely oral and customary world. The Conquest had resulted in the expropriation of virtually the whole of

the old English upper class, and even the great churches, like Canterbury, Worcester and Ely, had suffered grievous territorial losses at the hands of the new Norman lords. The text of Domesday Book is full of bitter disputes regarding lands unlawfully seized since the Conquest. The survey had thus something of the character of a judicial eyre, though in general the commissioners were more careful to put on record the opposing claims to ownership than to decide between them.

Contemporary and Subsequent Value.—Domesday Book thus gives a detailed, statistical picture of the new aristocratic society. For the king's officers it was a guide to the royal demesne, to the holders of baronies, and to a lesser degree of mesne baronies; while for the new nobility who had been largely enfeoffed without written evidence (*sine carta*) it filled the place of title deeds. Great landowners secured copies of those pages which concerned them, often inflated by additional local details: and there still survive a number of such Domesday satellites, of which the best known is the *Domesday Monachorum* of Christchurch, Canterbury (ed. by D. C. Douglas, 1944). With the passage of time the importance of Domesday Book grew steadily: it acquired legal authority and was often quoted in the law courts, as indeed it sometimes is today. But the details of manorial economy—the amount of plough and meadow land, the numbers of villeins and bordars—went quickly out of date, and this soon led to the compilation, not later than the early 12th century, of a further official abbreviation, the Breviate of Domesday, which omitted these facts. This was sufficiently important to be splendidly recopied in the 13th century, and is now in the Public Record office, London. There is a record of repairs to the binding of the smaller volume in the 14th century; while in 1869 both volumes were rebound and again in 1953.

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DOMESTIC APPLIANCES: *see* HOME EQUIPMENT.

DOMESTIC ECONOMY: *see* HOME ECONOMICS.

DOMESTIC RELATIONS, a term used to express the legal relations existing between the various units that compose the family or domestic group. *See* MARRIAGE, LAW OF; DIVORCE; ANNULMENT; HUSBAND AND WIFE, LAWS CONCERNING; WOMEN, LEGAL POSITION OF; CHILDREN, LAWS CONCERNING.

DOMESTIC SCIENCE: *see* HOME ECONOMICS.

DOMICILE (DOMICIL) **AND RESIDENCE,** terms used in law to designate a person's dwelling place for purposes of judicial jurisdiction, governmental burdens and benefits, and choice of law. Under all systems of law certain aspects of a person's legal existence do not vary with the state where he happens to be at any given moment but are governed by a personal law that follows him at all times. In Anglo-American countries one's personal law is that of his domicile; elsewhere, it is often that of his nationality.

The state of a man's domicile has judicial jurisdiction over him, *i.e.,* can try a case against him in its courts, even though he happens to be outside its borders at the time he is summoned. So far as governmental burdens and benefits are concerned, only the state of a man's domicile can impose an inheritance tax upon all of his intangibles. This state also permits a man to vote and to hold public office and on occasion will pay him a veteran's bonus. In the field of choice of law, it is the law of a man's domicile that determines the validity of his will with respect to personal property or that decides how such property shall be distributed in the event of an intestacy. The law of a man's domicile also may play a part in determining his legitimacy and the validity of his marriage.

It is a fundamental principle that every person must have a domicile at all times. If this were not so, there would be occasions when a man did not have a personal law. Corollaries to this principle are that a domicile is not lost until another domicile has been acquired and that a person cannot have more than one domicile at a time for the same purpose. The burden of proof is upon him who asserts that there has been a change of domicile.

Types of Domicile.—It is commonly said that there are three kinds of domicile: domicile of origin, domicile of choice and domicile by operation of law.

Domicile of origin is the domicile that a person acquires at birth. Generally, it is the domicile that the father has at that time. If, however, the father is deceased or the child is illegitimate, the domicile is that of the mother. In the United States a domicile of origin can be lost as readily as any other kind of domicile. In England such a domicile enjoys unusual importance. Greater evidence than would be necessary in the case of other kinds of domicile must be submitted to justify a finding that a person has lost his domicile of origin. Also, under a special English rule a person regains his domicile of origin as soon as he leaves a subsequently acquired domicile of choice and is on his way to another.

Domicile of choice is the kind of domicile possessed by most persons. Usually it will be in the state with which a person is most closely connected and whose law is therefore best suited to govern the legal matters described above. There are three requirements for the acquisition of such a domicile. First, the person must have the requisite legal capacity. Minors, incompetents and, to a lesser extent, married women lack such capacity. Secondly, there must be physical presence in the place where domicile is claimed. Presence by reason of physical compulsion will not satisfy this requirement. Hence a domicile of choice cannot be acquired in a jail, and it is difficult for a person to acquire such a domicile in a place to which he is sent by military orders. Thirdly, the person must bear the requisite attitude of mind toward the place. This attitude is the present intention to make the place one's home; an intention to make the place one's home at some time in the future will not suffice. To intend to make a place one's home it is necessary that one intends to stay there for an appreciable length of time. The longer one intends to stay in a place, the easier it will be to find that he has the requisite attitude of mind. The rule is stricter in England, where it is held that to acquire a domicile of choice in a place one must intend to remain there permanently. These three requirements must exist at the same time. Provided that they do so even for an instant, a domicile of choice has been acquired. Determination of a man's domicile of choice may present many difficulties in situations where his contacts are more or less equally divided between two or more states.

Domicile by operation of law is a domicile, other than one of origin, that is possessed by persons who lack legal capacity to acquire a domicile of their own. Minors are the prime example. A minor's domicile usually follows that of the father, so that if the father acquires a new domicile after the child's birth, the child will take that domicile also. Where the father is deceased or the child illegitimate, the child's domicile is that of the parent to whose custody he has been awarded. If there has been no custody award, the child's domicile is that of the parent with whom he lives.

Persons who are unable through lack of mental capacity to form an intention to make a place their home cannot acquire a domicile of choice. Provided that they are adults, the domicile of such persons will normally remain that which they possessed at the time when they became incompetent.

The domicile of a married woman follows that of her husband so long as she lives with him. If the spouses live apart or if the husband is deceased, a married woman has as much power as anyone else to acquire a domicile of choice.

Residence and Abode.—Complications are caused by the fact

that statutes rarely use the word domicile but refer to residence instead. Residence, in such a context, usually bears the same meaning as domicile. On occasion it may mean something else than domicile, such as a well-settled physical connection with the state without bearing toward it the requisite attitude of mind. Sometimes, residence means something more than domicile, namely, domicile in a place plus physical presence there during a specified period of time. Residence when used in a statute means, in any event, a far closer relationship with a state than mere physical presence there. As in the case of domicile, a residence, once it has been acquired, is not lost by a temporary absence from the state. Some statutes use the word abode instead of residence. When so used, abode may bear any of the meanings ascribed to residence. In contrast to domicile, a man may have more than one residence or abode at a time.

See also CONFLICT OF LAWS.

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DOMINANT: *see* SCALE.

DOMINIC, SAINT (DOMINGO DE GUZMÁN) (1170?–1221), founder of the Order of Preachers, known also as the Dominicans (*q.v.*) or Black Friars. He introduced the idea of an order with a universal mission of preaching, and also certain novel elements of organization and representative government. The order has retained its unity and its framework of law and custom under an unbroken sequence of masters general from St. Dominic to the present day.

Domingo de Guzmán was born at Caleruega in Castile, south of Burgos in northern Spain, perhaps a year or two later than 1170, the traditional date. His father, Felix de Guzmán, was lord of the manor in the village, and his mother, Jane de Aza, was also from the local nobility. He studied at Palencia and then joined the canons of Osma, who had recently become canons regular with the rule of St. Augustine, and there he gained experience both of monastic life and of the cure of souls. In 1203 the bishop of Osma, Diego de Azevedo, was sent on a royal mission abroad and took Dominic with him. This journey first made Dominic aware of the situation in the south of France with the Albigensian heretics.

The Albigenses (*see* CATHARI) were reviving and developing the Manichaean teaching of two supreme beings, good and evil, dominating spirit and matter respectively, so that all that concerned the body—eating, drinking, marriage and procreation and the possession of worldly goods—was essentially evil, and the ideal was the renunciation of these things and even of life itself. Thus there arose among them a caste of the "perfect" who led a life of great austerity, while the ordinary people were regarded as reprobates. Thousands were carried away by this false idealism, and a regular Albigensian hierarchy had come into existence. Moreover the local feudal lords, especially the count of Toulouse, were supporting the Albigenses. Pope Innocent III had launched a mission with papal legates and a group of monks commissioned to preach against the heresy.

This was the world in which Dominic and his bishop suddenly found themselves. On their return journey they visited the pope, who refused their request to go and preach to the pagans, indicating more urgent work close at hand. So they returned to France. It was 1206 and the legates and preachers, depressed at the failure of their mission, consulted Diego and Dominic, who saw the reason for it: the heretics would be regained only by an austerity equal to their own; the preachers must abandon their equipages and tramp the roads barefoot and in poverty. This was the birth of Dominic's "evangelical preaching."

The next year Diego returned to Spain, but Dominic remained in France and continued his campaign, an important part of which was the establishment as a convent of nuns at Prouille of a group of women converted from heresy (1207).

In 1208 disaster occurred: the papal legate, Peter Castelnau, was murdered by an emissary of the count of Toulouse. Here was a *casus belli*, and the pope called upon the Christian princes to take up arms. The leader on the papal side was Simon de Montfort, a subject of the king of France and *de jure* earl of Leicester though unable to claim his estates in England through troubles with King John. The Albigensian leader was Count Raymond of Toulouse, an opponent of the king of France and brother-in-law of King John, lord of neighbouring Aquitaine, who was also at variance with the pope and was excommunicated in 1209. Dominic's work, though confined to the Prouille area, was continuing, and six others eventually joined him. Meanwhile the civil war dragged on until Simon's victory at Muret in 1213. The Catholic party entered Toulouse, and Dominic and his friends were welcomed by the bishop (the attractive former knight and troubadour Foulques) and established as "diocesan preachers" in 1215.

From Foulques's charter in that year Dominic's design for an order devoted to preaching developed rapidly. A characteristic concern was for the theological formation of his men, whom he therefore took to the lectures at Toulouse of the Englishman Alexander Stavensby. Still in 1215, he went to Rome with Foulques (bound for the Lateran council) to lay his plans before the pope, who, however, recommended adoption of one of the existing rules. It was perhaps at this time that Dominic met Francis of Assisi (though the meeting may not have taken place till 1221), and the friendship of the two saints is a strong tradition in both the Franciscan and Dominican orders. In the summer of 1216 Dominic was back at Toulouse conferring with his companions, now 16 in number. This meeting has been called the *capitulum fundationis*. The rule of St. Augustine was adopted, as well as a set of *consuetudines*, partly based on those of the canons regular, concerning the divine office, monastic life and religious poverty, including mendicancy; these are still the core of Dominican legislation. In July Innocent III died, and it was from his successor, Honorius III, that Dominic, once more in Rome, finally received the bull of confirmation of his order on Dec. 22, 1216.

The order was now an established body within the church, and Dominic returned to Toulouse. On Aug. 15, 1217, he made a gesture of confidence in his men: he scattered them to Paris, the centre of learning, and to Spain, leaving two each at Toulouse and Prouille, while he and another went to Bologna and Rome. It was Dominic's special gift to conceive his ideal, form his men to that ideal and then trust them completely. His supreme leadership had great clarity of vision, even to the geographical distribution of his forces and precise details of legislation, firmness of command and certainty of execution. At the same time it was said of him that such was his gentleness that none came to speak to him, even for reproof, but went away happier, and his friend and biographer, Jordan of Saxony, reports that "he loved everyone, so everyone loved him."

The rest of Dominic's life was spent either in Rome, where he was given the church of S. Sisto, or traveling. In 1218–19 he made his great tour (3,380 mi. entirely on foot) from Rome to Toulouse and Spain and back via Paris and Milan, and in 1220 a tour of Lombardy. Everywhere his communities were growing, and he planned many new foundations covering the key points of France and northern Italy. In Rome the pope gave him the delicate task of reforming various groups of nuns, whom he finally gathered at San Sisto in 1221 (this date seems established by M. H. Vicaire), when the brethren moved to Sta. Sabina, which is still the residence of the master general.

At Pentecost in 1220 the first general chapter of the order was held at Bologna, when the present system of representative government was devised. At the second general chapter, held at Pentecost in 1221, also at Bologna, the order was divided geographically into provinces (with England as the eighth, the first brethren being dispatched to England from that chapter) and was established juridically as it is today. This was Dominic's last great work. After a visit to Venice he died at Bologna on Aug. 6, 1221.

Dominic was canonized in 1234, and his feast day is Aug. 4. The testimonies of witnesses provide a wealth of details and present him as a man at once inspiring as a leader and legislator and affectionate as a friend and father.

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du XIIIe siècle, provides (in French) the documents edited by Vicaire (1955). Many of the Latin texts and charters were published as *Monumenta historica S. Dominici* (in the series *Monumenta ordinis fratrum praedicatorum historica*, vol. 15–16, 1933–35). The best biography in English is B. Jarrett, O.P., *Life of Saint Dominic* (1924).

(S. Bh.)

DOMINICA, an island of the Lesser Antilles in the Caribbean sea. It was formerly a British colony of the Windward Islands and joined the West Indies federation in 1958; the federation was dissolved in 1962. Dominica lies between the French islands of Guadeloupe and Marie Galante to the north and Martinique to the south and about 25 mi. distant from each. Dominica is 31 mi. long, has a maximum breadth of 16 mi. and an area of 305 sq.mi. A range of high forest-clad mountains runs north to south, broken in the centre by a plain drained by the rivers Layou and Quanery, which flow west and east, respectively; the highest points are Morne Diablotin (4,747 ft.) and Morne Trois Pitons (4,672 ft.). The island is of volcanic formation, signs of activity including *solfataras* and hot springs. In the south, Boiling lake lies 2,300 ft. above sea level, and its waters are often forced 3 ft. above normal by pressure of escaping gases.

At sea level the temperature varies between 70° and 90° F., but in the mountains it frequently falls to 60° F. Rainfall varies greatly, from over 200 in. in the highlands to between 60 and 100 in. on the west coast; the island average is 113 in. Dominica has rich soil and is watered by many rivers and torrents, which provide power for lime-crushing mills. The fisheries are productive. Wild bees furnish honey and wax.

The main crops are bananas, citrus fruits, coconuts, cocoa, vanilla and mangoes; the main products are lime juice, lime oil, copra and rum. Chief imports are food, liquor, tobacco, textiles and machinery.

Dominica's system of government is ministerial. The executive council consists of the administrator, one official and five unofficial members. The population in 1960 was 59,916, chiefly Negroes. There is a small white community of French and British descent, and a handful of Caribs. A French patois is the language of the peasantry, but English is generally understood. The capital, Roseau (10,417 [1960]), and Portsmouth (3,000) are on the west coast, and both are ports. Roman Catholicism is the predominant religion. Primary education is compulsory at 47 elementary schools, and there are 4 secondary schools attended by 1,600 children. During the 1950s the island's income more than doubled and this, with other factors, led to a shortage of labour.

Several shipping lines call regularly at Roseau. Before completion, in 1960, of the airfield at Melville Hall, in the northeast, airlines using amphibians or seaplanes provided service to Soufrière bay, in the southwest of the island. Dominica has motor roads.

Christopher Columbus named Dominica in commemoration of Sunday, Nov. 3, 1493. The first colonists (1632) were French, but in 1748 an agreement between the French and British assigned Dominica to the Caribs. Nevertheless French influence increased, and a French governor ruled. In the wars from 1756 onward Dominica several times changed hands between the British and French, but after 1805 it remained British. At first administered as part of the Leeward Islands, in 1771 Dominica was made a separate colony. It was rejoined administratively to the Leewards in 1832 and remained thus until 1940, when it was transferred to the Windwards as a separate colony.

See *Colonial Office List* (H.M.S.O., annually). (R. To.)

DOMINICAL LETTER or **SUNDAY LETTER:** *see* CALENDAR.

DOMINICAN REPUBLIC (REPÚBLICA DOMINICANA) shares with Haiti the island of Hispaniola in the West Indies. It was the site of the first Spanish settlements in America and formed the Spanish colony of Santo Domingo (*q.v.*) for three centuries after the foundation of Isabela by Christopher Columbus in 1493. In 1795 it was ceded to France, but later was recovered by Spain and subsequently ruled for 22 years by Haiti (*q.v.*) before obtaining independence in 1844. Though one of the smallest (18,703 sq.mi.) of the American republics, it has played a relatively important part in international politics because of its location on one of the chief sea routes between Europe and eastern North America on the one hand and the Panama canal on the other. Its people live by agriculture, growing subsistence crops or working on plantations of sugar, cacao and other tropical products raised for export. The production of sugar, now the principal export, has greatly increased.

The geography of the Dominican Republic is treated unitarily with the geography of Haiti in the article HISPANIOLA. Some historical and economic aspects may also be found in the short provincial articles.

HISTORY

The Dominican Republic was until mid-20th century one of the poorer and more backward Latin-American states. The country attracted relatively few settlers during the colonial period, and many people of Spanish descent left it during the 19th century. Except for a small, educated upper class, the people are for the most part of Negro or mixed Negro and Spanish ancestry. (See *Population*, below.) Poverty and illiteracy made the establishment of a republican government difficult, and the country was ruled from independence by regimes set up and maintained by military force. Three times between 1822 and 1924 it was occupied by foreign armies. Internal disorder long discouraged the development of agriculture and industry, but in the second quarter of the 20th century, and especially after the inauguration of the Trujillo dictatorship in 1930, the country began to make substantial progress in such matters as agricultural production, road building and education.

Christopher Columbus discovered Hispaniola on his first voyage in 1492 and landed at Môle St. Nicolas. He left a number of his men on shore at La Navidad, in what is now Haiti. These were killed by the Indians, but on his second voyage in 1493 Columbus brought out a large number of new settlers, and in 1496 his brother, Bartholomew, founded the city of Santo Domingo (*q.v.*), as the capital of the first Spanish colony in America. Santo Domingo was the starting point of most of the expeditions that explored and conquered the other West Indian islands and the adjacent mainland. The colony prospered for several years, especially after Columbus was removed as governor in 1500, but its importance declined after the conquest of Mexico and Peru and after the native Indian population was destroyed by mistreatment and disease. So many settlers left that Spain practically abandoned the west end of the island, and in the 17th century the buccaneers from nearby Tortuga Island began to establish plantations there. In 1664 the French Company of the West Indies took possession of the west end, and in 1697 Spain formally ceded the area to France in the treaty of Ryswick. The east end of the island shared relatively little in the prosperity of the west, French St. Domingue, but its population increased during the 18th century with immigration from the Canary Islands and the importation of Negro slaves.

Spain ceded the rest of Santo Domingo to France by the treaty of Basel in 1795, but the European war prevented the actual transfer of possession. In 1801, however, the Negro leader Toussaint l'Ouverture (*q.v.*), who had seized power in the French colony, conquered the whole island. Toussaint was defeated in 1802 by an army sent by Napoleon, and French forces held the eastern end of the island until 1809, despite their failure in Haiti. In 1808–09 a creole revolt, led by Juan Sánchez Ramírez and aided by a British naval squadron, restored Spanish rule. The creoles revolted against Spain in 1821 and attempted to unite Santo Domingo to Simón Bolívar's Republic of Colombia. They set up a government headed by José Núñez de Cáceres, but this fell in 1822 when a Haitian army invaded the country. The Spanish end of the island was ruled as a conquered province by the Haitians until they were expelled by an uprising led by Juan Pablo Duarte (*q.v.*), and Dominican independence was proclaimed in the city of Santo Domingo on Feb. 27, 1844.

The constant fear of a new Haitian invasion and the internal disorder caused by the struggle for power between Pedro Santana and Buenaventura Báez made independence seem a doubtful blessing, and several Dominican leaders advocated placing the country under the protection of some foreign power. The U.S.,

France and Great Britain interposed to prevent attacks from Haiti, but the earlier projects for a European protectorate were defeated by jealousies among the powers and the lack of real interest in what promised to be a troublesome responsibility. In 1861 Pres. Pedro Santana brought about the reannexation of the country to Spain, but the restoration of the unenlightened centralized colonial government aroused much opposition and the Spanish army, hampered by yellow fever, was unable to maintain order. The Dominicans' resistance, and a realization that the end of the American Civil War would leave the U.S. free to follow up the strong protest that it had made in 1861, led to a final separation from Spain on July 11, 1865. Soon afterward a project for annexation to the U.S. was promoted by two adventurers named William Cazneau and Joseph Fabens, who held several concessions in the Dominican Republic, and gained the support of Báez, the most powerful political leader after the death of Santana in 1864, and of high officials of the U.S. government. A representative of President Grant negotiated treaties for annexation and for a 99-year lease of Samaná bay (*see* SAMANÁ) in 1869, but opposition in the U.S. senate prevented their ratification.

After Báez fell from power in 1874 there was a period of acute disorder until Ulises Heureaux became president in 1882. Heureaux's regime, a cruel and corrupt despotism, gave the country its first long period of peace. Sugar production, financed partly by North American capital, increased but reckless financial mismanagement paved the way for future trouble. The government repeatedly sold large amounts of bonds in Europe, squandering the proceeds and then refunding and scaling down its debts when it was unable to maintain service on them. After 1892 it carried on these transactions through the San Domingo Improvement Company of New York, which assumed a measure of control over the customs collections and went into partnership with Heureaux in other enterprises, including railroad building and the purchase of the national bank, formerly controlled by French interests.

When Heureaux was killed by political enemies in 1899 there was a period of disorder, with weak governments rising and falling in quick succession. One of these ousted the Improvement company from the customhouses, and the U.S. insisted that the resulting dispute be arbitrated. After a bitter controversy the Dominican government agreed to pay the company $4,500,000 in installments, and an arbitral tribunal ordered that the U.S. should take over certain customhouses if these installments were not met. Meanwhile several European governments pressed claims of their nationals and President Morales asked the U.S. for help. A treaty signed in 1905 provided that the U.S. government should take over the collection of the republic's customs revenues and should endeavour to arrange a general settlement with the country's creditors. This treaty was defeated in the U.S. senate, but a U.S. customs collectorship was nevertheless established under a temporary arrangement. In 1907 another treaty, providing for the collection of the customs by officials appointed by the president of the U.S., to afford security for a loan by U.S. bankers, was signed and ratified. The loan did not materialize but by 1907 a substantial sum was available for debt settlement because 55% of the customs revenues had been set aside for this purpose since 1905, and the creditors were persuaded to accept scaled-down settlements paid partly in cash and partly in bonds secured by the customs collections. This arrangement averted the danger of European intervention and gave the government more money than it had previously had for administration and public works.

The United States' moral support of the constituted authorities and the fact that insurgents could no longer finance their operations by seizing customhouses discouraged revolutions for several years, but new disorders set in when Pres. Ramón Cáceres was assassinated in 1911. When Col. Alfredo Victoria, the military commander of Santo Domingo city, installed his uncle Eladio Victoria as president, the other party leaders revolted. A mission sent by the U.S. government in 1912 persuaded all factions to agree on the election of Adolfo Nouel, the archbishop of Santo Domingo, as provisional president, but Monsignor Nouel resigned early in 1913 because he could not control the military chieftains who were the real rulers in several provinces. The congress then elected José Bordas Valdés for a one-year term, but within a few months a new civil war started. U.S. diplomatic intervention again restored peace, but only for a short time. In Aug. 1914 President Wilson threatened to intervene by force if the factional leaders did not lay down their arms and agree on a provisional president under whom free elections could be held. He promised to assure fair play in the elections by sending observers, and said the U.S. would itself suppress any revolution against the government that was chosen. The Dominicans agreed to the "Wilson plan," and Juan Isidro Jiménez became constitutional president in Dec. 1914.

It was clear by this time that the customs collectorship alone did not assure the government's solvency. After 1911 military expenditures and the payment of blackmail to potential revolutionists had left little money for other purposes, and a large floating debt had accumulated. The U.S. consequently demanded that Jiménez give a U.S. controller supervision over expenditures, and that the customs service take over the collection of the internal revenues. At the same time it urged the creation of a constabulary under U.S. officers to replace the unreliable and corrupt regular army. Jiménez rejected these proposals and they were not pressed for the time being. In April 1916 Jiménez attempted to free himself from the control of Desiderio Arias, the minister of war, who was the most powerful figure in the government. When Arias defied him, Jiménez resigned, refusing the proffered military aid of U.S. forces. The U.S., which regarded Arias' ambition as the chief obstacle to its efforts to establish stable government, at once landed marines at Santo Domingo and other ports and took military control. It demanded that Francisco Henríquez y Carvajal, the new provisional president, accept the financial and military reforms that it had urged on Jiménez. The customs service took over the collection of the internal revenues, so that the Dominican government had no funds, but Henríquez nevertheless refused to accept the proposed reforms and on Nov. 29, 1916, a U.S. military government was proclaimed.

Most of the Dominicans resented this intervention. U.S. marines had to suppress small revolts in 1917 and 1918, and martial law and a strict censorship of the press were continued after order was restored. There was much criticism of the occupation policy, in the republic and abroad, and the discontent increased when the prosperity brought by World War I was followed by an economic collapse. President Wilson announced in Dec. 1920 that the marines would soon be withdrawn, but the Dominican leaders refused to co-operate in establishing a native government because the U.S. still insisted on the reforms proposed in 1915. In 1922, however, the U.S. abandoned this condition and agreed with the Dominican leaders on a plan for the restoration of a free government. The occupation was withdrawn when Gen. Horacio Vázquez was inaugurated as president in 1924.

Economic prosperity and the efficiency of the new army, which had been trained by the U.S. marines, kept the country at peace until Vázquez attempted to bring about his own re-election in 1930. When his opponents revolted, the army offered little resistance, and soon afterward the commander of the army, Gen. Rafael Leónidas Trujillo Molina, was elected president. General Trujillo was the undisputed ruler until he was assassinated in 1961, retaining control through his command of the army during the periods when he permitted a friend or a member of his family to occupy the presidency. When he took office the country was suffering from the effects of low sugar prices, and a hurricane that destroyed most of the capital city in Sept. 1930 made matters worse. Within a few years the country began to make notable economic progress. Exports increased, and the highway system, begun during the U.S. occupation, was improved and extended. In 1940 a treaty with the U.S. abolished the customs collectorship, which had been in existence since 1905, and in 1947 the foreign debt was paid in full. The long-standing boundary dispute with Haiti was settled by a treaty signed in 1935. Two years later, however, the massacre of many thousands of Haitians living in the Dominican Republic brought the two countries to the verge of war, and a conflict was averted only by the interposition of the other American republics and the Dominican government's promise to pay a large indemnity. In 1941 the Dominican Republic declared war on Japan and Ger-

many immediately after Pearl Harbor. There were no important internal disturbances between 1930 and the late 1950s, but the dictatorial character of the government and its harsh treatment of political opponents exposed it to much criticism abroad.

On May 30, 1961, General Trujillo was assassinated. After a period marked by strikes and some disturbances, the Trujillo family fled the country and Pres. Joaquín Balaguer formed a coalition government. Balaguer, ousted by a two-day seizure of power by a military junta, was succeeded Jan. 18, 1962, by Rafael L. Bonnelly, who became president of the provisional council of state. A general election took place in Dec. 1962, and Juan Bosch was elected president. After several months in office, marked by a border conflict with Haiti and increasing domestic discontent, Bosch was deposed by a military coup in Sept. 1963 and replaced by a three-man civilian junta named by the leaders of the revolt. During the ensuing months several changes in the membership of the junta were brought about by pressure from the army and from civilian political groups jockeying for advantage. A major armed revolt broke out in Santo Domingo in April 1965 but was contained with the aid of U.S. troops. (D. G. Mo.)

POPULATION

Number and Distribution.—The census of 1950 enumerated 2,135,872 persons in the Dominican Republic, or the equivalent of 114 per square mile. By the 1960 census the total had risen to 3,013,525, with a density of 161 per square mile. (*See* Table.) Santo Domingo, the national capital, had a population of 367,053 in 1960, and the second largest city, Santiago, one of 83,523. The population is mainly rural, the 1960 census listing only 30.5% in places of 2,500 or more.

Composition.—The bulk of the Dominican Republic's people are of mixed white (mainly Spanish) and Negro descent. Thus the proportions classified as mestizo (*i.e.*, mulatto) were 67.5% in 1935 and 60.4% in 1950. Between 1935 and 1950 the percentage classified as white rose from 13.0 to 28.1 and that classified as Negro fell from 19.5 to 11.5. In all probability the proportion of whites actually rose slightly, but it is likely that differences in the criteria used in making the classification were responsible for most of the apparent change. A total of 339 persons classified as Asiatic also was reported in the 1950 census. The aboriginal population of Hispaniola (the Dominican Republic and Haiti) consisted of two main groups, both of which originated in South America: the Arawaks (including the Taino, Ciguayo and Lucayo) and the Caribs. The Indians were village dwellers, cultivating cassava, corn, sweet potatoes, yams, beans and peppers; they were fairly skilled at pottery making, basketry, woodworking and boatbuilding. After European contact the Indians succumbed to massacres and disease, and there is no evidence that they perceptibly influenced the racial mixture found in the Dominican Republic in modern times. Only 34,654 (1.6%) of the 1950 population were classified as foreign born, and of these, 19,193 were from neighbouring Haiti. The next largest groups came from the following: the British Antilles 2,579; Puerto Rico 2,216; Great Britain 2,066; Spain 1,800; and the U.S. 913.

Area and Population of Dominican Republic

Political subdivision	Area (sq.mi.)	Population (1960 census)*			Persons per sq.mi.	Capital (with 1960 population)
		Total	Urban	% urban		
National District						
Santo Domingo	570	462,192	367,053	79.4	810.9	Santo Domingo (367,053)
Provinces						
Azua	938	75,147	16,427	21.9	80.1	Azua de Compostela (12,350)
Bahoruco	532	52,343	14,763	28.2	98.4	Neiba (7,332)
Barahona	976	79,880	34,648	43.4	81.8	Santa Cruz de Barahona (20,398)
Dajabón†	344	40,822	7,716	18.9	118.7	Dajabón (3,230)
Duarte	499	161,326	35,396	21.9	323.3	San Francisco de Macorís (26,000)
Elías Piña†	690	43,266	5,046	11.7	62.7	Elías Piña (2,890)
El Seibo	1,154	115,604	17,538	15.2	100.2	Santa Cruz de el Seibo (4,621)
Espaillat	376	117,126	15,746	13.4	311.5	Moca (13,829)
Independencia	719	27,475	11,200	40.8	38.2	Jimaní (1,503)
La Romana	1,445	104,987	35,090	33.4	72.7	La Romana (24,058)
La Vega	1,329	248,069	40,668	16.4	186.7	Concepción de la Vega (19,884)
María Trinidad Sánchez†	506	85,185	12,321	14.5	168.3	María Trinidad Sánchez (9,337)
Montecristi	768	59,240	16,807	28.4	77.1	San Fernando de Montecristi (5,912)
Pedernales‡	390	8,652	3,959	45.8	22.2	Pedernales (2,466)
Peravia†	626	106,736	22,637	21.2	170.5	Baní (14,472)
Puerto Plata	726	163,896	26,090	15.9	225.8	San Felipe de Puerto Plata (19,073)
Salcedo	191	68,656	9,252	13.5	359.5	Salcedo (6,175)
Samaná	382	44,592	7,896	17.7	116.7	Santa Bárbara de Samaná (3,309)
Sánchez Ramírez	453	93,498	6,998	7.5	206.4	Cotuí (4,706)
San Cristóbal†	1,445	249,776	35,850	14.4	172.9	Benemérita de San Cristóbal (15,525)
San Juan de la Maguana†	1,375	148,206	26,336	17.8	107.8	San Juan de la Maguana (20,449)
San Pedro de Macorís	450	68,953	24,880	36.1	153.2	San Pedro de Macorís (22,935)
Santiago	1,201	287,941	95,153	33.0	239.8	Santiago (83,523)
Santiago Rodríguez	394	40,399	4,727	11.7	102.5	Santiago Rodríguez (3,590)
Valverde§	224	59,558	23,784	39.9	265.9	Valverde (17,885)
Total	18,703	3,013,525	917,981	30.5	161.1	

*Provisional figures. †Created in 1961. ‡Created April 1, 1958. §Created January 1, 1959.

The sexes are almost equally represented, the number of males per 100 females being 102.0 in 1960. Because of the high birth rate and the relatively high death rate, children of less than 15 years of age constitute a high proportion and persons of 65 and over a low proportion of the total population. Thus in 1950 the percentages of those under 15, between 15 and 64, and 65 or over were 44.5%, 52.6% and 2.9%, respectively.

Spanish, the official language, is spoken by all except the small groups of foreign born. The latter, mostly from Haiti, are usually employed on the sugar-cane plantations and are French speaking.

According to the 1950 census reports, over 98% of the people in the Dominican Republic are Roman Catholics, but the following totals also were reported: Protestants 33,440 (including 2,902 Adventists); no religion 1,845; and other 2,113.

Growth of Population.—The census of 1920 gave a population of 894,665, which by 1935 had increased to 1,479,417 and by 1960 to 3,013,525. During the period 1935 to 1960 the population of the Dominican Republic had increased at the rate of 3% per year, a rate that is equaled or exceeded by those of many Latin-American countries but that is unmatched in practically all other parts of the world.

After 1950 the reported birth rate averaged about 40 births annually per 1,000 population, but it was likely that the true rate was above 45. Also, it was improbable that it had begun to decline. The reported death rate, about 10 per 1,000 population, seemed to be substantially below the rate actually prevailing in the 1960s, probably between 15 and 20. The death rate, however, almost certainly was falling in the second half of the 20th century, possibly very rapidly, as the impact of modern health and sanitary measures was felt. (T. L. Sh.)

ADMINISTRATION AND SOCIAL CONDITIONS

Government.—The Dominican Republic has adopted more than 20 constitutions. New constitutions are drafted when relatively minor modifications are desired. The constitution proclaimed Dec. 1961 (amended Sept. 16, 1962) was only slightly different from the 1955 constitution, which was similar to the 1947, 1942 and 1934 constitutions.

The 1961 constitution established the Dominican Republic as a unitary state with separation of powers (legislative, executive and judicial branches) but with tendencies toward a semiparliamentary system. Thus, the legislature was empowered to force the president's ministers to appear and be subjected to interpellation. The judiciary was given the power to propose laws. All recent constitutions concentrate great powers in the executive, however.

Government is highly centralized and controlled by the president, who has broad authority to legislate by decree. "His Excellency the Generalísimo and Dr. Rafael Leónidas Trujillo, Benefactor of the Fatherland," undoubtedly the most powerful Dominican *caudillo* or leader of the 20th century, dominated government from 1930 until his assassination in 1961. With a single party (the Dominican party) and hand-picked lists of candidates along with straight-ticket voting without provision for blank ballots or write-ins, no organized opposition could exist. The

congress was composed of a senate and a chamber of deputies. The senate had 23 members, elected directly for five years, with one senator from each province and from the District of Santo Domingo. The chamber of deputies of 52 members was elected for five years from the provinces according to the ratio of one representative for each 60,000 population, with each province guaranteed at least two deputies. Every congressman was a member of the Dominican party. Provincial and local governments were controlled by the central government. Gen. Héctor Bienvenido Trujillo Molina, brother of the *generalísimo*, was elected president in a *candidato único* (single-candidate) election in 1952 and re-elected in the same way in 1957. Juan Bosch was elected president in Dec. 1962 and inaugurated Feb. 27, 1963. A constituent assembly framed a new constitution with a socialist orientation, which was put into effect in July 1963. However, conservative and military forces ousted Bosch from power on Sept. 25, 1963, on the grounds that his government was infiltrated by extreme leftist forces. A junta then assumed power.

The Dominican Republic is the only country in Latin America which permits the president to succeed himself. All men and women above 18 years of age (or less, if married) are entitled to vote and are eligible to elective office.

Education and Social Welfare.—Official statistics revealed that in 1950, 56.8% of the population aged ten or older were illiterate. The Education act of 1951 made primary education compulsory between the ages of 7 and 14, and provided free meals for needy children; however, the average length of primary school enrollment in the 1950s was only four or five years, and probably only about one-half of the children of school age were attending school. A determined effort was made after 1955 to eliminate illiteracy among adults. The University of Santo Domingo had an enrollment of about 3,800 in the mid-1960s.

In public health and in social-welfare services, the Dominican Republic is among the most advanced Latin-American countries. The greatest remaining threat to health in the 1960s probably was malaria, though with United Nations help the problem was being overcome. The social insurance laws go back to 1947. The system, paid for by contributions of employers and employees with some state support, provides medical, maternity and dependents' and cash benefits. There were about 25,000 members of a trade-union movement, which was directed and controlled by the government. (W. S. Ss.)

THE ECONOMY

Agriculture.—Much of the population derives its livelihood within a system of subsistence agriculture which emphasizes corn and cassava. Ownership of the land has been, however, in a few hands, and there has been a tendency toward concentration of holdings rather than toward wider distribution. The number of individual holdings declined immediately after World War II.

The economy of the Dominican Republic is basically agricultural, and the country is one of the leading producers of sugar. Sugar cane is grown along the southern coast from Barahona to La Romana and on the northern coast in the province of Puerto Plata. The processing of sugar cane has represented by far the principal industrial activity. The sugar mills, called *ingenios* or *centrales*, in addition to raw sugar, produce molasses and bagasse. A number of them have irrigation systems and all have private railroad facilities; otherwise there was little industry.

Trade and Finance.—Four commodities—sugar, coffee, cacao and tobacco—account for most of the country's total exports. The only nonagricultural export item of importance is iron ore, mined at Hatillo. The U.S. generally provides a large proportion of Dominican imports and takes much of its exports. The major exports to the U.S. are coffee and cacao; Great Britain buys about two-thirds of the nation's sugar exports.

The basic monetary unit is the Dominican peso (RD$) of 100 centavos (officially pegged at a value equal to the U.S. dollar). Prior to Oct. 1947, when the Monetary law was enacted, U.S. money constituted the only circulating paper currency in the country, with Dominican coins serving as subsidiary currency. The Central bank is the sole bank of issue and is authorized to perform

STOPELMAN—PIX FROM PUBLIX

DOMINICAN GIRLS SORTING COFFEE BEANS

the usual functions of a central bank.

Transportation.—The only public service railroad in the 1960s was the government-owned and operated United Dominican railways. That line ran from Sánchez, located on the Samaná bay coast in the northeastern sector of the country, up the Yuna river valley. The Dominican Republic had a total of 2,400 mi. of roads, of which about 80 mi. consisted of surfaced highways. Three highways fanning out from Santo Domingo comprised the backbone of the system. There were also about ten active seaports, of which Santo Domingo was the most important, handling about two-thirds of all imports and nearly half of the total exports.

See also references under "Dominican Republic" in the Index.

(W. C. Gn.)

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DOMINICANS (Ordo Fratrum Praedicatorum; O.P.; Friars Preachers; Black Friars; Order of Preachers), an order of mendicant friars founded by St. Dominic (*q.v.*) in 1216. Dominic became a canon of Osma and accompanied his bishop, Diego de Azevedo, on a tour of preaching among the Albigensian heretics in Languedoc, where he founded a nunnery at Prouille (1207), partly for his converts, served by a community of preachers. From this developed the conception of an institute of preachers to convert the Albigensians, which received provisional approval from Innocent III in 1215. Dominic gave his followers the rule of St. Augustine and made his first settlement at Toulouse; on Dec. 22, 1216, Honorius III issued the formal bulls of approval. The novelty of the institute was the commission to preach Christian doctrine, a task previously regarded as the prerogative and monopoly of bishops and their delegates (the success of the heretical preachers in the south of France revealed the extent to which this task had been neglected); a corollary was the obligation of theological study, and as early as 1218 Dominic sent seven of his followers to Paris university. In 1219 the brethren at Toulouse exchanged the dress of canons for a white woolen tunic, scapular and hood, with a black mantle for formal occasions and travel; and this dress was adopted officially the following year.

Constitution.—The two first general chapters of the order were held at Bologna in 1220 and 1221. From the beginning emphasis was laid on study and preaching as the fundamental purposes of the order, based upon an austere community life learned in the quasi-monastic regime of the friary. The legislation of the order was in two parts or "distinctions," one dealing with the discipline of conventual life, the other with the government of the order. In the first, the sole work of Dominic, the rule of St. Augustine was reinforced by the stricter customs of the Premonstratensians; the diet and fasts were those traditional

to monks, and the divine office was recited in choir, but liturgical service was kept at the minimum and dispensations for study and preaching were explicitly allowed.

In the second distinction, on the government of the order, partly the work of legally trained advisers, Dominic sanctioned a constitution of some complexity but eminently practical. It presented for the first time a fully developed and articulated supranational religious order, in which the principle of election was recognized throughout in the constitution of authority, and in which *ad hoc* commissioners or diffinitors, who were not office-holders, played an important legislative and executive part. The individual convent was the unit within a regional province, and the provinces made up the order. On each of the three levels there was a single permanent executive—the conventual prior, the provincial prior and the master general. On each level also there was an assembly meeting at stated intervals, the conventual, provincial and general chapters, of which the two last were also legislative bodies. The conventual prior was elected by his community; the provincial prior by the conventual priors and two delegates from each friary; the master general, who held office for life, by a chapter composed of the provincial priors and two delegates from each province.

The annual general chapter varied in its constitution: for two years the master general sat with two delegates from each province, in the third year with the provincial priors. No legislation could take effect until approved by three successive chapters. The general chapter was at first numerically small, while the provincial chapter might be large, but all business in this latter was conducted by the provincial and four diffinitors (*i.e.*, legislators) elected by the whole body. The weight thus given to the principles of election and delegation was not in intention democratic, but an acknowledgment of the abundance of intellectual and administrative ability in the order. Nevertheless it represented a shift from the patriarchal rule of a single family by a spiritual father to the wise administration of a great body of men by those whom their brethren considered the ablest.

From early days, also, an elaborate scheme of studies was in force. In each friary there was a doctor in charge of primary studies; in each province there was one or more *studium particulare* with a fuller staff to which friars of promise could be sent; finally *studia generalia* were established in university and other important towns (*e.g.*, Paris, 1228; Oxford, Cologne, Montpellier, Bologna, 1248; Cambridge, *c.* 1350) and attended by the cream of the order.

In this way there was established the first fully developed religious order, in which the activity of each part and of each individual was subordinated to the purpose of the institute. This purpose was no longer, as it had been with the monks and canons, the purely spiritual object of the sanctification of the individual and the liturgical service of God; it was the saving of souls within the church or within reach of her missionary activity. In such an institute, the individual belonged to the order, not to the house, and could be sent anywhere at any time about its business. Finally, the order, along with that of the Franciscans, had received its title deeds directly from the papacy and was from the first based upon the curia, obedient to its instructions and regarded as a valuable instrument in the hands of the papacy. Though the Friars Minor (Franciscans) were a numerous body before 1216, the Friars Preachers were the first to receive solemn recognition and the first to set up the machinery of an order, and their constitutions served as a model not only for the other orders of friars but also for other subsequent bodies of religious until the end of the middle ages.

History.—Under the four distinguished masters general who followed Dominic—Blessed Jordan of Saxony (1221–37), St. Raymond of Peñafort (1238–40), John of Germany (1240–52) and Humbert of Romans (1254–63)—the order spread rapidly throughout Europe, and soon became particularly strong in the Rhineland and western Germany. While retaining a spirit all its own, it both influenced and was influenced by its twin brother, the order of Friars Minor, with whom, as contemporaries observed, it maintained a relationship of uneasy rivalry which the authorities and the better elements in both orders endeavoured to soften by personal and official civilities.

Although the statement that the Franciscans made the Dominicans mendicant friars, while the Dominicans made the Franciscans into a student order, is a serious oversimplification, it indicates well enough the direction of their mutual relations. Dominican writers have resented the opinion of earlier historians that Dominic "cashed in," so to say, on the popular appeal of Franciscan poverty, but though it is certain that from the start the founder regarded strict apostolic poverty as a necessity for his preachers, the Dominicans were not separated from others by a vacuum, and it is difficult to suppose that they would have felt the need to become "mendicants" and "friars" but for the compelling force of the Franciscan ideal. On the other hand, it is even harder to suppose that the Franciscans, had they remained alone, would have devoted themselves so soon and so eagerly to theological study, and it is certain that the Dominican constitutions had an influence, though not perhaps an overwhelming one, on the evolution of the Franciscan organization between the deposition of Elias of Cortona and St. Bonaventure.

The two orders from early times, however, had different attitudes to poverty. To the Franciscans it was an integral, indeed a principal, part of their imitation of Christ; to the Dominicans it was merely one virtue among others, and they were insistent that true poverty lay in the lack of desire, rather than in the physical absence, of possessions. They were therefore able to avoid the distressing controversies which divided the Minors, and ultimately found their vocation better assured by the papal permission (1475) for the corporate possession of property. In the intellectual and theological fields, the latent rivalry took shape in the firm opposition of the Franciscans, under Bonaventure and Archbishop John Pecham, to the adoption of Aristotelian principles of thought by the Dominicans Albertus Magnus and Thomas Aquinas.

On the other hand, the *esprit de corps* of the two orders gave way to a solidarity against common opponents, and Dominicans and Franciscans presented a common front against the demands of the University of Paris, against the attack on the mendicant ideal by William of St. Amour, and in the later litigation with Oxford and Cambridge on the admission to degrees. They were also in alliance in the most important of all their struggles, that for freedom of action in face of the diocesan bishops. In this and other matters it became habitual for the papacy to load them with privileges of every kind, and to communicate to one order any benefit bestowed upon the other.

Within 40 years of their foundation the talent of the order was concentrated upon the schools at Paris, Bologna, Cologne and Oxford; many eminent masters of the universities took the habit and became in time regents in the friaries, whither they were followed by many of their pupils. Originally students of theology only, and with no distinguishing philosophical opinions, they were led by Albertus Magnus and his pupil Thomas Aquinas to a study of the newly available Aristotle and to the integration of philosophy and theology. After a short initial opposition, the system of St. Thomas was adopted as official (1278). Meanwhile the Dominicans pursued their vocation by preaching in southern France against the heresies of the Cathari and Albigenses and in Spain and elsewhere against the Moors and Jews. They also evangelized the heathen in northern Europe and the east. The papacy chose numerous bishops from the order, among them in early days Robert Kilwardby, archbishop of Canterbury; Albertus Magnus, bishop of Ratisbon; and Pierre de Tarentaise, archbishop of Lyons and later pope as Innocent V. When the Inquisition was established Dominicans were entrusted with its execution; Pierre Cauchon, who presided over the court that condemned Joan of Arc, and Tomás de Torquemada were Dominicans.

In the Rhineland, where their school at Cologne was second in importance only to Paris, Albertus had inspired a number of pupils, among them Dietrich of Freiburg and perhaps Meister Eckhart, with a form of Christianized Neoplatonism which, if doubtfully orthodox in Eckhart, helped to create a notable school of mystical theology with Johann Tauler and Heinrich Suso among

its most distinguished writers. Combining elements of the teaching of Dionysius the Areopagite with the system of Aquinas and traditional practice, they built up a scheme of mystical theology which influenced not only Germany, the Low Countries and England but also St. John of the Cross and other Spaniards in the 16th century.

Though the era of the Black Death and the Great Schism was one of general relaxation, Raymund of Capua and Conrad of Prussia initiated reforms that spread throughout the order, and groups of friaries adopted strict regimes; at Florence in particular the convent of S. Marco was the home of Fra Angelico, St. Antoninus and Girolamo Savonarola. On the other hand, many of the Dominican preachers and theologians of the 15th century, in common with those of other orders of friars, were out of touch with the spiritual and intellectual needs and desires of northern Europe, and by their rigid technical approach to all questions and by their preaching in favour of mechanical and often superstitious practices of piety they failed to bridge the gulf between obscurantism and reform. Dominicans were among the *bêtes noires* of Erasmus, and it was Johann Tetzel, a Dominican friar, who by his ill-conceived preaching of indulgences in Germany detonated the Lutheran explosion.

In medieval England the Dominicans had some 53 houses with a population of 1,700 in 1349 and about 700 in 1534, but the province produced few friars of distinction save Kilwardby, Thomas Sutton, Nicholas Trivet (an orthodox Thomist who was also a chronicler and a student of Latin literature) and R. Holcot (a follower of William Ockham). The Dominicans, however, between 1250 and 1400 occupied in England and elsewhere an influential position as court confessors, counselors and diplomats, and no fewer than three English Dominicans became cardinals between 1303 and 1310. After the Black Death, which hit the friars hard, the only memorable name is that of John Bromyard, theologian and popular preacher, who along with his confrères and friars of other orders took a vigorous part in the opposition to John Wycliffe.

The Dominicans were among the first and most energetic missionaries in the "expansion of Europe" under the Spanish and Portuguese explorers and later under the French. In the new world three friars were distinguished among others: Bartolomé de Las Casas, bishop of Chiapas in Mexico, who fought long and nobly against the enslavement and exploitation of the Indians; St. Louis Bertran, the apostle of New Granada and West Indian islands; and Julian Garcés, a follower of Las Casas. In the 16th century also the Dominican theologians of Italy and Spain inaugurated a great revival of Thomism. Francis a Sylvestris and Tommaso de Vio, better known as Cajetan, wrote classical commentaries on the *Summa contra gentiles* and the *Summa Theologica* respectively, while Francis of Vitoria opened a brilliant era at Salamanca. It was an austere and reforming Dominican who, as Pius V, issued the bull *Regnans in excelsis* against Elizabeth I. Among the celebrated theologians of the age at Trent and elsewhere were Melchor Cano; Dominic de Soto; Domingo Bañez, the director of St. Teresa of Ávila and the father of modern Thomism; and John of St. Thomas, a leading mystical theologian. At the turn of the century occurred the celebrated and unresolved controversy between Dominicans and Jesuits on the nature of grace associated with the names of Bañez, Luís de Molina and Robert Bellarmine. In the 17th century missionaries of the order penetrated to China, Japan and the Philippines. In China they were embroiled with the Jesuits in the vexatious controversy over "accommodation" in doctrine and ritual with the native Chinese, but both there and in Japan they gave numerous martyrs to the faith.

The Dominicans, in common with all other orders, declined under the rationalism and secularization of the 18th century but they gave a fourth pope to the church in Benedict XIII. Later, the persecutions and suppressions of the revolutionary and Napoleonic eras left few friars outside the Italian and Iberian peninsulas. A revival followed in the mid-19th century, with French influence at its head, in particular Henri Lacordaire and A. V. Jandel, for more than 20 years master general, and though harassed in 1880 and expelled for more than 20 years beginning in 1903, the French Dominicans have continued to provide the intellectual leadership of the order. In the first half of the 20th century there was a steady expansion, particularly in the United States, which, after Spain and France, is the nation of greatest influence.

The Dominicans enjoyed an access of prestige when in 1879 Leo XIII recalled Catholic schools to Thomism, and entrusted the Preachers with the production of the great Leonine edition of St. Thomas' works. Since then a succession of great names has given lustre to the order: H. S. Denifle, historian of the medieval universities, of Luther, and of much besides; P. Mandonnet, historian of medieval thought; M. J. Lagrange, orientalist and biblical scholar; and A. Gardeil, a distinguished theologian. Besides their school of philosophy and theology in Rome (the Angelico), the order has at Sta. Sabina historical and liturgical institutes and a publishing centre for learned work. It staffs the biblical school in Jerusalem, founded by Lagrange in 1890; the theological faculty of the University of Fribourg in Switzerland; and the university at Manila. In almost every province journals of religious life and thought are published; among those with world-wide reputation are the *Revue biblique* and the *Revue Thomiste*.

The medieval English province was dissolved in 1538, and though Queen Mary I restored the order for a few years at Smithfield no permanent link was maintained with the past. The founder of the present succession was the English friar Thomas Howard, later the "cardinal of Norfolk," who set up a novitiate for Englishmen at Bornhem in Holland (1657), whence the Englishmen were transferred later to Antwerp and served on the English mission. The order returned to England in the mid-19th century but remained few in number until the 20th century, when a development took place, especially during the provincialate of B. Jarrett, and a large priory was opened at Oxford. The province has charge of the church in Grenada (West Indies) and stations in South Africa.

In Ireland Dominicans remained at work throughout the penal times, and in the 19th century T. Burke was widely known as a preacher. In 1962 a Spaniard, Aniceto Fernández, was elected master general of the order.

Special Characteristics.—The Dominican order has always been noted for an unswerving orthodoxy, based upon the philosophical and theological teaching of Aquinas, and has steadfastly opposed novelty, opportunism or accommodation in theology. While the close integration of Aristotelian philosophy and traditional theology has given a remarkable strength and cohesion to the Dominican system of teaching, it has led also to a certain rigidity and an absence of clear distinction between what is dogmatically certain and what is deducible with greater or less probability. At the same time there has always been a current of social democracy and liberalism among the friars, appearing in such different personalities as St. Antoninus, Savonarola, Las Casas, Lacordaire, T. Burke and the English friar Vincent McNabb. The Dominicans of the 13th century popularized and appropriated the devotion known as the rosary, and the friars wear the beads at their girdle; they have a rite of Mass and a version of the breviary peculiar to the order.

Second Order.—The Second Order of enclosed nuns (called Preacheresses) sprang from the house at Prouille, whence sisters were taken to the nunnery of Sta. Sabina in Rome (1220). Thereafter numerous foundations were made throughout Europe. In the Rhineland in particular convents were many and communities large, and it was among the nuns of these houses that Tauler and other Dominican preachers spread their doctrine of the ascetical and mystical lives with remarkably fruitful consequences. In England the nunnery at Dartford was one of the largest and most observant in the later middle ages. The nuns of the Second Order are strictly enclosed and contemplative, save where, as in Germany, they devote themselves to teaching.

The Preacheresses' habit, like that of the friars, is black and white: white tunic and scapular, linen wimple and black veil.

Third Order.—The Third Order likewise came into being in Dominic's lifetime for both men and women, and in both cases

the tertiaries tended to adopt a life almost indistinguishable from that of a religious order. There are throughout the world numerous congregations of Dominican nuns, mainly engaged in teaching and nursing, and in some cases resembling very closely the Second Order in their way of life.

In England the first house was founded by Mother Margaret Hallahan (d. 1868), and the various branches of the order have been united; foundations have been made in North America and various countries of the Commonwealth of Nations. St. Catherine of Siena, St. Catherine de' Ricci and, among those living in the world, the first saint of America, St. Rose of Lima, were members of the Third Order.

Third Order nuns wear white tunic and hood, leather belt and black cloak.

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DOMINION STATUS was an expression often used before 1939 to describe the status of the British countries then known as the dominions, namely Canada, the commonwealth of Australia, New Zealand, the Union of South Africa, Eire and Newfoundland. Though there was no formal definition of dominion status, a pronouncement by the imperial conference of 1926 described Great Britain and the dominions as "autonomous communities within the British Empire, equal in status, in no way subordinate one to another in any aspect of their domestic or external affairs, though united by a common allegiance to the Crown and freely associated as members of the British Commonwealth of Nations."

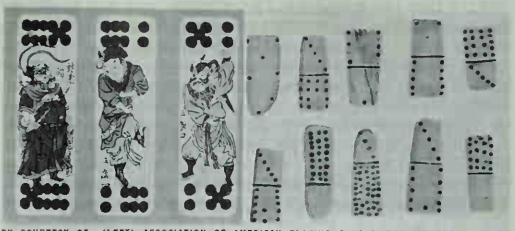
The main characteristics of dominion status were regarded as complete legislative authority as provided in the Statute of Westminster, 1931, and, in the executive sphere, the right of dominion ministers to direct access to the sovereign, in contrast to the previous position whereby advice on dominion matters could be tendered only by United Kingdom ministers. Internationally, it connoted the recognition of the dominions (except Newfoundland) as separate states, entitled to have separate representation in the League of Nations and other international bodies, to appoint their own ambassadors and to conclude their own treaties. At the same time the dominions were not considered to stand in the same relation to the United Kingdom or among themselves as foreign countries. After 1947 the use of the expression was abandoned as it was thought in some quarters to imply a form of subordination, and the phrase "members of the commonwealth" came into use to describe the United Kingdom and the dominions enumerated above (except the Republic of Ireland which left the commonwealth in 1949, and Newfoundland, which in 1949 became a province of Canada), as well as India, Pakistan, Ceylon, Ghana and the Federation of Malaya, all of which later attained the same status. (*See* COMMONWEALTH OF NATIONS.)

The definition of 1926 was modified by a declaration by the commonwealth prime ministers' meeting of 1949. According to this, India, which intended to adopt a republican form of constitution, desired to continue full membership in the commonwealth and accepted the British sovereign as the symbol of the free association of the independent member nations and as such the head of the commonwealth; the other countries of the commonwealth recognized India's continued membership on those terms. A similar declaration relating to Pakistan was issued by the prime ministers' meeting of 1955. In 1961 the Union (Republic) of South Africa withdrew from the commonwealth.

See N. Mansergh, *Problems of External Policy, 1931–1939*, "Survey of British Commonwealth Affairs Series" (1952); K. C. Wheare, *Statute of Westminster and Dominion Status*, 5th ed. (1953). (Cs. W. D.)

DOMINOES, a game played with rectangular blocks of wood or other material, each identified by the number of dots on its face. Such a block is usually 1½ to 2 in. in length, its width being about half its length and its thickness about one-eighth its length. The blocks are usually called bones, dominoes or pieces, but are sometimes called men, stones or even cards.

The face of each piece is divided, by a line or ridge, into two square ends, and is marked similarly to a pair of dice side by side except that some ends are blank. The usual set comprises 28 pieces, respectively marked 6-6 ("double six," etc.) 6-5, 6-4, 6-3, 6-2, 6-1, 6-0, 5-5, 5-4, 5-3, 5-2, 5-1, 5-0, 4-4, 4-3, 4-2, 4-1, 4-0, 3-3, 3-2, 3-1, 3-0, 2-2, 2-1, 2-0, 1-1, 1-0, 0-0. Any group of pieces having a common end comprise a suit, doublets belonging to one suit each and all other pieces to two suits. Of two bones the one bearing the greater number of dots is called heavier, the other lighter. Some sets run up to 9-9 and others as high as 12-12.



BY COURTESY OF: (LEFT) ASSOCIATION OF AMERICAN PLAYING CARD MANUFACTURERS; (RIGHT) THE SMITHSONIAN INSTITUTION

(LEFT) CHINESE DOMINO CARDS WITH CHARACTERS FROM A FABLE; (RIGHT) ESKIMO IVORY DOMINOES

Dominoes in China are as ancient, or almost, as playing cards (*see* CARDS, PLAYING). They were apparently designed to represent all the possible throws with two dice, for Chinese dominoes (which they call "dotted cards") have no blank faces. It does not necessarily follow, however, that western dominoes were derived from the Chinese. In Europe dominoes are relatively new, there being no record of them before the middle of the 18th century in Italy and France. Apparently they were introduced into England by French prisoners toward the end of the 18th century. The name may have been derived from pieces made of ebony with ivory faces and resembling a black cloak called a domino. The Innuit Eskimos gamble wildly at dominoes. Their game, in which as many as 148 pieces are used, was derived from the European game.

The principle in nearly all modern dominoes games is the matching of one end to another, identically or reciprocally numbered. The principal varieties are:

The Block and Draw Games.—Two play. The dominoes are shuffled face downward on the table. The lead, or set, is usually decided by drawing for the highest bone, but it is sometimes held that any doublet takes precedence. The bones are then reshuffled, and each player draws at random the number of bones required for the particular form of the game, usually seven. The bones left behind are called the boneyard (U.S.), or stock.

The leader plays first, generally playing his highest domino, since at the end the player loses according to the number of pips in the bones he has left in his hand. By some rules, a player after playing a double may play another bone which matches it; *e.g.*, if he plays double-six he may play another bone which has a six at one end. The second player has to match the leader's pose, or play, by putting one of his bones in juxtaposition at one end; *i.e.*, if the leader plays four-five, the second player has to play a bone which contains either a four or a five, the five being applied to the five or the four to the four. Doublets are placed *à cheval* (crosswise). If a player cannot match, he says "go," and his opponent plays, unless the Draw game—the usual game—is being played, in which case the player who cannot match draws from the stock (two bones must always be left in stock) until he finds a bone that matches. If a player succeeds in posing all his bones, he calls "Domino!" and wins the hand, scoring as many points as there are pips on the bones still held by his opponent. If neither player can match, that player wins who has the fewest pips left in his hand and he scores as many points as are left in the two hands combined (sometimes only the excess held by his opponent); but when a player has called "go!" his adversary must match if he can, in which case the other player may be able to match in turn. A game may be 50 or 100 points.

All Fives (or Muggins).—Each player takes five bones. If the leader poses either double-five, six-four, five-blank, or three-two, he scores the number of pips that are on the bone. If in the course of play a player can play such a bone as makes the sum of the end pips 5, 10, 15 or 20, he scores that number; *e.g.*, if to two-four he can play double-four (*à cheval*) he scores 10; if to six-one he plays six-four he scores 5. He must pose if he can match; if he cannot, he draws until he can. Scores are called and taken immediately. At the point of the domino, the winner scores in points the multiple of five which is nearest to the number of pips in his adversary's hand; *e.g.*, he scores 25 if his adversary has 27 pips, 30 if he has 28. If neither hand can match, the lowest number of pips wins, and the score is taken as before, without addition or subtraction, according to the adversary's pips.

All Threes is played in the same manner as Muggins, save that three or some multiple of three is aimed at.

Threes and Fives is similar, but only one point is scored for each five or three made at the two ends, though they can be scored in combination. Thus A plays six-five; B six-one; B scores 2 points for five-one (two threes). A plays one-five; B double-five; B now scores 8 more, 5 for five threes and 3 for three fives.

Sniff, very popular in the U.S., lends itself to skilful play better than most dominoes games. It is essentially All Fives (described above). Two may play, drawing seven bones each; or three or four, drawing five bones each. The first double played is called sniff. The sniff may first be put down endwise (in which case only one of its ends then counts) or sidewise, at the holder's option; thereafter it is permissible to play to this bone both endwise and sidewise, so that there are usually four open ends with which to reckon. One need not play, although able to, if he wishes instead to draw from the stock; but the last two bones may never be drawn, and since the holding of additional bones may be an advantage it is customary to limit each player to two draws, after which he must play if able and pass if unable to play.

Domino Whist is played by four players. Partners are drawn for as at whist; the player drawing the highest domino leads. Each player takes seven bones. There are no tricks, trumps or honours. The bones are played as in ordinary dominoes, a hand being finished when one of the players plays his last bone, or when both ends are blocked. Pips are then counted, and the holder or holders of the highest number score to their debit the aggregate number of points. The side that is first debited with 100 points loses the game.

Matador.—This is a favourite and is also one of the most scientific forms of the game. It is played on a different principle from the preceding variations, the object being not to match the end number, but to pose such a number as, added to the end, will make seven; *e.g.*, to a five a two must be played, to a three a four, etc. Seven dominoes are drawn and the highest double begins. When a player cannot make a seven on either end he must draw from stock until he secures a bone that will enable him to make seven, two bones remaining in the stock. As Matador is played with dominoes no higher than six, a blank means blocking of that end. In this case no further play can take place at that end excepting by posing a matador, which may be played at any time. There are four matadors, the 6-1, 5-2, 4-3, and double-blank. It is often better to draw one or more fresh bones than to play one's last matador. In posing a double counts as a single number only, but in scoring the full number of pips is counted. When the game has been definitely blocked the player whose pips aggregate the lower number scores the number of the combined hands (sometimes only the excess in his opponent's hand), the game being usually 100. Matador can be played by three persons, in which case the two having the lowest scores usually combine against the threatening winner; and also by four, either each for himself or two on a side. With four players only five bones are drawn by each.

See A. H. Morehead *et al.*, *The New Complete Hoyle*, rev. ed. (1956).

DOMINUS, the Latin word for master or owner, particularly of slaves. As a title of sovereignty the term under the republic at Rome had the same associations as the Greek *despotes*. Ancient historians such as Tacitus, describing the transition from the republic to the empire, applied the word *dominatio* to the episodes of personal ascendancy such as those of Sulla, Pompey and eventually Caesar, which were steps toward monarchy. The early emperors, for instance Tiberius, were at pains to disclaim the title (*see* EMPEROR), but Caligula arrogated it and later Domitian insisted on being addressed as "dominus et deus." This finally became an official title of the Roman emperors under Diocletian.

In medieval Latin *dominus* was used to signify the superior in a feudal relationship, the "lord" of a territory or the overlord of a vassal; *e.g.*, the English kings' style of *dominus Hibernie*, lord of Ireland. Equivalent to Eng. "lord," "sir" or "master," Fr. *seigneur, sieur* or *sire* and Ger. *Herr*, it came to be used as a prefix of respectful address: Sp. *don* and Port. *dom* are derived from it. The prefix was also accorded to the clergy (It. *don* for priests), to religious (especially to Benedictines, still addressed as dom) and to graduates of universities. The English use of "sir" for parsons before the Reformation is a parallel, but it is uncertain whether that of "don" for fellows or tutors of colleges in universities is derived from the academic use of *dominus* or from allusion to Sp. *don*. The variant "dan" occurs in medieval English and in archaistic contexts later ("Dan Chaucer," etc.).

DOMITIAN (TITUS FLAVIUS DOMITIANUS), Roman emperor A.D. 81–96, chiefly remembered for the reign of terror under which prominent members of the senate lived during his last years, was born Oct. 24, 51, the second son of Vespasian (*q.v.*) and Flavia Domitilla. During the civil war of 69 he remained unharmed in Rome, but on Dec. 18 he took refuge in the Capitol with his uncle Flavius Sabinus, escaping into hiding when the Capitol was stormed by supporters of Vitellius (*q.v.*). On the entry of his father's supporters into Rome two days later he was saluted as *Caesar*, and he became praetor next year. He attempted to turn the repressive campaign of Petillius Cerialis in the Rhineland into a triumphal operation of his own; and for this and other excesses he is said to have required his father's pardon when the latter arrived at Rome in autumn 70. He was however made *princeps iuventutis* and was consul six times in Vespasian's lifetime; moreover it was recognized that he would eventually succeed his brother Titus (*q.v.*), who had no son and was 11 years Domitian's senior.

On Vespasian's death Domitian expected the same position as Titus had received under Vespasian, in particular tribunicial power and some form of *imperium* (*see* EMPIRE). These were not granted, and Domitian was evidently antagonistic to his brother; he is alleged to have hastened his death, which occurred on Sept. 13, 81.

As emperor he was hated by the aristocracy. In the Trajanic writers Tacitus and Pliny (Suetonius is less partisan) it is hard to disentangle stock vituperation from genuine belief, but it seems certain that cruelty and ostentation were the chief grounds of his unpopularity rather than any military or administrative incompetence.

Indeed his strict control over magistrates in Rome and the provinces won Suetonius' praise. In his secretariat he used both freedmen and knights, some of whom retained their posts after his death; and his *consilium* of close advisers, including senators, involved no departure from precedent. In legislation he was severe, and incurred censure for attempting to curb vices from which he himself was not immune. A fairer criticism might be undue paternalism. An edict ordaining destruction of half the provincial vineyards was typical: it was designed to encourage corn growing and to limit wine imports into Italy (where meanwhile no increased output was permitted), but Domitian was unable to carry the matter through.

His military and foreign policy was not uniformly successful. Both in Britain (*see* AGRICOLA, GNAEUS JULIUS) and in Germany advances were made early in the reign, and the construction of the Rhine-Danube *limes* (fortified line) owes more to Domitian than to any other emperor. But consolidation in Scotland was halted by serious wars on the Danube (*see* DACIA), where Domitian never achieved an entirely satisfactory settlement and,

worse still, lost two legions and many other troops. This, though admitted even by Tacitus to be due to the slackness or rashness of his commanders, was naturally held against him at Rome. But it did not affect his popularity with the army, whose pay he had wisely raised by one-third in 84.

The real issue was his own constitutional and ceremonial position. He continued his father's policy of holding frequent consulates (he was consul *ordinarius* every year from 82 to 88); he became censor for life in 85, with consequent control over senatorial membership and general behaviour; he wore triumphal dress in the senate; and he presided, wearing Greek dress and a golden crown, over four-yearly games on the Greek model, with his fellow-judges wearing crowns bearing his own effigy among effigies of the gods. A grave source of offense was his insistence on being addressed as *dominus et deus* ("master and god").

The execution of his cousin Flavius Sabinus in 84 was an isolated event, but there are hints of more general trouble about 87. The crisis came with the revolt of Antonius Saturninus, governor of Upper Germany, on Jan. 1, 89. This was suppressed by the Lower German army, but a number of executions followed, and the law of *maiestas* ("treason") was later employed freely against senators. The years 93–96 were regarded as a period of terror hitherto unsurpassed.

Among Domitian's opponents was a group of doctrinaire senators, friends of Tacitus and Pliny and headed by the younger Helvidius Priscus whose father of the same name (*q.v.*) had been executed by Vespasian. Their Stoic views were probably the cause of his expulsions of "philosophers" from Rome on two occasions. It is unlikely that he was carrying out any considered policy on the organization of thought, any more than that his condemnation in 95 of his cousin Flavius Clemens for *atheotes* ("irreligion") is part of a deliberate attack on Christianity.

His financial difficulties are a vexed question. Cruelty came earlier in his reign than rapacity, but eventually he regularly confiscated the property of his victims. His building program had been heavy: Rome received a new forum (later called Forum Nervae) and many other works. Then there were Domitian's new house on the Palatine and his vast villa on the Alban mount. Meanwhile the increased army pay was a recurrent cost. Probably only his confiscations averted bankruptcy in the last years.

The conspiracy which caused his murder on Sept. 18, 96 was led by the two praetorian prefects, various palace officials, and the emperor's wife Domitia Longina (daughter of Gnaeus Domitius Corbulo, *q.v.*). Nerva (*q.v.*), who took over the government at once, must clearly have been privy. The senate was overjoyed at his death, but the army took it badly; and next year they insisted on punishment of those responsible.

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DOMRÉMY-LA-PUCELLE, a village of eastern France in the *département* of Vosges, is situated on the Meuse, 116 km. (72 mi.) S.E. of Reims by road. Pop. (1954) 173. Part of the village is modern, the rest is medieval. Domrémy was the home of St. Joan of Arc, and her birthplace is now a museum devoted to her memory. In the church close by is the font in which Joan was baptized, and near the bridge is a statue of her by A. Mercié (1902). A mile to the south, on the "Bois-Chenu" hill, is a basilica erected in 1881 in memory of Joan of Arc and all French soldiers. Nearby is the Fontaine des fiévreux where the girl heard some of her voices. (*See* JOAN, SAINT.) In World War II Domrémy was in German hands from June 1940 to Sept. 1944.

(J. F. le L.)

DON is the name of several British rivers, of which the two most important are in Aberdeenshire, Scot., and Yorkshire, Eng.

The Aberdeenshire Don, noted for its salmon and trout, flows generally eastward from its source on the slopes of Meikle Geal Charn till it reaches the North sea at Aberdeen. About 82 mi. in length, it is roughly parallel with the Dee (*q.v.*), but in comparison has more quietly flowing stretches amid green rolling hills or lowland. Rising at about 2,000 ft., in its first 10 mi. it receives many short hill streams on both sides. The main stream swings across a fairly broad glen (it may be a misfit stream, the Avon having captured its former upper course). The place name Strathdon implies a broad valley, and the triangular lowland between gorges north of Coillebhar hill and south of Bennochie is named the Howe (lowland vale) of Alford. From Monymusk the Don swings broadly, flowing east-southeast across an arable and stock-farming lowland, to enter the sea by an artificial course (*c.* 1750) through the north of Aberdeen.

The Yorkshire Don, rising in the Pennines at 1,500 ft., flows east for 5 mi. to Penistone, where it turns southeastward into a deep, narrow valley following the strike of the Lower Coal Measures. In a mainly rural scene are residuals of early iron and woolen industries attracted by water power, ganister and thin coal seams. At Sheffield the Don turns sharply northeastward in a deep, narrow, fault-guided valley cut into a lower plateau in Middle and Upper Coal Measures; this is the heart of the south Yorkshire steel manufacturing area. From Doncaster, an old Roman crossing place and modern mining centre, the valley opens out into the agricultural Vale of York, and the river joins the Ouse at Goole after a course of about 70 mi. Until regulated in the 17th–18th centuries by the Dutch engineer Cornelius Vermuyden and others, the lower Don meandered widely across a heavily drift-covered glacial lake bed. (A. T. A. L.)

DON (ancient TANAIS), one of the great rivers of Europe in the south central European part of the Russian Soviet Federated Socialist Republic of the U.S.S.R., is 1,224 mi. long and drains a basin of 170,849 sq.mi. The Don rises in the Central Russian upland near the town of Novomoskovsk in Moscow *oblast,* southeast of Tula and follows a southerly course to a point about 50 mi. S. of Voronezh, where it swings southeastward and then eastward to within 48 mi. of the Volga. It then takes a great curve to the southwest and finally west-southwest to enter the head of the Taganrog gulf of the sea of Azov. The total fall of the river from source to mouth is only 623 ft., about 1 in 10,000. As a result its course, even in the upper reaches, is extremely winding and its current sluggish. The upper course lies in a fairly narrow valley, widening in the middle reaches to 4–5 mi. and in places up to 20 mi. At this point the width of the river is about 270–400 yd. and there are innumerable sandbanks. At the great bend near the Volga the Don flows into the giant Tsimlyanski reservoir, about 200 mi. long, constructed in 1950–51 in connection with the building of the Volga-Don canal. Below the Tsimlyanski barrage the Don flows in a broad, often swampy flood-plain to its delta, which is gradually filling up the shallow Taganrog gulf. The entire length of the river is characterized by a high, steep right bank, in places up to 200 ft. high or more, which is greatly dissected by ravines. The left bank is a low, broad flood-plain or steppe, backed by a series of terraces.

The average annual flow at the mouth is 31,783 ft. per second, but seasonal variation is considerable. At Kalach a maximum of 508,533 cu.ft. per second has been recorded during the spring snow-melt and a minimum of 2,719 cu.ft. in summer low water. Widespread flooding of the low left bank occurs in spring, but the Tsimlyanski reservoir has allowed more regulated flow in the lower course. The river remains frozen from early November until the second half of March.

The Don has a large number of tributaries, many of which are themselves sizable rivers. The largest are, on the right bank, the Sosna, Tikhaya Sosna, Chir (248 mi. long) and Northern Donets (631 mi.), and on the left bank the Voronezh (229 mi.), Khoper (626 mi.), Medveditsa (475 mi.), Sal and Manych (162 mi.).

The Don is navigable from the mouth to Khlebnoye, about 50 mi. north of Voronezh, but above the Tsimlyanski reservoir sandbanks are a considerable handicap and navigation is of only moderate importance. The reservoir and lower course form a major shipping artery, open to sea-going craft and carrying heavy passenger and goods traffic, with timber, petroleum, coal and grain

the chief freights. This section of the Don, with the Volga-Don canal, forms the outlet for the entire Volga-Kama-Caspian system of waterways. A ship canal, built in 1925, improves navigation through the delta. The Don has been an important line of communication since the period of Kievan Russia (*see* KIEV), when it formed a trade route from the Russians to the Khazars (*q.v.*). Peter the Great, in his campaigns of 1695 and 1696 against the Turkish fortress of Azov at the river mouth, built fleets of ships in oak forests around Voronezh and sailed his armies down the Don. He planned and started work on a canal to link the upper Don to the Oka, but this was abandoned after the failure of his Turkish campaigns. Along the Don settled the most famous of the Cossack hosts, who took their name from the river and who maintained their identity within the former *oblast* of the Don Cossacks (or Don Army) down to the Revolution.

The major cities on the Don are Voronezh and the port of Rostov-on-Don (*q.v.*), which has usurped the functions of the older Azov. Kalach is an important port near the end of the Volga-Don canal. The Tsimlyanski barrage provides hydroelectric power and also irrigation water for the extensive vineyards and market gardens along the lower Don. The river supports a considerable fishing population who market salmon, herring, salt fish and caviar. (R. A. F.)

DONATELLO (diminutive of DONATO) (*c.* 1386–1466), Italian sculptor, one of the founders of Renaissance art, was the son of Niccolò di Betto Bardi, a member of the Florentine wool carders' guild. Nothing is known about the beginnings of his career, but it seems likely that he learned the craft of stonecarving from one of the group of sculptors working for the Florence cathedral in the years around 1400. Between 1404 and 1407 he was for some time a member of the workshop of Lorenzo Ghiberti, who in 1402 had won the competition for the bronze doors of the baptistery. While his early work betrayed an important artistic debt to Ghiberti, Donatello soon developed a style of such revolutionary boldness that he must be adjudged second only to his friend Filippo Brunelleschi as a founding father of Renaissance art. Whether or not he went to Rome with Brunelleschi as early as 1402 or 1403 (the evidence for this trip is much disputed), he shared the latter's enthusiasm for the art of classical antiquity and was on intimate terms with the humanists, the creators of Renaissance scholarship and philosophy.

In Nov. 1406 Donatello was carving two small marble figures of prophets for the north portal of the Florence cathedral, but he seems to have completed only one of them, since he did not receive payment for the other. Unfortunately, neither statue has survived. Thus his earliest work of which we have certain knowledge was the marble "David" (Museo Nazionale, Florence) that he did in 1408–09. Originally intended for one of the buttresses of the cathedral, the figure was transferred in 1416 to the Palazzo Vecchio, where it stood for many years as a civic-patriotic monument. Donatello adapted it to its new function by removing a scroll from David's right hand and exposing the left leg, which had been hidden, in Gothic fashion, behind a sheath of drapery. Other early works of the master, still partly Gothic in style, were the impressive seated marble figure of "St. John the Evangelist" (Cathedral museum, Florence) and the wooden crucifix in S. Croce, both of about 1409–11. The latter, according to a persistently repeated anecdote, was made in friendly competition with Brunelleschi, but the story is clearly fictitious.

The full power of Donatello's genius was first felt in the two marble statues of "St. Mark" (1411–13) and "St. George" (about 1415–16) for niches on the exterior of Or San Michele, the church of the Florentine guilds (the "St. George" was replaced by a copy; the original is in the Museo Nazionale). Here, for the first time since classical antiquity and in striking contrast to medieval art, the human body was rendered as a self-activating, functional organism, and the human personality was endowed with a confidence in its own individual worth. These figures can stand on their own legs, physically as well as spiritually. The same qualities were increasingly evident in the series of statues that Donatello did for the niches of the campanile, the bell tower of the Florence cathedral, beginning in 1416. All these figures, together with their companions by other and lesser masters, were later removed to the Cathedral museum, where they can be studied at close range. The documents relating to them, although rich in number, presented problems of interpretation and identification that were very difficult to overcome. They indicate that Donatello did five statues altogether: a beardless and a bearded prophet as well as the group of Abraham and Isaac for the east niches (1416–18, 1418–20 and 1421, respectively) and two figures, the so-called "Zuccone" and the so-called "Jeremiah" (actually a Habakkuk) for the west niches. The so-called "St. John the Baptist" and the so-called "Poggio Bracciolini"—both misnomers retained now only for the sake of convenience—used to be claimed for Donatello but have turned out to be the work of Nanni di Bartolo (one of the master's assistants) and of Bernardo Ciuffagni, a rather mediocre artist of Donatello's own generation who also did the "St. Peter" at Or San Michele, another figure previously attributed to Donatello. The "Zuccone" (1423–25) well deserves its reputation as the finest of the campanile statues and one of the artist's masterpieces. Both it and the "Jeremiah" (begun in 1427; delivered in 1435) show highly individual features inspired by Roman portrait busts. Their entire appearance, which suggested classical orators of singular expressive force, had so little in common with the traditional image of Old Testament prophets that by the end of the 15th century they could be mistaken for portrait statues pure and simple.

H. W. JANSON, "SCULPTURE OF DONATELLO," © PRINCETON UNIVERSITY PRESS, 1957, AND OXFORD UNIVERSITY PRESS

"ZUCCONE" BY DONATELLO, FROM THE CAMPANILE OF THE FLORENCE CATHEDRAL, 1423–25. IN THE CATHEDRAL MUSEUM, FLORENCE

In his relief panels for the north door of the baptistery, Ghiberti had begun to extend the apparent depth of the scene by placing the boldly rounded foreground figures against more delicately modeled settings of landscape or architecture. Taking this pictorial tendency as his point of departure, Donatello in his marble panel of "St. George Killing the Dragon" (1416–17, base of the St. George niche at Or San Michele) invented a bold new mode of relief known as *stiacciato*. Its actual depth of carving was extremely shallow throughout, yet for that very reason the effect of deep atmospheric space was far more striking than before, since the sculptor no longer modeled his shapes in the usual way but rather seemed to "paint" them with his chisel. Tonal values (or shades) were created through subtle modulations of the relief surface that were meant to control the angle at which the light was reflected by the carved forms. A blind man could read a Ghiberti relief with his fingertips; a *stiacciato* panel, on the contrary, must be seen, for it depends on visual instead of tactile perceptions.

After the pioneer effort of the St. George relief, Donatello continued to explore the possibilities of the new technique in his marble reliefs of the 1420s and early 1430s. They included the "Pazzi Madonna" (about 1422; Staatliche Museen, Berlin), the "Shaw Madonna" (about 1425–28; Museum of Fine Arts, Boston), the "Assumption of the Virgin" (1427–28; tomb of Cardinal Brancacci, S. Angelo a Nilo, Naples) and the "Ascension and Delivery of the Keys to St. Peter" (about 1428–30; Victoria and Albert museum, London). His last marble *stiacciati*, so far as is

known, are the "Entombment of Christ" (tabernacle in the Sagrestia dei Beneficiati, St. Peter's, Rome), which he carved during a Roman sojourn in 1432–33, and the "Feast of Herod" (about 1433–35; Musée Wicar, Lille). However, the splendid stucco roundels below the dome of the old sacristy of S. Lorenzo, Florence, still followed the same technique, with the addition of colour for better legibility at a distance (about 1434–37).

In the meantime, Donatello also became a major sculptor in bronze. His earliest work in that material was the overlifesize statue of "St. Louis of Toulouse," executed about 1423 for a niche at Or San Michele (replaced by Verrocchio's group of "Christ and St. Thomas"). Toward 1460 the St. Louis was transferred to Sta. Croce, where until 1903 it stood in a niche above the main portal. It was then transferred to the museum of Sta. Croce. A cleaning of the statue restored its original gilt surface and revealed the full beauty of the work. Contrary to the unfavourable opinion of older scholars, the St. Louis was an achievement of the first rank, artistically as well as technically. Even though the garments completely hide the body of the figure, Donatello succeeded in conveying the impression of harmonious organic structure beneath the drapery. Unlike Ghiberti, Donatello never maintained a bronze foundry, but used the casting facilities of others (usually bell founders). This, however, was a matter of convenience, rather than evidence of lack of technical competency, and does not justify the view that the master's bronzes were the result of collaboration with other sculptors better versed in the requirements of the medium. If Donatello needed a collaborator at the time he was engaged on the St. Louis, it was probably a specialist in decorative architecture, since he had been commissioned to do not only the statue but also the niche for it. This niche was the earliest of its kind to display the new architectural style created by Brunelleschi without residual Gothic forms. It could hardly have been designed by Donatello alone; he may have been assisted by Michelozzo, with whom he entered a limited partnership one or two years later (in 1424–25). To the joint enterprises of the two masters, Donatello contributed only the sculptural centre—the fine bronze effigy on the tomb of the schismatic pope John XXIII in the baptistery (1425–27), the "Assumption" relief of the Brancacci tomb in Naples and the balustrade reliefs of dancing angels on the outdoor pulpit of Prato cathedral (1433–38). Michelozzo was responsible for the architectural framework and the decorative sculpture. The architecture of these partnership projects, essentially Brunelleschian in character, differed sharply from that of comparable commissions undertaken by Donatello alone in the 1430s (the tabernacle in St. Peter's, Rome; the "Annunciation" tabernacle in Sta. Croce, Florence; and the singers' pulpit, or *cantoria*, for the Florence cathedral, later placed in the Cathedral museum), all of which showed an unorthodox ornamental vocabulary drawn from classical and medieval sources as well as a most un-Brunelleschian tendency to blur the distinction between the sculptural and the architectural elements. The graceful and lyrical figures of the Sta. Croce "Annunciation" were set against a background of the same ornament that occurred on the tabernacle itself, and the frieze of ecstatically dancing angels on the *cantoria* ran behind, not between, the paired colonnettes of the balustrade.

Even during his partnership with Michelozzo, Donatello carried out a number of independent commissions of a purely sculptural character, including several pieces in bronze for the baptismal font of S. Giovanni in Siena. The earliest, and most important, of these was the "Feast of Herod," an intensely dramatic relief (designed between 1423 and 1425) with an architectural background that displayed for the first time Donatello's command of scientific linear perspective; this mathematically precise system of foreshortening and space projection had been invented only a few years earlier by Brunelleschi. To the Siena font Donatello also contributed two statuettes of virtues ("Faith" and "Hope," about 1428), austerely beautiful female figures whose style pointed toward the Sta. Croce "Annunciation," and three nude *putti* (child-angels), one of which was stolen and was later acquired by the Berlin museum (1429). These *putti* prepared the way for the bronze "David" (about 1430–32; Museo Nazionale), the first large-scale, free-standing nude statue of the Renaissance. Well proportioned and superbly poised, it was conceived independently of any architectural setting. Its air of harmonious calm made it the most classical of the master's works. The small bronze doors for the old sacristy of S. Lorenzo (about 1440), in contrast, showed paired saints and apostles disputing with each other in extraordinarily vivid and even violent fashion.

In 1443 Donatello was about to start work on a much more ambitious set of bronze doors for the sacristies of the Florence cathedral when he was lured to Padua by the commission for a bronze equestrian statue of the famous Venetian *condottiere* Erasmo da Narni, called Gattamelata. Completed between 1447 and 1450 but not installed on its pedestal in front of the church of S. Antonio until 1453, this overlifesize monument showed the general, in pseudo-classical armour, calmly astride his mount. The head was an idealized portrait instinct with Roman nobility and intellectual power. This statue was the ancestor of all the equestrian monuments erected since the mid-15th century.

While in Padua, Donatello also did a bronze crucifix for S. Antonio (1444–47), a splendidly expressive work that makes an instructive comparison with the master's early crucifix in S. Croce, as well as the high altar of S. Antonio (1447–50), consisting of 7 bronze statues, 21 bronze reliefs and a large panel of the entombment of Christ in limestone. Unfortunately, the architectural framework of the structure was destroyed a century later, and the subsequent arrangement, dating from 1895, was both aesthetically and historically wrong. Among the statues, the majestic Madonna and the delicate, sensitive St. Francis command particular notice; of the reliefs, the finest were the four "Miracles of St. Anthony," wonderfully rhythmic compositions of great narrative power.

The late style of Donatello was seen for the first time in the wooden statue of "St. John the Baptist" in Sta. Maria Gloriosa dei Frari, Venice, completed shortly before the master's return to Florence in 1453–54. It was marked by a new depth of insight into psychological reality; the powerful bodies found in Donatello's previous work now became withered and spidery, overwhelmed, as it were, by tremendous emotional tensions within. This final expressionist phase of the master also produced the wooden "Magdalen" in the baptistery, Florence (about 1455), the marble "Young St. John" ("Giovannino Martelli") in the Museo Nazionale, the bronze "St. John" in the Siena cathedral (1457) and the bronze group of "Judith and Holofernes" in front of the Palazzo Vecchio in Florence (1457–60). After several years of residence in Siena during the late 1450s, when he was preparing to do a great pair of bronze doors for the Siena cathedral (a commission he suddenly abandoned about 1460), Donatello spent the last years of his life designing two bronze pulpits for S. Lorenzo, the church of his old patrons, the Medici. Covered with reliefs showing the passion of Christ, the pulpits were a work of tremendous spiritual depth and complexity, even though some parts were left unfinished at the master's death (on Dec. 13, 1466) and had to be completed by Bertoldo and other lesser artists. *See* SCULPTURE: *Renaissance Sculpture;* RENAISSANCE ART; *see* also references under "Donatello" in the Index.

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DONATI, GIOVANNI BATTISTA (1826–1873), Italian astronomer chiefly remembered for his work on comets, was born at Pisa on Dec. 16, 1826. In 1854–64 he discovered six comets, one of which, first seen on June 2, 1858, bears his name. These discoveries led to his appointment as professor of astronomy and director of the observatory at Florence in 1864. A pioneer in celestial spectroscopy, he discovered, in Aug. 1864, the gaseous composition of comets, and contributed to early classification systems for stellar spectra. He was supervising the construction of a new observatory at Arcetri when he died in Florence on Sept. 20, 1873. (O. J. E.)

DONATION OF CONSTANTINE (*Constitutum* or *Donatio Constantini*) is the supposed grant by the emperor Constantine the Great to Pope Silvester I (314–335) and his successors of spiritual supremacy over the other great patriarchates and over all matters of faith and worship, and of temporal dominion over Rome, Italy and the entire western world. The gift was claimed to have been motivated by Constantine's supposed gratitude to Silvester for miraculously healing his leprosy and converting him to Christianity. Compounded of various elements (notably the apocryphal *Vita S. Silvestri*) and now universally admitted to be a forgery, the Donation was fabricated perhaps at Rome, more probably in the Frankish empire, between the middle and end of the 8th century. In the 9th century it was included in the collection known as the False Decretals (*see* DECRETALS, FALSE), and two centuries later was incorporated in Gratian's *Decretum* by one of his pupils. The evidence of its Roman origin is mainly internal; that of its origin in the Frankish dominions is based on the facts that the earliest manuscript (in the Bibliothèque Nationale, Paris) containing it appears to have been written there and that the earliest quotations from it are by Ado of Vienne, Hincmar of Reims and Aeneas of Paris, all Frankish authors. It was regarded as genuine by both friends and enemies of the papal pretensions throughout the middle ages, though at the close of the 10th century Leo of Vercelli, Otto III's chancellor, proclaimed its true character.

Although the document was in existence before 800, the earliest certain appeal to it by a pope was made only as late as 1054 by Leo IX in a letter to Michael Cerularius, the patriarch of Constantinople. From that time forward it was increasingly employed by popes and canonists in support of the papal claims, and from the 12th century onward it became a weapon of the spiritual against the temporal powers; it is, however, as the church historian Joseph Hergenröther pointed out, possible to exaggerate its importance in this respect. By the partisans of the empire the Donation was looked upon as the origin and source of all evils, and Constantine was regarded as having, in his newborn zeal for the faith, betrayed the imperial trust.

The genuineness of the *Constitutum* was first critically assailed in the Renaissance. In 1440 Lorenzo Valla's *De falso credita et ementita Constantini donatione declamatio* opened a controversy that lasted until the close of the 18th century, when the defense finally was silenced. Though many Roman Catholic scholars of the 15th and 16th centuries felt obliged out of loyalty to the Holy See to defend its authenticity, Nicholas of Cusa and Caesar Baronius rejected it.

Since the last half of the 19th century the controversy has centred about the interpretation of the character of this forgery, its provenance, date and meaning within the framework of papal history. There have been three major theories: (1) G. H. Böhmer held that the forgery dates from about 753 and is probably the work of Christophorus, a papal notary, who carried it with him when he went to the court of Pepin in 754 with Stephen II. According to Böhmer, the document was forged with an eye to acquiring the exarchate of Ravenna. (2) E. Mayer denied that the *Constitutum* could have been forged before the news of the iconoclastic decrees of the Council of Constantinople of 754 had reached Rome, pointing out the efforts made by the Byzantines between 756 and 767 to detach Pepin from the cause of Rome and the holy images. The forgery, which occurred about 775, had a double object: as a weapon against Byzantine heresy and as a defense of the papal patrimony. (3) L. Loening held that the *Constitutum* was a pious fraud perpetrated by a cleric of the *curia* under Adrian I with the idea of securing a *de jure* basis for the territorial dominion which the popes had *de facto* established in Italy with the help of Pepin and Charlemagne.

The tendency seems to be to shift the provenance toward the monastery of St. Denis near Paris (where the document first appeared), to date it close to the year 800 and to interpret it as an expression of Frankish independence vis-à-vis Byzantium rather than as a declaration of the temporal and spiritual supremacy of the papacy.

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DONATISTS, named after their leader Donatus, were Christians representing a powerful puritan tradition in the north African church who broke with the Catholics in 312 over the election of Caecilian to the vacant bishopric of Carthage. Despite almost continuous pressure from the successive Roman, Vandal and Byzantine rulers of north Africa, the Donatist church survived until the extinction of Christianity in north Africa in the early middle ages.

The ultimate causes of the schism were both doctrinal and social. Throughout the 3rd century the prevailing tradition in the African church had regarded the church as a body of the elect, vivified by the Holy Spirit in baptism, confronting the assaults of the pagan world, and awaiting the final doom of this world fortified by the hope of a martyr's crown. This view, which was espoused by Cyprian and developed in response to earlier controversy, had as its corollary the belief that the validity of sacerdotal acts depended on the presence of the Holy Spirit in the minister, and that a minister who was not in a state of grace could not administer a valid sacrament. At the same time, riches and sin had tended to become identified; mammon and the Roman world were equally to be shunned.

The increase in the numbers and power of the church during the 3rd century had challenged these ideas. About 220 and about 255–256 Rome and Carthage had clashed over the basic question of the nature of the church. In Africa itself, the puritanical view received reinforcement by the conversion of the native population of Numidia to Christianity in the years 270–300, while the laxer element gradually gained the upper hand in Carthage and the Romanized cities.

The great persecution of 303 produced a crisis. The puritans refused to accept for clerical office the *traditores* who had surrendered copies of the Scriptures to the authorities. On the death of Mensurius, bishop of Carthage, in 311, there was bitter opposition to the election of Caecilian, who had been his archdeacon but who was accused of cruelty toward imprisoned confessors seven years before and of having allowed himself to be consecrated by a *traditor* bishop, Felix of Aptunga. The primate of Numidia, Secundus of Tigisis, who had acquired in the previous 40 years the right of consecrating the bishop of Carthage, felt himself slighted. He arrived in Carthage with 70 bishops, and in solemn council declared Caecilian's election invalid. In his stead, the council appointed a reader (*lector*), Majorinus, the servant of a rich opponent of Caecilian named Lucilla.

These events coincided with Constantine I's defeat of Maxentius at the Milvian bridge on Oct. 28, 312. The new ruler of the west found himself compelled to take sides, because of Africa's importance as a source of wheat and oil supplies for Rome. He granted Caecilian and his supporters financial privileges (winter 312–313) but allowed Caecilian's opponents' claim to arbitration (April 15, 313). A mixed commission of Italian and Gallic bishops under the presidency of Miltiades, bishop of Rome, himself an African, found Caecilian innocent of all charges, on Oct. 2, 313. Meantime, Majorinus had disappeared from the scene and had been replaced as the rival bishop of Carthage by Donatus, a Numidian from Casae Nigrae on the fringes of the Sahara.

Donatus appealed against Miltiades' judgment, and Constantine summoned a council of bishops from the western provinces of the empire at Arles on Aug. 1, 314. Again Caecilian was upheld, and his position was strengthened by a canon that ordination was not invalid merely because it had been performed by a *traditor*. Then, after two inquiries (Aug. 19, 314, and Feb. 15, 315) Felix of Aptunga was declared innocent of the charges brought against him. Despite further appeals by Donatus and his supporters in the summer of 315 and early in 316, Constantine gave a final decision in favour of Caecilian in Nov. 316. Four years later, in Dec. 320, the Donatist cause seemed hopelessly prejudiced in its stronghold, Numidia, by a lawsuit brought by a Donatist cleric against his leaders in the court of the governor of the province.

The evidence showed these to be themselves guilty of the crime of *traditio* with which they accused Caecilian.

The schism, however, was not destined to die out. Persecution attempted from 317 to 321 failed, and in May 321 Constantine grudgingly granted toleration to the Donatists. The movement now gained the upper hand throughout north Africa. Only a tactical mistake by Donatus in seeking from Constantine's son Constans recognition as sole bishop of Carthage in 346 enabled the Roman government once more to act against him. In Aug. 347 Donatus with other leaders was exiled to Gaul, where he died *c.* 355, and church unity under Caecilian's successor at Carthage, bishop Gratus, was enforced.

With Julian's accession in Nov. 361, however, a complete change took place. The Donatist exiles returned in triumph, and for 30 years the Caecilianist tradition, though accepted by the Roman world as Catholic, was a minority in Africa. However, internal divisions following the death of Parmenian (391), a Gaul or Spaniard whom Donatus had named as his successor, and ill-judged support of the rebellion of Gildo (398), gave their opponents, now led by St. Augustine, their chance. Donatism was suppressed by a series of imperial decrees in 405. In 411 a conference presided over by Augustine's friend the imperial tribune Marcellinus was held in Carthage to decide the question as to which party. Donatists or their opponents, was to be regarded as the official Catholic Church in Africa. Though the result was a foregone conclusion, the Donatists, numbering 284 bishops to their opponents' 286, defended themselves stubbornly for three days. Marcellinus, however, decided against their doctrinal contention, that "the church of God in the Scriptures should be proclaimed everywhere holy and without spot," in favour of the Catholic view, that the church on earth was a mixed body containing good and evil members, held together by the sacraments; and against the Donatists' historical contention that Caecilian's consecration had been invalid. (*See* also AUGUSTINE, SAINT.) In 412 and 414 severe laws denied the Donatists civil and ecclesiastical rights. But, expecting hostility from the world as part of the natural order, they survived these blows, and lived on through the Vandal occupation to embarrass Pope Gregory I's representatives in north Africa in the last years of the 6th century.

Historically, the Donatists belong to the tradition of early Christianity that produced the Montanist and Novatianist movements in Asia Minor and the Meletians in Egypt. They were inspired by the Old Testament, and by the struggle of the Maccabees against the Hellenistic world. However, their opposition to state interference in church affairs (epitomized in Donatus' challenge *quid est imperatori cum ecclesia?*) differed only in degree from the attitude accepted by western leaders, such as Ossius of Córdoba and Ambrose of Milan. To this, however, they added, through the peasant warriors called Circumcellions, a program of social revolution combined with eschatological hopes. Martyrdom, following a life of penance, was the goal of the religiously minded Donatist. In their religious hopes and their fanatical zeal, they illustrate aspects of early Christianity which expressed popular opposition to Roman rule in the 4th and 5th centuries.

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DONATUS, AELIUS (fl. mid-4th century A.D.), a famous grammarian and teacher of rhetoric at Rome, one of whose pupils became St. Jerome. He wrote a large and a small school grammar, *Ars maior* and *Ars minor*. The latter, written for young students, gives, by question and answer, elementary instruction in the eight parts of speech. It remained in use throughout the middle ages, and its author's name became a common metonymy in the forms *donat* and *donet* for "grammar" or indeed any kind of "lesson." The larger work, in three parts, deals with the elements of grammar, the eight parts of speech, and errors and beauties of language. It has been argued that Diomedes used Donatus. Others suppose that Donatus used the same sources as Diomedes and Charisius. Certainly Donatus has little claim to originality, but no grammar is cited so often, and many commentaries were written on it.

Donatus also wrote commentaries on Terence and Vergil. The former in its original form is lost and the version which has survived lacks the notes on the *Hautontimorumenos* ("The Self-Tormentor"). Donatus' valuable commentary was based on excellent sources, such as Asper, and on careful study of Terence. It contains interesting notes on scenic representation and comparisons with Greek originals. Of the commentary on Vergil there survive only the preface and dedication, a life of Vergil, the introduction to the *Bucolics*, and quotations.

Aelius Donatus is to be distinguished from Tiberius Claudius Donatus, probably late-4th century A.D., author of the *Interpretationes Vergilianae*, a commentary on the *Aeneid*.

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DONCASTER, a county and parliamentary borough in the West Riding of Yorkshire, Eng., 31 mi. S.E. of Leeds by road. Pop. (1961) 86,322. It lies astride the ridge dividing the watershed of the rivers Don and Trent. It is the centre of a large coal-mining area and an important station of the Eastern region of British railways, whose principal locomotive and rolling stock works are there. It also stands on the Great North road, and on the Don river which, with its canal, links the Trent and Humber with the ports of Goole and Hull. The parish church of St. George (architect Sir G. G. Scott) occupies the site of an older structure, destroyed by fire in 1853, and has a central tower 170 ft. high. St. James's church was erected by the same architect and Lord Grimthorpe. Other important buildings are the guildhall, mansion house (1748, one of the three original mansion houses in England), public library, school of art, museum, art gallery, technical college, corn exchange (1873) and market hall. The grammar school, probably founded in the 14th century, was rehoused in the 19th. There are also a girls' high school and a central modern school.

Systems of road transport connect the borough with the coal-mining towns of the district, which lies over a vast area of hidden coal fields dipping eastward toward the Trent. Agricultural trade is extensive and the town has large markets, although coal working is a bigger industry; wire ropes and fencing, brass tubes and fittings, electrical equipment, agricultural machinery, clothing, nylon and confectionery are manufactured.

The Doncaster racecourse lies 1 mi. S.E. of the town and is owned and managed by the corporation. On this course the St. Leger, named after Col. Barry St. Leger, a British officer in the American Revolution who originated the race in 1776 at Cantley common, is run in September, the last classic race of the season. The grandstand was erected in 1777. The airport is next to the racecourse.

Adjoining the borough are the Saxon and Norman ruins of Conisbrough castle and the remains of the Norman Tickhill castle.

History.—A Roman station (Danum) was located there, and numerous remains of the Roman period have been found. In the reign of Edward the Confessor, Doncaster belonged to Tostig, earl of Northumbria; but before 1086 it had been granted to Robert, earl of Mortain, whose successor William was attainted for treason in the reign of Henry I. The overlordship then fell to the crown, and the families of Fossard, Mauley and Salvin successively held the manor as underlords. The first charter of incorporation was that granted by Richard I in 1194; nine succeeding charters were granted by later monarchs. In 1623 Ralph Salvin tried to regain the manor of Doncaster from the mayor and burgesses who, fearing that the case would go against them, agreed to

pay about £3,000, in return for which he gave up his claim. In 1200 a fair on the vigil and day of St. James the Apostle was confirmed, and by the charter of 1194 the burgesses received licence to hold a fair on the vigil, feast and morrow of the Annunciation. These fairs were confirmed by Henry VII in 1505. The fairs and markets are still held under these charters. Doncaster was created a county borough in 1927.

DONDERS, FRANS CORNELIS (1818–1889), Dutch ophthalmologist, perhaps the most notable 19th-century Dutch physician and creator of scientific clinical refraction, was born on May 27, 1818, in Tilburg, and studied at Utrecht. After serving as an army surgeon, he became professor of physiology at Utrecht in 1847. From 1852 onward he specialized in ophthalmology, to which belong his studies of the *muscae volitantes* (1847), the relation between convergence of visual axes and accommodation (1848), regeneration of the cornea (1848), hypermetropia (1858), ametropia (1860) and astigmatism (1862). His chief work, *The Anomalies of Refraction and Accommodation*, was published in England in 1864. With A. von Gräfe he founded the *Archiv für Ophthalmologie* in 1854. Donders died in Utrecht on March 24, 1889.

See E. Clarke, *A Brief Review of the Work of Donders* (1914).

DONEGAL (DUN NA NGALL), the most northerly county in the Republic of Ireland, is bounded on the west and north by the Atlantic ocean, on the east by Lough Foyle and the counties of Londonderry and Tyrone and on the south by Counties Fermanagh and Leitrim. It has a land area of 1,865 sq.mi.

Physical Features.—The rugged Donegal coast line is heavily indented with inlets, two of the major ones being Lough Swilly and Lough Foyle. Between these lies the peninsula of Inishowen at the tip of which is Malin head, the most northerly point in Ireland. The main rivers of the county are the Finn and Erne. The former rises at Lough Finn and flows through the county uniting with the Mourne at Lifford to form the Foyle while the Erne enters the sea at Ballyshannon.

The fundamental mountain ranges, Blue Stack in the south and the Derryveagh in the north, are continuations of the Caledonian system from Scotland. The underlying rocks of the county are predominantly Pre-Cambrian, including the granite of the Derryveagh mountains. The highest mountains, Errigal (2,454 ft.) and Muckish (2,197 ft.), are composed of quartzites. The schists have suffered denudation and often form the floors of valleys. In the eastern and inland parts of the county are extensive Silurian formations. The mountains were a centre of heavy glaciation and the U-shaped valleys, morainic deposits and drumlins found in the county are evidence of this.

The climate is west European with warm summers and mild moist winters. In western Donegal the average January temperatures vary from 40° to 44° F. In northern Donegal the average July temperatures vary from 56° to 58° and in other parts they rise to 60°. For most of the county the rainfall is about 40 in. but in the southwest it exceeds 60 in.

History.—The name Donegal is from *Dun na nGall*, "the fort of the strangers," and was extended from the town to the whole county which was "shired" in 1585. The ancient name was Tirconaill (Tyrconnell; *q.v.*), meaning the "land of Conall." Conall was one of the sons of Niall of the Nine Hostages who ruled at Tara from A.D. 380 to 405. Niall's sons, Eoghan and Conall, conquered northwest Ulster about 400, founding the kingdom of Aileach. Its capital or headquarters was at the still extant Grianan of Aileach, a great concentric stone fortress on a hill 802 ft. high at the narrowest part of the peninsula between Loughs Swilly and Foyle, 5 mi. W. across the frontier from Londonderry city. Eoghan (Owen), the older brother, took for his share Tir Eoghain (Tyrone, the land of Eoghan) and Inis Eoghain (Inishowen, the island or peninsula of Eoghan); his descendants, the O'Neills, ruled central Ulster until 1603. Conall, the younger brother, took the western part, Tir Conaill, and his descendants, the O'Donnells, ruled that area, often the rivals and sometimes the allies of the O'Neills, until the two great families came to final defeat in 1603.

The remote position of Tirconaill enabled it to escape serious interference by Anglo-Norman invaders and, although the O'Neills several times did homage to one of the earls of Ulster, no O'Donnell ever did so. The O'Donnells were also able to defeat a northward thrust from the Anglo-Norman conquerors of Connaught in the 13th century. They also introduced the custom of importing "Galloglasses," fighting men from Scotland. Although they held their own, the O'Donnells had a stormy history all through the middle ages. Among changes within their sphere of interest was the emergence in the 14th century of the O'Dohertys as lords of Inishowen, and an extension of O'Donnell influence over the Maguires of Fermanagh and the O'Connors of Sligo. Manus O'Donnell in 1541 gave undertakings of loyalty to the government of Henry VIII. Led by Hugh Roe O'Donnell (Red Hugh), the O'Donnells were the stanch allies of Hugh O'Neill in the great Ulster war at the close of Elizabeth I's reign. After the final defeat of the Irish cause in 1603, Hugh O'Neill and Rory O'Donnell were kindly received in London by James I, and Rory was created 1st earl of Tyrconnell. Feeling their position impossible, however, O'Neill and O'Donnell took flight secretly for the continent in 1607—the "Flight of the Earls." (*See* O'DONNELL; O'NEILL.) The county of Donegal was included in the scheme for the Plantation of Ulster immediately afterward, and its story becomes merged in the general history of Ireland. In the Franciscan abbey in Donegal town, however, was Michael O'Clery (*q.v.*) who, with three other men of learning, felt concern at the obliteration of the Gaelic past, and compiled the *Annals of the Four Masters*, a chronicle of Irish history up to 1616. The ruins of the Church of the Four Masters are in Donegal town. St. Columba (*q.v.*) was born in the county, at Gartan, in 521. A very early legend tells of St. Patrick's sojourn on an island in Lough Derg, in the south of the county, and for hundreds of years an annual pilgrimage to St. Patrick's Purgatory has taken place (*see* DERG, LOUGH).

Population and Administration.—The population is mainly concentrated on the shoreland and the river valleys with remarkable densities on the west and south coasts. However, the greatest area of population is in the combined valleys of the Finn and Foyle, while the lowlands round Lough Swilly are also well populated. The main towns (1961 pop.) of the county are Donegal town, Buncrana (3,165), Ballyshannon (*qq.v.*) and Letterkenny (4,329). The total population in 1961 was 113,815.

Donegal contains 50 parishes, 149 electoral divisions and 2,648 townlands. Lifford, although only a small village, is the administrative centre. The Donegal County council, consisting of 28 elected members, acts as the local authority for the administrative area of Donegal, with an urban council in each of the towns of Letterkenny, Buncrana and Bundoran while Ballyshannon is administered by town commissioners. There is a county manager.

The Economy.—In the Foyle and Finn basins lie the most fertile areas and they are intensely cultivated, while the rugged western seaboard is unsuitable for tillage. Only about one-third of the county is suitable for cultivation. Afforestation of nonproductive land is progressing. Agriculture, the main industry, consists of tillage and rearing of cattle, sheep and poultry, mainly for domestic needs. The two chief crops are oats and potatoes. Donegal is one of the largest potato growing counties in the Irish republic and much of the crop is exported.

Fishing is the second most important industry. Killybegs on the west coast, with a large plant for the curing and freezing of fish for export and a fish meal factory to consume any surplus, is the main centre. Kelp, a source of iodine, is also made from seaweed. Salmon fishing is carried on in the rivers Finn, Foyle, Erne and Gweebarra.

The tourist industry is third in importance. People visit Donegal for its rugged scenery, its many beautiful beaches, its shooting and fishing, and its golf courses at Rosapenna, Lisfannon and Bundoran. Large numbers of students visit Donegal to extend their knowledge of Gaelic.

A hydroelectric station at Ballyshannon, together with the turf-fired generating station at Gweedore, provides most of the county's electric power. Another hydroelectric power plant was constructed on the river Clady in the west.

In west Donegal the manufacture of handmade woolen garments

and "Aran" sweaters is of importance, while from the toy factory at Crolly, in the Gaeltacht (Irish language speaking area), come the "Crolly dollies." At Mountcharles the hand embroidery industry has been preserved and employs large numbers of "outdoor" workers, and at Convoy the world-famous Donegal tweeds are woven. There are small skirt factories at Carndonagh, Lifford, Buncrana, Castlefinn and Ballybofey.

The main roads in Donegal provide the communication between the towns. After 1959 the old County Donegal railway (the last narrow-gauge railway in the British Isles) closed down and was replaced by buses. (T. J. McM.; Hu. S.)

DONEGAL (Dun na nGall, "fort of the strangers"), a small seaport and market town on the river Eske, at the head of Donegal bay, County Donegal, Republic of Ireland, lies 131 mi. W. of Belfast by road. Pop. (1956) 1,413. It is famed for its historic associations and its picturesque environment. Just south of the town, on the shore of the bay, stand the ruins—broken walls and a splendidly proportioned Gothic arch—of Donegal abbey, founded in 1474 by the O'Donnells for the Franciscan order. In the abbey the important Irish chronicles, *The Annals of the Four Masters* (*see* Irish Literature), were compiled between 1632 and 1636. The Franciscans, re-established at Rossnowlagh (6 mi. S.S.W.), have opened a county museum with specimens of ancient craftsmanship and literature. Donegal castle, a stronghold of the O'Donnells, was rebuilt by Sir Basil Brooke in 1610.

(T. J. McM.)

DONELAITIS, KRISTIJONAS (in German Christian Donalitius) (1714–1780), the first Lithuanian poet whose work was appreciated outside Lithuania. Born at Lasdinehlen, near Gumbinnen (now Gusev), East Prussia, Jan. 1, 1714, he studied Lutheran theology and classical languages at Königsberg university (1736–40) and in 1743 became pastor of the village of Tolmingkehmen (Tolminkiemis) where he remained until his death, Feb. 18, 1780. Donelaitis lived in a district of East Prussia where Lithuanian was still spoken; he spoke German and Lithuanian equally well, writing fables and idylls in Lithuanian and short didactic works in German, but they remained unpublished in his lifetime. His main work, *Metai* ("The Seasons"), written in hexameters (never before used in Lithuanian), echoes classical literature in describing the four seasons but depicts the countryside and the life of the serfs of 18th-century Lithuania. In 1818 L. J. Rehsa of Königsberg published *Metai* as *Das Jahr in vier Gesängen,* with a German translation: it was later translated into other languages. His works also include *Aisópas arba pásakos,* a book of fables published and edited by Rehsa (1824), the themes of which are frequently taken from folklore or classical literature.

Bibliography.—His poems, ed. by G. H. F. Nesselmann (1869), include a Ger. trans. Another Ger. trans., by L. Passarge, appeared in 1894 and his collected works in Rus. trans. in 1951. *See* also M. Biržiškos, *Duonelaičio gyvenimas ir raštai su kalbos paaiškinimais* (1927); V. Mykolaitis, "Donelaičio 'Metai'," *Lietuviu literatūros instituto Darbai,* vol. i (1947). (J. A. A.)

DONELSON, FORT, an entrenched camp at Dover, Tenn., erected by the Confederates in the American Civil War (*see* American Civil War) to guard the lower Cumberland river in Tennessee and the approach to Nashville by river. In mid-Feb. 1862, Gen. U. S. Grant applied the combined army and navy tactics that had resulted in his capture of Ft. Henry on the Tennessee river on Feb. 6, 1862, in a move on Ft. Donelson. On the 12th he moved overland the less than ten intervening miles and took up an unintrenched position on ridges overlooking Ft. Donelson. There he waited in cold and rainy weather for the naval flotilla to run down the Tennessee to the Ohio and up the Cumberland. The Union gunboat attack on the water batteries of the fort on the 14th failed. Commodore A. H. Foote was wounded and two of his strongest gunboats disabled. The next day the Confederates attempted to cut their way through the Union right and failed. Grant quickly launched an attack on the opposite end of the Confederate line and by nightfall occupied the outer line of rifle pits. The Confederates meanwhile elected to give up the defense, and during the night the senior generals, J. B. Floyd and G. J. Pillow, went up the river by steamer with about 2,000 men, and Col. N. B. Forrest with 1,000 cavalry escaped by road. On the 16th, Gen. S. B. Buckner surrendered unconditionally with 15,000 men. The fall of Ft. Henry and Ft. Donelson broke the Confederate line from Columbus to Bowling Green, opened the way by river into Tennessee, and forced the evacuation of such strongholds as Columbus and Nashville.

See C. C. Buel and R. U. Johnson (eds.), *Battles and Leaders of the Civil War* (1884–87), *Personal Memoirs of U. S. Grant,* vol. 1 (1909). (C. W. Te.)

DONETS BASIN (Donetski Bassein or Donbass), the largest coal field of the Union of Soviet Socialist Republics with its associated heavy industrial area, lies in the steppes of the eastern Ukraine and adjoining parts of the Russian Soviet Federated Socialist Republic. Administratively the Donbass falls within Lugansk and Donetsk (*q.v.*; formerly Stalino) *oblasts* of the Ukrainian S.S.R. and Rostov *oblast* of the Russian S.F.S.R. From 1954 to 1957 the Donbass portion of Rostov *oblast* formed the separate Kamensk *oblast* (now abolished). The northern limit of the coal field is marked by the Northern Donets river, from which it derives its name, while through the centre of the field run the hills of the Donets ridge, rising to 1,204 ft. The exploited coal field covers nearly 9,000 sq.mi., but deposits have been established extending as far west along the middle Dnieper as the Pripyat. This "Greater Donbass" covers more than 23,000 sq.mi., but by the early 1960s the western extension was exploited only locally on a small scale.

The Donbass possesses vast reserves of coal, including much of high quality. Proved reserves total 50,290,000,000 tons, with a further 63,490,000,000 tons probable reserves and 76,200,000,000 tons possible reserves. Of the proved reserves 23% are anthracite, 9.4% semianthracite, 20.7% coking coals, 38.8% bituminous and 8.1% subbituminous. All the coal is in the Carboniferous strata (88% in the middle Carboniferous) and preserved in a deep trench in the underlying crystalline foundation of the Russian platform. The thickness of the strata is considerable and there are 260 coal-bearing seams, of which about 40 are worked, all over 1½ ft. thick. The average thickness of seam is just under 3 ft. and seams only rarely exceed 5 ft. Along both the northern and southwestern margins of the field there has been considerable faulting of the seams. The mines are not generally deep, although most of the seams nearest the surface have been worked out. Of more than 530 pits operating in the 1960s only six exceeded 700 m. (2,296 ft.). There is no open-cast mining.

The Donbass was the first coal field of the U.S.S.R. to be exploited. Coal was discovered there in 1721 and mining first started at the beginning of the 19th century. The Crimean War, which cut off English imported coal, gave a stimulus, but large-scale production began only after the coming of the railways in the 1870s. The metallurgical industry began to expand after the building in 1886 of a railway to the iron ore mines of Krivoi Rog (*q.v.*). The last two decades of the 19th century saw rapid development and the creation of a "Black Country" in the Donbass. By 1913 the area was producing 87% of the coal and 74% of the pig iron in Russia. After the Revolution rapid expansion of the Donbass continued and, despite the grave setback caused by heavy damage during World War II when the region was occupied by the Germans, the region remains the largest coal producer, although the growth of new industrial areas in the Urals, Siberia and elsewhere has reduced the proportion of the Donbass in total U.S.S.R. production. In the early 1960s the Donbass averaged about 190,000,000 tons of coal annually or approximately 36% of the national total and well over twice as much as the Kuzbass (Kuznetsk basin), the next largest producer. Production of anthracite exceeded 57,000,000 tons and coking coals 45,000,000 tons. The main mining centres are Donetsk (*q.v.*), Makeyevka, Gorlovka, Kadiyevka, Shakhty, Novoshakhtinsk, Chistyakovo, Krasny Luch and Krasnodon.

Donbass coal is the basis for large-scale heavy industry in the area. Fire clays and limestone are also obtained locally. Iron ores are brought by rail from Krivoi Rog, west of the Dnieper or by ship from Kerch in the Crimea. Around Nikopol on the lower Dnieper manganese is mined. Petroleum and natural gas are brought by pipeline from the north Caucasus. Hydroelectric

power is available from the large stations on the Volga at Kuibyshev and Volgograd, and on the Dnieper at Zaporozhye and Kakhovka. Complete integrated iron and steel plants with coke ovens, blast furnaces, steel furnaces and rolling mills have been developed at Donetsk, Makeyevka, Yenakiyevo, Konstantinovka, Kramatorsk (*q.v.*) and Kommunarsk (formerly Voroshilovsk). Other centres, such as Lugansk (formerly Voroshilovgrad) and Lisichansk have smaller plants. Much of the steel produced is used in the heavy-engineering and machine building industries of the Donbass, notably at Lugansk (*q.v.*; especially locomotives), Kramatorsk (heavy machinery), Donetsk and Kadiyevka. The chemical industry has developed rapidly, especially at Slavyansk and Artemovsk (*q.v.*), using coking by-products and the rock salt mined near Artemovsk. Mercury is also mined in the Donbass and cement making is important. In Soviet times a wide range of light consumer industries has been introduced to support the heavy industries and expanding population. In all branches of industry the great devastation of World War II accelerated the re-equipment of factories and mines with modern machinery, while concentration into larger units during reconstruction has made economies of scale possible.

The total population of the three *oblasts* which cover the Donbass was 10,025,967 (1959), of whom 7,499,674 were urban. The largest town is Donetsk, with 699,162 inhabitants.

The Northern Donets is a tributary of the Don, 631 mi. long and draining a basin of 38,439 sq.mi. It rises in the central Russian upland near the village of Kholodnoye and flows southward past Belgorod and a little to the east of Kharkov. In this upper course it is a small stream only 30 ft. wide. South of Kharkov the river curves to the southeast and follows a highly sinuous course to the north of the Donbass to join the Don just below Konstantinovski, 115 mi. from its mouth. The lower course is up to 300 ft. wide with many sandbanks. The average annual flow is 5,650 cu.ft. per second, with a maximum of nearly 100,000 cu.ft. in the spring floods. Freeze-up lasts from early December to late March. A series of six weirs makes navigation possible as far upstream as Donetsk (formerly Gundorovka in Rostov *oblast*). (R. A. F.)

DONETSK, *oblast* (formerly Stalino *oblast*) of the Ukrainian Soviet Socialist Republic in the U.S.S.R., lies in the eastern Ukraine, covering an area of 10,232 sq.mi. It stretches from the Donets ridge in the north, across the low, gently rolling Azov uplands and the level coastal plain to the sea of Azov. The north is drained by the Northern Donets and its tributaries, the west by the Volchya and the south by several small rivers flowing to the Azov sea, but there is little surface water and many of the streams dry out in summer. The whole area is in steppe, on fertile chernozem (black earth) soils, and the greater part is under the plow.

The *oblast*, which was formed in 1938, had a population of 4,262,048 (1959). It includes the western half of the Donets basin (*q.v.*) industrial area and this is reflected in the exceptionally high proportion (more than 85%) of urban dwellers. The largest of the 39 towns and 138 urban districts are Donetsk, the *oblast* centre (699,162), Makeyevka (357,575), Gorlovka (292;616), Zhdanov (283,570) and Kramatorsk (115,385). Despite the overwhelming predominance of coal mining, iron and steel manufacture, heavy engineering and chemicals in the economy, the *oblast* is important agriculturally, chiefly for winter wheat, maize (corn), sunflowers and market gardening. (R. A. F.)

DONETSK (renamed from Stalino in Nov. 1961 and formerly Yuzovka), a town and *oblast* centre of the Ukrainian Soviet Socialist Republic in the U.S.S.R., and the largest city of the Donets basin (*q.v.*) industrial area. Pop. (1959) 699,162. The town stands on the headwaters of the Kalmius river. In 1872 an ironworks was founded there by a Welshman, John Hughes (from whom the pre-Revolutionary name Yuzovka, *i.e.*, Hughesovka, was derived), to produce iron rails for the growing railway network of Russia. Later steel rails were made. The plant used coal from the immediate vicinity and both coal mining and steel making advanced rapidly. By 1914 there were four metallurgical plants, ten pits and a population of about 50,000. The giant integrated coking-iron smelting-steelmaking plant now makes Donetsk one of the largest metallurgical centres of the U.S.S.R. The great destruction of World War II during the German occupation led to the rebuilding of its factories and their re-equipment with modern machinery. There are a number of heavy engineering plants, producing especially mining equipment. In addition there are food processing and other light industries. Donetsk has industrial, medical and pedagogic institutes, several technical schools and research institutes for coal, pit planning and the physiology of work. (R. A. F.)

DONGA, a Bantu word for a narrow watercourse or eroded gully. Adopted by Europeans in South Africa from the Kaffirs, it was applied to similar ravines or watercourses elsewhere. It is almost equivalent to the Arabic *khor*, which also means the "dry bed of a stream," and to the Indian *nullah* (properly "a watercourse").

DONGAN, THOMAS: *see* LIMERICK, THOMAS DONGAN.

DONGOLA, a subdistrict and a town in the Northern province of the Republic of the Sudan. The subdistrict extends along both banks of the Nile and forms the northern part of Merowe-Dongola district, between the Third and Fourth cataracts. Pop. (1956) 151,736. Area 27,520 sq.mi. Dongola reach is a plain of desert erosion where Nubian sandstone overlies the basic complex, with granitic and volcanic rocks sparsely distributed in the desert. It has a continental desert-type climate and rainfall is very slight. The common feature of the region is barren desert, but thorny drought-resisting vegetation is found in wadis. Grazing allowed by nomad tribes (Hawawir, Ababda, Bisharin, Kababish and Gar-rarish) and the felling of trees for fuel have reduced the vegetation cover. Near the Nile, plants are more plentiful and there are abundant date palms. Doum palms (*Hyphaene thebaica*) also are common.

The area of fertile soil is mainly confined to the lands watered by the river and varies from a few feet in width in some places to two or three miles in others. It is classed as alluvial riverain soil composed almost entirely of recent silts deposited from the flood-waters of the Nile, and is intensively cultivated.

The principal market towns are Argo, Dongola and Kerma. There is a regular Nile steamer service between Kareima, in the northern subdistrict of Merowe, and Kerma in Dongola subdistrict. Motor transport is common and the small airport at Dongola town is not often used. The population of Dongola consists mainly of Danagla (the indigenous people after whom Dongola is named), some Arabs and small groups of nonindigenous peoples. The Danagla influence extends from Kerma in the north to Debba and Gushabi in Merowe district to the south. Characteristics derived from Nubian ancestors have survived. Farming is the main livelihood of the Danagla. They are good agriculturalists and use different types of lift irrigation such as *saquias*, shadoofs and pumps. The chief crops grown are cereals (wheat, durra); pulses (chick-peas, horse beans); and vegetables. Of the cash crops the most important are dates and citrus fruit.

DONGOLA TOWN is the main centre in the subdistrict of Dongola, a small mud-built market town on the west bank of the Nile about 836 mi. N. of Khartoum. Pop. (1956) 3,350. Founded about 1812 by the Mamelukes who fled from Egypt to Nubia, it is referred to as Dongola al-Urdi (Dongola Camp) to distinguish it from Dongola al-Aguz (Old Dongola) which it supplanted.

At the beginning of the Anglo-Egyptian condominium rule, Dongola was chosen as the provincial headquarters. Further administrative reorganization reduced it to a district headquarters and later, when Merowe and Dongola reaches were amalgamated to form one district, the former became the district headquarters and Dongola town lost much of its administrative functions. After this centralization local administration, headed by a nazir (chief), was established in Dongola to deal with certain local affairs.

The fate of Dongola al-Aguz was even more decisive. From a large city and the seat of the Christian kingdom of Dongola it was reduced to ruins and its large 14th-century church converted into a mosque. (A. EL-S. O.)

History.—Dongola, once the fertile land of Cush, was visited by Old Kingdom Egyptian traders. There was an Egyptian trad-

ing post at Kerma, the capital of Cush *c.* 2000 B.C. Military expeditions included Dongola in the Egypt of the New Kingdom, *c.* 1528 B.C. Gem-aten at Kawa was founded by Amenhotep III *c.* 1380 B.C., and a temple built by Tutankhamen survives there. Jabal Barkal became a centre of the worship of Amon (Amen-Ra), with several temples. After the collapse of the New Kingdom, the Egyptianized descendants of the kings of Cush invaded Egypt *c.* 725 B.C. and established the 25th dynasty. Their capital was Napata near Jabal Barkal, and they were buried under pyramids at Kuru nearby. The temples at Barkal and Kawa were then enlarged, for much wealth came to Napata as capital of a powerful state. Taharqa (Tirhakah) and his successor Tanutamon (Tanwetamani) were both expelled from Egypt by the Assyrians, but after 660 B.C. the kings of Cush, still powerful, continued to threaten Egypt until, about 590 B.C., Psamtik II forestalled them by sending an army, which sacked Napata. Meroë near Shendi then became the capital of Cush, while Napata remained until about 300 B.C. the religious capital, the kings being buried there under pyramids. In 23 B.C. Dongola was invaded by the Roman Petronius to recover the statue of Augustus stolen from Aswan. He met the queen at Napata, but refusing to wait for the statue, which was at Meroë, razed Napata. Early in the Christian era the great temple there was restored by King Natakamani, who also set up two colossal statues of himself before a temple on Argo Island. In the 4th century Dongola was the home of the Nobatae. The large mound graves of their kings are at Zuma and Tangasi near Napata. They were presumably the Red Noba whose frontier was reached by the Aksumite army after sacking Meroë about A.D. 350. The Nobatae were converted to Monophysite Christianity in 543 during the reign of Justinian. In 569 Mukurra, approximately coterminous with Dongola and the central of three Nubian kingdoms, was converted to Orthodox Christianity. Its capital was at Old Dongola. It had absorbed the northern kingdom by 652, when it was invaded by Muslims from Egypt. A treaty, which lasted for 600 years, was made, by which in return for a tribute of 400 slaves, a gift in kind was received from Egypt.

By 985 some Muslims were settled in Lower Nubia, the frontier of Dongola was at the Second cataract, the trade was by barter, the exports being slaves, camels, cattle, iron and corn. In 1173 an ambassador sent by Saladin reported that Dongola was a poor country, the king rode bareback and knew no Arabic, and his palace was the only house not built of grass. In 1240 Kanem had a post west of Dongola al-Urdi, to secure its trade with Egypt; and from 1275 Dongola was repeatedly invaded from Mameluke Egypt. To this period belong the stone forts copying contemporary European castles (at Sai I, Khandaq, Bakhit and Old Merawi), with which Dongola attempted to protect itself; also the tiny churches on islands, whither many inhabitants fled. David, king of Dongola, took refuge in the northern district of Alwa, but the ruler sent him to Sultan Baybars. During the next generation Egypt repeatedly interfered by force in the affairs of Dongola until in 1315 a Muslim was made king and the tribute abolished. In the confused events which followed, Arabs from Lower Nubia took an ever greater part in events in Nubia, and by the end of the 14th century, hordes of Arabs were pouring through Dongola into the Sudan, happy to escape the Mamelukes.

By 1517 the Turk Selim I was ruler of Egypt and, invading the Sudan, was surprised to find that it was ruled by Muslims (the Fung), who held his forces near the Third cataract. During the reign of the Fung sultan Badi Abu Dign (1645–80), the Shaigia of Dongola revolted, securing the independence of the area between Deiga and the Fourth cataract. There, centres such as Kajebi, Merawi East and Amri were ruled by petty chiefs who lived in fortified houses of stone. The Shaigia were famous for their schools and brigandage. Their revolt cut the Fung off from Dongola, their chief source of horses, and rendered the route to Egypt dangerous.

After Mohammed Ali had overcome the Mamelukes, his son Ismail Pasha in 1820 invaded the Sudan, capturing Dongola and crushing the Shaigia, who resisted bravely. Thus Dongola became a province of Egypt.

Following the failure of the British relief expedition of 1884–85 and the mahdist capture of Khartoum it was decided to withdraw to the region of the Second cataract, and the Dongola province was evacuated. The British vanguard left Dongola town in June 1885 and the mahdists occupied it at the end of August. They held the province for 11 years, during which its northern villages were depopulated and their riverside lands laid waste. It was reoccupied by forces under the command of Maj. Gen. Sir H. (later Lord) Kitchener in 1896, Dongola being recaptured on Sept. 23. It remained a province of the Anglo-Egyptian Sudan until 1936 when it was incorporated as a district in the Northern province. *See* also SUDAN, REPUBLIC OF THE.

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DÖNITZ, KARL (1891–), German naval officer, was born in Gruneau, near Berlin, Sept. 16, 1891, and entered the navy on April 1, 1910. He was promoted through the various ranks, becoming a rear admiral on Oct. 1, 1939, vice-admiral in 1940 and admiral in 1942. Dönitz commanded the German submarine force until Jan. 30, 1943, when he was promoted to the rank of grand admiral and became commander in chief of the navy, retaining this position until the end of the war. After the defeat of Germany in 1945 the inter-Allied tribunal at Nürnberg sentenced him to imprisonment, from which he was released in 1956. (J. B. HN.)

DONIZETTI, (DOMENICO) GAETANO MARIA (1797–1848), Italian opera composer, was born on Nov. 29, 1797, at Bergamo. He began his musical studies with Simon Mayr, who was organist of Bergamo cathedral and a successful composer of operas, and completed them at the Liceo Filarmonico at Bologna under Stanislao Mattei. Donizetti's father intended him to become a church musician, but the young man's tastes lay in the theatre. He scored his first success at one of the Venetian opera houses in 1818 and during the next 12 years composed no fewer than 31 operas, most of them produced in Naples and now forgotten. In 1830 his *Anna Bolena*, produced in Milan, carried his fame abroad to all the European capitals and across the Atlantic. Two years later he scored another lasting success with *L'Elisir d'amore*, a comedy full of charm and character with a text by Felice Romani. *Lucrezia Borgia*, also with a libretto by Romani, achieved considerable success in 1833 at La Scala, Milan, and elsewhere. Like Rossini and Bellini, before him, Donizetti now gravitated to Paris. His *Marino Faliero*, produced in Paris, suffered from comparison with Bellini's *I Puritani*, and he returned to Naples for the production of his tragic masterpiece, *Lucia di Lammermoor*, in 1835. He continued working in Naples (where his young wife died in 1837) until in 1838 the censorship refused to allow the production of *Poliuto* on religious grounds. He returned to Paris where the field had been cleared for him by the death of Bellini and Rossini's retirement. There he revived some of his best operas, including *Lucrezia Borgia*, which, however, had to be withdrawn because of the opposition of Victor Hugo, on whose drama the libretto was based. *Poliuto* was produced as *Les Martyrs* in 1840, preceded a few months earlier by the *opéra comique*, *La Fille du régiment*, which gained enormous popularity through the performances of Jenny Lind, Adelina Patti, Emma Albani and others throughout the 19th century. Later in the same year the Paris Opéra produced *La Favorite*, Donizetti's first essay in French grand opera, for which he himself wrote the text of the last (and best) act. The piano arrangement of the score was made by the as yet unknown Richard Wagner, who was in Paris at the time. Apart from *Linda di Chamounix*, produced in Vienna in 1842, the only other work of note is the *opera buffa*, *Don Pasquale*, produced at the Théâtre Italien in Paris in 1843. For this delightful and witty farce, Donizetti wrote his own text. *Dom Sébastien*, his second work for the Opéra, was a complete failure. Melancholia, presaging the final stages of general paralysis, had already begun to quench the spirit of the gay and debonair composer. The remaining years are a sad story of degeneration to helpless insanity, first in an asylum near Paris and then at his native Bergamo, where he died on April 8, 1848.

As the list of his numerous operas shows, Donizetti was a most

facile composer. He acquired from his masters, Mayr and Mattei, just the right amount of technical proficiency to serve his purpose and no more. His theatrical flair enabled him to give musical emphasis to the dramatic situations on the stage without probing deeply below their surface, while his abundant fund of melodic invention never failed to provide lyrical expression to the emotions of the characters. Historically his tragic operas, of which *Lucia* and *La Favorite* are the best, represent a transitional stage between Rossini's and Verdi's. His comedies have a wit and gaiety entirely their own. Apart from opera, he composed string quartets and other chamber works and also sacred music.

See G. Barblan, *L'opere di Donizetti nell' età romantica* (1948); A. Fraccaroli, *Donizetti* (1944). (Dr. H.)

DON JUAN, a fictitious character, confusedly derived from folklore and given literary personality in the tragic drama *El Burlador de Sevilla* ("The Rake of Seville," attributed to Tirso de Molina and published in 1630), and generally regarded as a symbol of libertinism. The story in which he usually figures tells how, at the height of his licentious career, he dishonoured a girl of noble family and killed her father who tried to avenge her; how, later, seeing a commemorative effigy on the father's tomb, he flippantly invited it to dine with him; and how the stone ghost duly arrived for dinner as the harbinger of death. Don Juan is at his artistic best in the original Spanish tragedy where his attractive qualities—his nervous vitality, his arrogant courage and his sense of humour—heighten the dramatic value of the catastrophe. The power of this drama derives from its rapid pace, the impression it gives of cumulative tension as Don Juan's enemies gradually hound him to destruction, and the electrifying fact that he is nervously goaded by excess to defy, beyond redeemable limits, even the ghostly forces of the unknown. Refusing to repent he crashes to eternal damnation. Through Tirso's tragedy he has become a universal character comparable with Don Quixote, Hamlet and Faust, and expresses, psychologically, man's challenge to the world of his limitations.

Later Spanish versions retain Don Juan's likable qualities and avoid the calculated cynicism of certain foreign ones; but they tend to reduce the shock of the Tirsian catastrophe. A milder arrangement by Antonio de Zamora, called *El convidado de piedra* ("The Stone Guest"), was popular in the 18th century; José de Espronceda's poem, *El estudiante de Salamanca* (1839), where a Don Juan with a different name and under romantic auspices takes part in a mysterious dance of death, is more picturesque than dynamic. But by the 19th century many foreign versions of the Don Juan legend had become influential, and the highly popular *Don Juan Tenorio* (1844) of José Zorrilla, still performed in Spain at All Souls' tide, borrowed lavishly from French sources. Zorrilla's play sentimentalizes the legend by furnishing a pious heroine and a serious love interest, perhaps indirectly inspired by the Faust theme, and by procuring Don Juan's repentance and salvation. Spanish-Italian relations in the 17th century facilitated literary exchanges, so that the Don Juan story soon became known to strolling Italian players some of whom traveled to France with this theme in their repertoire of pantomime.

Famous among non-Spanish literary versions are Molière's *Le Festin de Pierre* ("The Stone Banquet"; 1665), based on earlier French arrangements; Prosper Mérimée's novel *Les Âmes du Purgatoire;* and the drama *Don Juan de Marana* by the elder Dumas. Early English arrangements—T. Shadwell's *The Libertine* (1676), for example—are uninspired, but later the libertine reappears with new personality and purpose in Byron's *Don Juan* and Shaw's *Man and Superman.* The theme readily lent itself to opera and was used with greatest distinction by Mozart in *Don Giovanni.*

See A. Farinelli, *Don Giovanni* (1946); J. Casalduero, *Contribución al estudio del tema de Don Juan en el teatro español* (1938); G. Marañón, *Don Juan* (1940). (I. L. McC.)

DONKEY: *see* Ass.

DONNAY, CHARLES MAURICE (1859–1945), French dramatist, illustrating early 20th-century tendencies, was born in Paris, Oct. 12, 1859, and began his career as the poet of the literary cabaret, *Le Chat Noir.* He made his name in the theatre with *Amants* (1895), which marked an important date in the evolution of the French drama between the Théâtre Libre and World War I. It also inaugurated his *théâtre d'amour,* which included *La Douloureuse* (1897) and *L'Affranchie* (1898). A second cycle of plays, including *Le Retour de Jérusalem* (1903) and *Les Eclaireuses* (1913), dealt with current social problems, and *La Chasse à l'homme* (1919) and *La Reprise* (1924) were comedies of manners depicting the new postwar France. Donnay died in Paris, March 31, 1945.

See H. Duvernois, *Maurice Donnay* (1928); P. Bathille, *Maurice Donnay* (1931); M. Donnay, *Mon Journal, 1919–39* (1953). (D. Ks.)

DONNE, JOHN (1572–1631), English poet and priest, was spoken of by his contemporary, Ben Jonson, as "the first poet in the world in some things." When he died, as dean of St. Paul's, he had earned another reputation as the greatest preacher of his age. Both as poet and priest he sank in reputation after the Restoration; but in the 20th century he rose, as a poet, to a fame as great as he had enjoyed when living, or even greater; and interest in his poetry brought a revival of interest in his sermons. As master of the so-called "metaphysical school" of poets he became the idol of critics in England and the United States, and the influence of his highly individual style can be seen widely in poetry written between World Wars I and II.

Donne was born some time in the first half of 1572 in the City of London. His father, also John Donne, was a prosperous merchant of Welsh ancestry, who rose to be warden of the Ironmongers' company in 1574. Two years later he died. Donne's mother was Elizabeth Heywood, daughter of John Heywood, epigrammatist and playwright, whose wife was the daughter of Sir Thomas More's sister. Both Donne's parents were Roman Catholics, and through his mother he came of a family remarkable for its loyalty to the Roman Church as well as for literary activity. His mother's brothers, Ellis Heywood and Jasper, the translator of Seneca's plays, were both Jesuits who died in exile. His younger brother, Henry, died at the age of 19 in 1593, having caught fever in the prison to which he had been committed for sheltering a priest.

In 1584 Donne matriculated at Hart hall, Oxford. As it was impossible for a Roman Catholic to take the oath of supremacy required at graduation he left without taking a degree. No records confirm Izaak Walton's statement that he went to Cambridge on leaving Oxford. He entered as a law student at Thavies Inn, London, in 1591, and transferred to Lincoln's Inn in 1592. Sir Richard Baker remembered him as living there "not dissolute, but very neat, a great visiter of Ladies, a great frequenter of Playes, a great writer of conceited Verses." The Lincoln's Inn records will not allow for any prolonged absence from London between 1592 and 1596, so that if, as Walton says, Donne traveled extensively in his youth, it must have been in the period between leaving Oxford and entering the Inns of Court. Walton's picture of Donne at Lincoln's Inn differs from Baker's. He says that he would rise at four and work in his chamber until ten and that "about the nineteenth year of his age, he, being unresolv'd what Religion to adhere to" put aside other studies "to survey and consider the Body of Divinity, as it was then controverted betwixt the *Reformed* and the *Roman Church.*" But the dandy and wit, and the serious student, are both reflected in the poems Donne wrote at this time: the sensual, witty *Elegies* and the mordant *Satires.* In the latter, particularly in the noble satire "Of Religion," his moral gravity finds expression.

Donne went on the earl of Essex's Cadiz expedition of 1596 and on the Islands voyage in 1597. "The Storm" and "The Calm," brilliant examples of poetical journalism, describe this second expedition. On his return he became secretary to Sir Thomas Egerton, the lord keeper (afterward Lord Chancellor Ellesmere). He had, by this time, conformed to the Church of England. What seemed a promising start to a diplomatic career was made abortive by his secret marriage in Dec. 1601 to Ann More, the young niece of his employer's wife. Donne was imprisoned for the offense of marrying a minor without her guardians' consent, and the girl's father, Sir George More, secured his dismissal from Egerton. On his release, he found himself without employment and his wife

without a dowry. He had spent his patrimony as a young man about town and the next years were years of poverty and humiliating dependence. Donne's marriage, the great error of his life from the worldly point of view, was its true turning point. There is no evidence for any period of religious crisis in his life, and, if the term "conversion" is to be used in discussing the change from "Jack Donne" to "Dr. Donne," it must be taken to mean a gradual process by which a wilful, passionate and ambitious temperament was schooled by harsh circumstances and natural responsibilities. The ruin of his career was the beginning of the process, and love for his wife, which he said, after her death, had led him to seek God, a main means in achieving it.

The finest of Donne's poems, the *Songs and Sonnets*, cannot be dated with any certainty; but some were certainly written after his marriage, since they assume a king upon the throne, and it is impossible not to wish to connect the more serious and impassioned of them with Ann More. The same kind of probability would lead to the dating of the more cynical and outrageous in the Lincoln's Inn period, at the same time as the Ovidian *Elegies* and the prose *Paradoxes and Problems*. These last, however, are a warning of the uncertainty of such a conjecture, since Donne was capable of amusing himself with this kind of witty trifling as late as 1607. Donne did not write for publication. He was a "poet on the by," writing to please himself and his friends. Original as the *Songs and Sonnets* are, many are brilliant variations on stock themes. It is Donne's artistry which makes them seem so direct and personal. The impulse behind any one of them may well have been an artistic pleasure in making something new out of an old topic rather than a wish to express personal feeling.

From 1602 to 1615 Donne struggled to find ways to support himself and his growing family. Ann Donne bore him 12 children, seven of whom survived her, before her early death in 1617. At first he depended on charity, but after a few years he found a use for his extensive learning in helping Thomas Morton (afterward bishop of Durham) in his controversies with Roman Catholics. As early as 1607, according to Walton, Morton, on becoming dean of Gloucester, urged Donne to take orders, so that he might offer him preferment. Walton, who almost certainly had the story from Morton, says that Donne refused on grounds of personal unworthiness. He was probably also reluctant to abandon all hope of a secular career, and about this time his prospects brightened. Sir George More relented over the dowry, and Donne became a client of Lucy, countess of Bedford, and through her had contact with influential persons. His first published work, *Pseudo-Martyr*, written to persuade Roman Catholics to take the oath of allegiance, appeared in 1610. It earned Donne an honorary M.A. at Oxford and the notice of the king. This weighty work was followed by *Ignatius his Conclave* (1611), a brilliant and bitter little squib against the Jesuits, and a little earlier Donne wrote, but did not publish, *Biathanatos*, a learned casuistical treatise on the possible lawfulness of suicide. In 1610 Donne found a new patron in Sir Robert Drury, who took him abroad from Nov. 1611 to Aug. 1612; and on his return he courted the king's powerful favourite, Viscount Rochester, later earl of Somerset. He wrote to Rochester expressing an intention to take orders; but a later letter to a friend, asking him to use his influence with Rochester to secure a diplomatic post, shows him vacillating and in April 1614 he was elected to parliament. There is no doubt of Donne's reluctance to take orders, or of the fact that he finally gave way in obedience to King James's direct pressure. He was ordained on Jan. 23, 1615, and at the age of 43 began a new life.

During these middle years Donne wrote two poems for publication, the *Anniversaries* of 1611 and 1612, in commemoration of the death of the 15-year-old daughter of his patron, Elizabeth Drury. He also composed funeral pieces, complimentary epistles, and two epithalamiums: one for the wedding of Princess Elizabeth and the other for the wedding of Somerset and the countess of Essex. (The old notion that Donne was concerned with the scandal of the countess' divorce arose from a confusion between him and Sir Daniel Dunne.) Most of his *Divine Poems* belong to this period also, notably "A Litany" and two sets of sonnets: "La Corona," a linked sequence on the mysteries of the Christian religion, and the greater part of the "Holy Sonnets," in which with intense feeling and great force of language he treats the age-old themes of meditation: sin, death and judgment. After his ordination Donne wrote very little poetry. His creative impulse found a new outlet in preaching.

Donne felt a deep satisfaction in the exercise of his ministry, and was assiduous in performing his duties. Like all distinguished churchmen of his day, he was a pluralist, holding country livings as a nonresident and the city living of St. Dunstan-in-the-West, Walton's parish, from 1624. In 1616 he was appointed reader in divinity to the benchers of Lincoln's Inn; in 1619 he went abroad as chaplain to Viscount Doncaster (later earl of Carlisle) on his mission to the German princes in an effort to avert the outbreak of the Thirty Years' War; and in 1621 he was made dean of St. Paul's. There was a proposal to make him a bishop in the autumn of 1630; but Donne was by then a very sick man. He died in London on March 31, 1631, and was buried in St. Paul's, where his monument, the only monument to survive the fire of 1666, still stands. There are many tributes to Donne's impressiveness in the pulpit. He was a favourite preacher at court, and much approved by that learned theologian, King James. James's more devout, if less learned, son, Charles I, chose Donne to preach the first sermon of his reign. But Donne's finest sermons were preached in St. Paul's on the great feasts. They are splendid examples of the formal sermon, preached under heads given by the dividing of the text and buttressed with massive scriptural and patristic quotations, full of flashes of poetic imagination, and displaying a profound knowledge of the human heart as well as a firm grasp on the central doctrines of Christianity. A few sermons were printed in Donne's lifetime. His only other publication after his ordination was *Devotions upon Emergent Occasions* (1624), the fruit of a serious illness in the winter of 1623. During this illness, an attack of spotted fever, Donne wrote the "Hymn to God the Father" and probably also the "Hymn to God my God in my sickness," although Walton says that he wrote this last poem on his deathbed.

Walton's account of Donne's last days is not wholly reliable. He drew heavily on Donne's own account of the pious death of Magdalen, the mother of Edward and George Herbert, whose funeral sermon Donne had "preached weeping." Donne was too ill to preach at Christmas 1630, but he was able to preach before the king on Feb. 12, 1631, the first Friday in Lent, his "old constant day." His appearance, as an obviously dying man, made a deep impression and many said that "Dr. Donne had *preach't his own Funeral Sermon*." This last sermon, under the title *Death's Duel*, was published shortly after his death. Between preaching this sermon and his death, Donne had his picture painted in his shroud and composed his epitaph. The picture was the original of the engraved portrait prefixed to *Death's Duel*, and from it Nicholas Stone carved the monument in St. Paul's, where Donne stands in his shroud upon an urn, "looking towards Him whose name is the Rising." Since the folds of the shroud are plainly not carved from a standing figure, Walton's story of Donne's standing for it on an urn, wrapped in his shroud, in his study can be regarded with some skepticism.

Eighty sermons, which Donne had written out in full as a legacy to his son, were published by him in 1640, with the first version of Walton's *Life of Donne* prefixed. A further 50 appeared in 1649, and the younger Donne scraped the bottom of that barrel with the *XXVI Sermons* of 1661. He also published *Essays in Divinity* and *Letters to Several Persons of Honour* in 1651, and made public some works which his father would have preferred to remain unprinted, the *Juvenilia* (1633) and the sombre *Biathanatos* (entered on the Stationers' Register, 1646; publ., undated, 1647). The *Poems*, which had circulated widely in manuscript copies, appeared in 1633, and an enlarged edition in 1635. It is not known who was responsible for these editions. There were further editions in 1639, 1649, 1650, 1654 and 1669. Between the last of these and the appearance of Donne in John Bell's *Poets of Great Britain* (1779), there is only Jacob Tonson's edition of 1719.

Walton revised his *Life of Donne* (1640) in 1658 and again in 1670 and 1675. His declared purpose, to show the world "the best

plain picture of the Authors Life that my artless Pensil, guided by the hand of truth, could present," underrates the extent of his art, and the degree to which he was actuated by the desire to present his hero in the most edifying light. Sir Edmund Gosse's *Life and Letters of John Donne* (1899) remains the only full biography. It is extremely unreliable. All students of Donne need to be on their guard against Walton's gift for charming and probable anecdote, and Gosse's habitual inaccuracy and constitutional inability to distinguish between fact and surmise.

In his own day Donne's poetry was praised for its wit. The 20th century, although acknowledging the brilliance of his use of unexpected and recondite images, pedantically precise hyperboles and daring paradoxes, values him more for his power to catch in verse the ring of passion and to render the accents of a "naked, thinking heart." It was the blend of passion and ratiocination, or the illusion which his poetry gives that thought and argument are arising immediately out of passionate feeling, which made him the master of both the later W. B. Yeats and of the young T. S. Eliot, who were reacting against the meditative lyricism of the romantic tradition in its decline. Combined with this play of intellect and scorn of conventionally poetic imagery goes a refusal of poetic diction and a handling of metrical effects which makes Donne's poetry hover between the singing voice of passion and the speaking voice of argument and expostulation. This dramatic realism of style and versification made Donne the idol of the first half of the 20th century. He was perhaps over-praised; but at his best he gives, as almost no other poet does, the illusion that we are listening to the very accent of passion become conscious of its power.

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DONNER, GEORG RAPHAEL (1693–1741), Austrian sculptor, whose works are representative of the transition from the baroque to the neoclassical style, was born on May 24, 1693, at Esslingen in Lower Austria. He went to Heiligenkreutz intending to take holy orders, but he was there encouraged to follow his artistic bent by the sculptor Giuliano, and, after working in his studio, entered the Vienna Academy. His fine work brought him to the notice of the court and he found employment in Salzburg for some years, afterward returning to Vienna, where he died on Feb. 15, 1741. His masterpiece is the fountain on the Neumarkt in Vienna, which he executed in the years 1738 and 1739. The figures originally cast in lead, a technique favoured by the artist, were replaced by exact copies in bronze in 1873. Other works are the fountain with Perseus and Andromeda in the courtyard of the Vienna Rathaus and a statue of Charles VI in the Belvedere, Vienna. Donner's refined plastic form and clear outline contrasted with the art of his contemporaries and predecessors, who tended toward exaggerating the restlessness of Bernini's baroque style, and influenced his followers to adopt a more classic conception of form.

DONO, PAOLO DI: *see* UCCELLO, PAOLO.

DONORA, a borough of Washington county, Pa., U.S., lies along the Monongahela river, 30 mi. S.E. of Pittsburgh. Located in the soft coal region of western Pennsylvania, Donora is one of the many industrial towns of that area. The economic life of the community is largely dependent upon a plant which manufactures wire and steel products including barbed wire, woven fence, welded concrete reinforcing wire, nails, welding rods and stranded cable. A zinc plant was dismantled and moved in 1958 because of excessive cost of producing zinc in that area. In 1948 Donora was the scene of a smog disaster resulting in 20 deaths (*see* DUST: *Concentration*).

Donora was incorporated as a borough in 1901. For comparative population figures *see* table in PENNSYLVANIA: *Population*. (M. R. Wo.)

DONOSO CORTÉS, JUAN, MARQUIS DE VALDEGAMAS (1809–1853), Spanish author and diplomatist famous for his political writings, was born at Valle de Serena, near Badajoz, May 6, 1809. He entered politics as an advanced liberal, but made a complete reversal after 1848, and in his *Ensayo sobre el catolicismo, el liberalismo, y el socialismo* (1851), denounced reason as the enemy of truth and liberalism as leading to social ruin. With all its rhetorical excesses, the *Ensayo* remains one of the finest specimens of impassioned Spanish prose during the 19th century. Among his oratorical pieces stands out his *Discurso sobre la Biblia*, delivered on his election to the Royal Spanish Academy (1848). He died in Paris, March 3, 1853.

DONUS (DOMNUS) (d. 678), pope from 676 to 678, was elected to succeed Adeodatus (II) in August and consecrated on Nov. 2, 676. He was buried on April 11, 678.

DOOLEY, THOMAS ANTHONY (1927–1961), "jungle doctor," author and lecturer, was born in St. Louis, Mo., on Jan. 17, 1927. After a year of premedical training at the University of Notre Dame he served for two years (1944–46) as a navy corpsman (medical aide) attached to the U.S. marine corps. He graduated from the St. Louis university school of medicine in 1953.

While serving his internship in the navy, he was assigned in May 1954 as medical officer at a Haiphong evacuee staging area for refugees fleeing from Communist-controlled North Vietnam following the Indochinese war. The misery and disease he saw among an estimated 600,000 refugees processed there started him on a career of providing medical aid in underdeveloped countries. After being discharged from the navy in 1956, he used the proceeds of a best-seller book, *Deliver Us From Evil*, which described his Haiphong experience, to establish a small hospital in the Laotian village of Nam Tha. After turning that hospital over to the Laotian government in late 1957, he returned to the United States and became cofounder, with Peter D. Comanduras, of Medico, Inc., international medical aid organization. He started its first hospital at Muong Sing, Laos, and his books (others were *The Edge of Tomorrow* and *The Night They Burned the Mountain*) and lecture tours provided much of the financing for its overseas operations in the next three years.

Recurrence of cancer, which began in the summer of 1959, caused his death in New York city on Jan. 18, 1961. (R. H. St.)

DOOLITTLE, JAMES HAROLD (1896–), one of the most versatile figures in U.S. aeronautics, was born on Dec. 14, 1896, at Alameda, Calif. He was educated at the University of California and Massachusetts Institute of Technology (Sc.D., 1925). After receiving pilot training during World War I, he remained in the U.S. army air corps until 1930, when he entered private business. During the 1920s and 1930s he was an outstanding racing pilot, and he led in the introduction of such developments as "blind" flight (flying only by instruments). Back on duty with the army air corps after 1940, Doolittle's aggressive spirit won him selection as leader of the raid against Tokyo on April 18, 1942, for which he was awarded the medal of honor. During World War II Doolittle commanded in succession the 12th air force in North Africa and two strategic air forces in Europe—the 15th, operating from Italy, and the 8th, flying from England. He was the only nonregular air force officer to command a major combat air force, as a lieutenant general, during the war. In 1946 Doolittle returned to private business, continuing, however, to serve on advisory boards and commissions concerned with aviation problems. (A. GG.)

DOOM, originally a law or enactment, the legal decision of a judge, and particularly an adverse sentence on a criminal (O.E. *dóm*, a word common to Teutonic languages for that which is "set up" or "ordered"). The word is thus applicable to the adverse

decrees of fate, and particularly to the day of judgment. The verb "deem," to deliver a judgment, is seen in "deemster," the name of the two judges of the Isle of Man (*q.v.*). *See* also ENGLISH LAW.

DOON DE MAYENCE, one of the hero barons of the *chansons de geste* (*q.v.*).

DOOR is a screen, usually of wood, metal, glass or a combination of materials, installed to swing, fold, slide or roll in order to close an opening to a room or building. Doorway is the entrance (including a doorframe), usually constructed of masonry, wood or metal and consisting of jambs and a lintel, or arch, often including panels of glass or other materials, sometimes surrounded by architectural and sculptural elements.

Doorways.—Originating as a crude opening in primitive building, the doorway, or portal, has been an important architectural element since the emergence of monumental building (*c.* 3000 B.C.). The typical Egyptian doorway was a large rectangular opening (42 ft. high in the great temple at Karnak) cut through sloping stone walls and crowned with a cavetto cornice. In Mesopotamia the doorway was characteristically arched, constructed of brick and often faced with glazed tiles. The Greek doorway was perfected in the Erechtheum (5th century B.C.) at Athens, where the opening (17 ft. high) is narrower at top than bottom. Constructed entirely of marble, the jambs and lintel consist of flat moldings, studded with rosettes, surmounted by a *cyma reversa* (*see* CYMA) carved with anthemia (*see* ANTHEMION) and supported by consoles. The Roman doorway is typified in the Pantheon (2nd century A.D.) at Rome, where the rectangular enframement (46 ft. high) consists of flat moldings and entablature, enclosing a bronze-grilled transom supported by brazen Doric pilasters.

The Roman type persisted into Byzantine and Romanesque architecture. Romanesque design, however, dramatized the Roman arch, as in the portal of S. Michele at Pavia, where diminishing arches form a deep splay in thick stone walls. Columns and archivolts were usually carved with stylized animal or vegetable forms; the tympanum was sculptured in religious inconography. With the new use of the pointed arch, the Romanesque portal was gradually transformed into Gothic, culminating in France in the cathedral at Amiens (13th century), where deeply splayed portals consist of slender columns with attached elongated statues of biblical personages, and archivolts carved as a heavenly host enclose a sculptured tympanum. A terrifying Last Judgment usually was preferred for the central portal, with a statue of the Virgin or Saviour on the median jamb. Smaller Gothic doors usually were framed with continuous moldings forming a pointed arch.

The Roman portal was revived in the Italian Renaissance; *e.g.,* the doors added by Lorenzo Ghiberti to the baptistery at Florence. Such doorways sometimes were elaborated by the addition of a carved arch above the entablature. In the 16th–18th centuries doorways usually were composed in the orders of architecture (*i.e.,* with pedestals, columns or pilasters, entablatures, and pediments or arches) in a variety of usage, often including sculpture, achieving rich, original effects in the baroque period. Stricter classical usage returned in the 18th century, as in the Georgian architecture of Great Britain and its American colonial version, in which wooden orders generally were substituted for stone. A Georgian innovation was the semicircular fanlight, widely used *c.* 1750–80. By the end of the century side lights had been added and the fan correspondingly enlarged, producing the fashionable Venetian door.

The eclecticism of the 19th century produced revivals of historical styles and inventive combinations of them. Side lights and transoms were variously used, glass becoming more and more prominent after 1850. The organic designs of the *art nouveau* and the increasing importance of commercial building led to the virtual disappearance of the monumental portal in 20th-century architecture, in which the doorway has been generally reduced to a simple structural frame (usually metal), often repeating the modular system of the building's enclosure and being an integral part of it.

Door.—*Early Types.*—The first doors were merely hides or textiles. In Egyptian wall painting of the fifth dynasty are representations of doorways equipped with matting that could be rolled up and lowered. Doubtless common in antiquity, this usage has persisted in Mediterranean countries, where flaps of leather (or strings of beads) are used as secondary doors. However, doors of rigid, permanent materials appeared simultaneously with monumental architecture. The most important doors were often stone or bronze; the most numerous were wooden.

Stone.—Stone doors often were used on tombs. A marble, paneled Roman example, probably from the time of Augustus, was found in Pompeii; a similar Greek door (*c.* A.D. 200) from a tomb at Langaza has been preserved in the Istanbul museum. This Hellenistic type persisted in the distinctively lithic architecture of Syria of the 4th–6th centuries.

Bronze.—The use of monumental bronze doors, a tradition that has persisted into the 20th century, was derived from the technique of casting bronze hollow (usually by the cire-perdue, or "lost wax," process), which was perfected in Greek sculpture of the 5th century B.C. The portals of Greek temples were often fitted with cast bronze grilles; the Romans applied the technique to the production of solid doors. They were characteristically double doors; *i.e.,* consisting of two leaves, or valves, each hung at one side of the doorway, closing together without a median jamb or mullion. They were mounted as crapaudine doors; *i.e.,* supported by pivots fitted into sockets in threshold and lintel. The earliest large examples are the double doors of the Roman Pantheon, each valve (24 ft. high) consisting of flat panels originally gilded. Late imperial examples in Rome (all 4th century) have survived in the Baths of Caracalla, the Temple of Romulus (vestibule to the church of SS. Cosmas and Damian) and Constantine's church of St. John Lateran, the latter pair enriched with four gilded Corinthian columns. The Roman paneled design and mounting technique continued in Byzantine and Romanesque architecture.

The art of casting was preserved in the eastern empire for centuries after the decline of the west, the most notable Byzantine examples being the double doors (dated 838) in Justinian's great church of Hagia Sophia at Constantinople. In the 11th century bronze castings from Constantinople were imported into southern Italy. Bronze plates (cast *c.* 1066) were attached to the wood-framed doors of the church at Monte Cassino. Hollow-cast double doors were brought to the cathedrals of Salerno (1099) and Amalfi, to St. Mark's, Venice, and elsewhere. In these instances, the classical flat panels were ornamented with silver-damascened figures.

Bronze doors were introduced into northern Europe when Charlemagne brought a Byzantine pair (cast *c.* 804) to the cathedral at Aachen. The first bronze doors to be cast in one piece in northern Europe were produced (*c.* 1015) in the famous foundry sponsored by Bishop Bernward of Hildesheim for the cathedral there. A technical and artistic marvel of the age, these double doors were designed with a series of historiated panels in relief, establishing a sculptural tradition that distinguishes Romanesque and later bronze doors from the flat-paneled Roman and Byzantine style. Others followed (11th century) at Augsburg and Mainz; and Germanic influence, being felt as far as northern Italy, accounted for the series of 48 hammered bronze panels of biblical scenes attached to the wood-framed doors of S. Zeno Maggiore in Verona.

Hollow casting with panels in relief was revived in the 12th century in southern Italy, notably by Barisanus of Trani (cathedral doors, 1175), and carried northward by artists such as Bonanno of Pisa, doors by whom have survived in the cathedrals at Monreale and Pisa. The Italian development was given impetus by the rising artistic activity of the 14th century in Tuscany, where the principal examples are the pairs of sculptured, paneled bronze doors on the Florentine baptistery: the Gothic south doors (1330–36), by Andrea Pisano, and the north doors (1403–24), by Lorenzo Ghiberti, which initiated the Renaissance. Ghiberti's east doors (1425–52), sculptured with Old Testament scenes and gilded, have become known as the *Porta del Paradiso,* according to a description attributed to Michelangelo. After the model of

Florence, double bronze doors with panels in relief, by Antonio Filarete, were cast for St. Peter's, Rome, and many others subsequently were designed by the major sculptors of the Italian Renaissance. Bronze doors were not generally used in northwestern Europe until the 18th and 19th centuries, important French examples being the double doors of the Panthéon (finished 1790) and of the Madeleine (finished 1842) in Paris. The first monumental bronze doors in the United States were erected in 1863 in the capitol at Washington. Designed by Randolph Rogers, they consist of two valves of four panels each, under a semicircular tympanum, portraying the life of Columbus.

Wooden: Ancient and Oriental.—The wooden door was doubtless the oldest and commonest type in antiquity. Archaeological and literary evidence indicate its prevalence in Egypt and Mesopotamia, the forests of Lebanon being an important source of materials. Apparently large doors were constructed of heavy vertical planks held together by dowels or metal bands or sheathed in hammered metal. Fragments from the Assyrian palace at Balawat (9th century B.C.), preserved in the British museum, indicate that the palace had double wooden doors, each valve over 8 ft. wide and 27 ft. high, bound with ten-inch bronze bands depicting religious and military scenes. Solomon's temple (*c.* 900 B.C.) is reputed to have had folding doors of cypress (or fir) and of olive, constructed without metal but carved and overlaid with pure gold (I Kings vi, 31–35).

According to Pompeiian murals and surviving fragments, doors in the houses of prosperous Greeks and Romans looked much like modern wood-paneled doors, being constructed of stiles and rails (vertical and horizontal members) framed together to support panels and equipped with locks, keys and occasionally hinges. The classical wood-framed, paneled type persisted into the Christian epoch, richly carved double doors of the 5th century surviving in Sta. Sabina, Rome, and S. Ambrogio, Milan. The Roman door was adopted in Islamic countries, where a tradition of highly skilled carpentry modified the rectangular panels into elaborate polygonal and stellar patterns, often forming intricate grilles ornamented with metal mountings. This technique was perpetuated in Indian and in Turkish architecture of the 16th century and afterward, as in the mosque of Rustem Pasha, Istanbul. The technique was similar in China and Japan, where the prevalent wooden door usually consisted of two panels: the lower solid, the upper a delicate wooden lattice backed with paper.

Wooden: Traditional Types.—The traditional types of wooden door descend directly from the middle ages and the Renaissance. The typical medieval door was constructed of vertical planks backed with horizontals (battens or ledges) on the inside, or in simpler form with diagonal braces. The batten door and braced door have persisted in remote districts into the 20th century. The vertical joints were covered with thin fillets, and the door was strengthened by long iron hinges (commonly used from the 12th century onward) and wrought nails in decorative patterns. In large churches where the principal doors were opened only occasionally, there was for daily use a small wicket, or framed door, set within the larger door.

The paneled door was reinvented in the 15th century in France and in the 16th in England, door design repeating the wall paneling thenceforth through the stylistic sequence to the end of the 18th century. For symmetry a door was sometimes made to appear as part of the wall (jib door), or a single door was made to look like double doors (double-margin door). Double doors were everywhere used in important portals, assuming monumental proportions in France—*e.g.*, the wooden doors (*c.* 1680) of St. Gervais, Paris—and striking richness in Spanish architecture, a resurgence of Moorish feeling producing numerous small panels in a variety of intricate geometrical designs.

In domestic architecture, interior double doors of wood appeared in Italy in the 15th century, France in the 16th, England in the 17th and in the American colonies in the 18th. Their design was derived from the Roman paneled type, which was revived in the Italian Renaissance, a pair (*c.* 1480) with rich inlaid woods existing in the Palazzo Ducale, Urbino. In the 16th–17th centuries panels became more elaborate, often arched, carved, painted and gilded; the classically rectangular flat panel becoming standard again in the 18th century. In France the sequence through the styles Louis XIV, XV and XVI has been preserved in the interiors at Versailles. A characteristic Anglo-American type was the Georgian door of three or six flat panels. This and other historical types, and a variety of 19th-century flat-paneled doors, have persisted as standard manufactured items into the 20th century. Gradually simplified to one large panel, the wood-framed door has been largely superseded by the flush-panel door, constructed with a hollow or solid core smoothly covered with wood veneer or plastic laminate.

Special Types and Modern Doors.—A number of special types have become standard manufactured doors. The louvered door (or blind door), with fixed or movable slats, was evolved in the 18th century by enlarging the Venetian-style window blind recently made fashionable in English Georgian architecture. It has been most used in the United States. The screen door was an American innovation of the late 19th century, when wire mesh was mass-produced. The storm door (or weather door) also became common in the 19th century. The dutch door (batten or paneled), an outside door cut in two near the middle, allowing the upper half to be opened while the lower remains closed (originally to exclude barnyard creatures), descends from a traditional Flemish-Dutch type introduced into the American colonies in the 17th century. The half door (paneled or louvered), being approximately half height but hung near the centre of the doorway, allowing an opening above and below, was common in the 19th century (U.S.).

Glazed doors date from the 17th century, first appearing in the houses (begun 1605) in the Place des Vosges, Paris, as window casements extended to the floor. Widely used as double doors in France (17th–19th centuries), the French door was incorporated into English architecture late in the 17th century, appearing in America in the 18th. An 18th-century modification was the sash door, paneled in the lower half and glazed in the upper. The mirror door was a 17th-century French invention. The rising production of glass in the 19th century made increasingly larger panes economically possible, and by 1900 the door with one large panel of plate glass was common. The perfection of safety glass produced the door of a solid glass slab $\frac{1}{2}$ or $\frac{3}{4}$ in. thick. Tinted glass and units composed of two large glass sheets sealing a vacuum have been developed for climate control. The wood frame supporting large glass panels has been generally superseded, in commercial and public buildings, by extruded frames of metal: bronze, stainless steel, aluminum.

Metal doors of bronze, steel or aluminum have been increasingly made, in the form of hollow flush-panel doors or reproductions of historical types. Metal-clad doors were developed (early 19th century) principally as fire doors, being constructed of a solid wooden core covered with tin or galvanized steel drawn through steel dies, as the kalamein door. Other, later types have been made with a core of polystyrene covered with anodized aluminum, stainless steel or porcelain. The heaviest industrial type has been the nuclear-shielding door of lead, steel or concrete, a large example consisting of a steel shell filled with concrete $2\frac{1}{2}$ ft. thick and weighing 20 tons.

From mid-19th century onward there have been increasing technical developments, such as automatic door closers and openers —hydraulically, pneumatically or electrically activated—and innovations in hanging doors: pivoted, folding, sliding, rolling. The commonest pivoted type is the swinging door, operated equally in either direction. The revolving door was developed *c.* 1900 in the United States, consisting of four valves (glass) mounted at right angles and revolving about a central pivot in a circular vestibule, thus forming a perpetual air lock. The folding door became common in the 19th century as a series of wooden leaves hinged together to fold to one side of the opening. The 20th-century type has generally been made to resemble a curtain, being carried on an overhead track with a pantographic frame supporting a light, pliable material, such as veneer strips, textile, rubber, leather or plastic. The sliding door (wood paneled) appeared in the 19th century, characteristically carried by rollers on a metal

track disappearing into the wall. The sliding door (flush panel or glass) has been further developed and refined since 1900 after the inspiration of sliding wall panels in Japanese houses. Large wooden sliding doors have been common in barns, metal clad in factories; and the metal-frame type has been widely applied in large structures; *e.g.*, aircraft-hangar doors 75 ft. wide and 46 ft. high. The rolling door (developed 19th century), constructed of tubular astragals of aluminum or steel (galvanized or stainless) rolling up on an overhead track, has become common in industrial installations and as large as 48 ft. wide and 39 ft. high in gantry cranes on the St. Lawrence seaway. This type has also been made to roll up as a window shade or side-coiling. Other industrial types include the canopy door, constructed to swing out as an awning, in sizes as large as 60 ft. wide and 20 ft. high, or in units bifolding or telescoping when raised.

See also references under "Door" in the Index volume.

(E. A. C.)

DOPPLER, CHRISTIAN JOHANN (1803–1853), Austrian physicist, discoverer of the effect known by his name. He was born at Salzburg on Nov. 29, 1803. Educated at Salzburg and Vienna, he became, in 1850, director of the Physical institute and professor of experimental physics at Vienna. Doppler's earliest writings were on mathematics, but his name is associated with his work in physics. In 1842 he published a paper "Über das farbige Licht der Doppelsterne," which contained what is now known as the Doppler effect (*q.v.*). (*See* LIGHT: *Waves and Interference.*) He drew the analogy between the sound coming from a moving source and the light coming from a moving star; as the pitch of sound from a moving source varies, so Doppler thought the colour of the light from a star would be altered.

The principle was verified experimentally for sound by C. H. D. Buys Ballot in 1845, but the correct explanation in the optical case was given by Armand Fizeau in 1848. Doppler's principle is applied to the motion of stars in the line of sight, and is used for the discovery of double stars.

Doppler died at Venice on March 17, 1853.

DOPPLER EFFECT, the change in the observed frequency of a vibration because of relative motion between the observer and the source of the vibration. In sound (*q.v.*) this effect is an everyday experience; when a blowing horn is passed on the highway, the observer may notice that the pitch of the note seems to change. The Doppler effect for light waves is evident in spectroscopy (*q.v.*). *See* LIGHT: *Waves and Interference; see* also references under "Doppler Effect" in the Index.

DOR, an ancient Canaanite seaport on the Mediterranean, the site of the modern agricultural settlement of Nasholim, 15 mi. S. of Haifa in northwestern Israel. During the first Israelite conquest Joshua defeated its king, but Israel did not expel the Canaanites. In the early 11th century B.C. Wen-amun, an Egyptian temple official who was sent to Byblos to procure lumber, was robbed at Dor, and was pursued by the men of Dor to Byblos. Dor was the centre of one of Solomon's administrative districts (I Kings iv, 11), and it remained in Israel after the division of the kingdom. After 722 B.C. it became headquarters for the Assyrian province of Dor. It underwent other sieges, and with the building of Caesarea nearby by Herod the Great it declined permanently.

(E. D. GR.)

DORAT (DAURAT), **JEAN** (Lat. AURATUS) (1508–1588), French humanist and one of the seven poets of the Pléiade, was born at Limoges in 1508. He belonged to a noble family, and, after studying at the Collège of Limoges, went to Paris to be presented to Francis I, who made him tutor to his pages. He was also chosen as tutor to his son, Jean Antoine, by Lazare de Baïf, after whose death in 1547 he became the director of the Collège de Coqueret, where, besides Baïf, he had among his pupils Ronsard, Rémy Belleau and Pontus de Tyard. Joachim du Bellay was added by Ronsard to this group and these five young poets, under the direction of Dorat, formed a society for the reformation of French language and literature. They increased their number to seven by the initiation of the dramatist Étienne Jodelle and thereupon they named themselves La Pléiade, in emulation of the seven Greek poets of Alexandria. The election of Dorat as their president proved the weight of his personal influence and the value which his pupils set on the learning to which he introduced them, but as a writer of French verse he is the least important of the seven.

Meanwhile he collected around him a sort of academy and stimulated the students on all sides to a passionate study of Greek and Latin poetry, while he himself wrote incessantly in both those languages. His influence extended beyond the bounds of his own country and he was famous as a scholar in England, Italy and Germany. In 1556 he was appointed professor of Greek at the Collège Royal, a post which he continued to hold until, in 1567, he resigned it in favour of his nephew, Nicolas Goulu. Charles IX gave Dorat the title of *poeta regius*, one which he had justly earned by his numerous compositions for court ceremonies. His flow of language was the wonder of his time; he is said to have composed more than 15,000 Greek and Latin verses. The best of these he published at Paris in 1586 as *J. Aurati Lemovicis poetae et interpretis regii poemata.* He died in Paris on Nov. 1, 1588, having survived all his illustrious pupils of the Pléiade, except Pontus de Tyard. He was a little, restless man, of untiring energy, rustic in manner and appearance. His unequaled personal influence over the poets of his age gives him an importance for which his own writings do not fully account.

His *Oeuvres poétiques* were edited by C. Marty-Laveaux in his *Pléiade française* (1875).

DORCHESTER, DUDLEY CARLETON, VISCOUNT (1573–1632), English diplomat who conducted important negotiations on behalf of James I and Charles I, was born in Oxfordshire on March 10, 1573. Educated at Westminster school and at Christ Church, Oxford, he then spent several years on the continent, acquiring a good command of foreign languages, before accompanying a diplomatic mission to France in 1602. Later he became secretary to the earl of Northumberland, but this appointment impeded his rise in the diplomatic service, for when Northumberland was implicated in the Gunpowder plot, Carleton also fell under suspicion. He was soon able to clear himself, but it was not until 1610 that he was given another diplomatic post. That year he was knighted and sent as ambassador to Venice, where he remained for five years and accomplished the difficult task of negotiating peace (treaty of Asti) between Spain and Savoy. From 1616 to 1625 he was ambassador to the Netherlands. There, in 1621, he acted as host to the elector palatine, Frederick V, and his wife when they were obliged to take refuge at The Hague. Their visit came at a time when Carleton was encountering great difficulty in receiving prompt payments of his salary and allowances; by 1622 his salary was £2,895 in arrears.

Carleton was finally given adequate reward for his long service to the crown in 1625 when, having won the favour of the duke of Buckingham, he returned to England and was appointed vice-chamberlain of the royal household and a member of the privy council. He was created Baron Carleton of Imbercourt in 1626 and Viscount Dorchester in 1628. His work was confined mostly to special diplomatic missions until he was appointed principal secretary of state in 1628. He died on Feb. 15, 1632.

In the opinion of the earl of Clarendon, Carleton "understood all that related to foreign employment, and the condition of other princes and nations, very well: but he was utterly unacquainted with the government, laws, and customs of his own country, and the nature of the people." Modern historians generally share this opinion and distinguish between his work as ambassador and his achievements as secretary of state. (R. C. Jo.)

DORCHESTER, GUY CARLETON, 1ST BARON (1724–1808), soldier and governor of Quebec whose wise policy toward French Canada had far-reaching effects, was born in County Tyrone, Ireland, of Anglo-Irish parentage, Sept. 3, 1724. After serving with distinction on the Continent under the duke of Cumberland, he participated in the attack on Quebec with James Wolfe (*q.v.*). Wounded in this engagement, he left Canada shortly thereafter. After taking part in various other campaigns (Belle Isle, Port Andro, Havana), he returned to Canada in 1766 to rule as lieutenant governor of Quebec in the absence of the governor, whom he succeeded officially in 1768.

With statesmanlike vision Carleton insisted that the only way to keep the colony was to give it a constitution fitted to its French character. He was instrumental in the passage of the Quebec act (*q.v.*), 1774, by which French Canadians got Catholic emancipation half a century before their coreligionists in England. As a consequence of this wise and tolerant measure, most French Canadians remained neutral when American forces invaded Canada, by Dec. 1775 overrunning it. Carleton was forced to flee from Montreal and make his headquarters in Quebec, where he was besieged until spring, when the Americans fled before the arrival of a strong British army. Knighted in July for having saved Quebec, Carleton disappointed the home government by not using this army to strike south and cut the old colonies in two. Denied command of the expedition to the south in 1777, he resigned his office and in 1778 he departed.

Returning to America in 1782 at the close of the American Revolution as commander in chief, he dealt skillfully with the difficult problem created by the thousands of Loyalists huddled in New York, finding a refuge for them in the maritime provinces. Back in England by late 1783, he advised the government on the affairs of British North America, aspiring vainly to become its governor general. In 1786 he was raised to the peerage, commissioned governor in chief of each colony except Newfoundland, and sent back to Quebec, where he was expected to work out a new system of government for the old Canada (the province of Quebec). In this he failed, and he opposed its division in 1791 into Upper and Lower Canada. In 1794 he committed two grave indiscretions that threatened the peace with the United States and brought a stern rebuke from London. Again, unable to admit that he had done wrong, he resigned. He finally departed in 1796, an embittered old man. He died on Nov. 10, 1808, at Stubbings, near Maidenhead.

See extended treatment of Dorchester in A. L. Burt, *The Old Province of Quebec* (1933) and *The United States, Great Britain and British North America* (1940), which has been summarized in *Guy Carleton, Lord Dorchester 1724–1808, Revised Version* by the same author (1955). (A. L. Bu.)

DORCHESTER, a market town and municipal borough and the county town of Dorset, Eng., in the West Dorset parliamentary division, 8 mi. N. of Weymouth by road. Pop. (1961) 12,266. It stands on an eminence on the right bank of the river Frome, 6 mi. N. of the English channel. St. Peter's church is a Perpendicular building with a fine tower. All Saints and Holy Trinity churches were rebuilt in the 19th century, but St. George's, Fordington, retains Norman and Transitional details. Of public buildings the principal are: the town hall, market house and corn exchange, shire hall, the county museum and the county hospital. The oldest secular building in the town is Naper's (or Napier's) Mite, formerly an almshouse (1615), but restored and reopened in 1955 as shops for selected trades. The grammar school, founded in 1569, is in modern buildings. A statue to Thomas Hardy, the poet and novelist, was unveiled in 1931. Hardy was born near Dorchester, the "Casterbridge" of his Wessex novels. A room containing part of his study and other memorabilia was opened in the museum in 1939. There is also a statue to William Barnes, the Dorsetshire poet (1801–86). The town has been noted for its ale since the 17th century. The cloth industry flourished during the 16th century, and serge was manufactured in the 17th. Dorchester is a place of considerable agricultural trade, and large sheep and lamb fairs are held in May. Agricultural machinery, printing and leatherworking are local specialties.

Durnovaria, at the intersection of a number of Roman roads, was a Romano-British country town of considerable size, probably successor to a tribal centre of the Durotriges. The walls can be traced in part, and many mosaics, remains of houses, etc., have been found. Running northwestward was an aqueduct and to the north are traces of the so-called Celtic fields as well as remnants of farms and similar sites. Remains of an "amphitheatre," which dates to pre-Roman times, are at Maumbury Rings in the south of the town. Maiden Castle, on a hill 2 mi. S.W., is a vast earthwork encircled by gigantic entrenchments and ramparts, occupying 120 ac. Excavations in 1934–38 indicated that the hill was the site of an important settlement which began in the Neolithic period and grew with subsequent fortifications to its present size in Iron Age times. In the early 1st century A.D. the Belgae came into control of it, but after A.D. 43 it was taken by the troops of the future emperor Vespasian. Though the site declined, in the 4th century a Romano-Celtic temple was built on the hill. Another smaller encampment is at Poundbury, to the northwest, and barrows and numerous other remains have been found in the vicinity.

Little mention of Dorchester (Dornceaster, Dorcestre) occurs in Saxon annals, but a charter from Aethelstan to Milton abbey in 939 is dated at *villa regalis quae dicitur Dorocestria*, and at that period it possessed a mint. According to the Domesday survey it was a royal borough, and mention is made of a castle at Dorchester in records of the 12th and 13th centuries. The Franciscan priory, founded before 1331, is thought to have been constructed out of its ruins. Edward II granted the borough to the bailiffs and burgesses at a fee-farm rent of £20 for five years. The first charter of incorporation was granted by James I in 1610. Dorchester returned two members to parliament from 1295 until the Representation of the People act, 1868, when the number was reduced to one; in 1885 the representation was merged in the county. Edward III granted to the burgesses the perquisites from three fairs and three weekly markets. Elizabeth I granted an additional three days' fair at Candlemas. Dorchester was the scene of the "bloody assizes" of Judge Jeffreys in 1685 after the battle of Sedgemoor. In 1834 the six "Tolpuddle martyrs" were sentenced in the town for administering illegal oaths concerning trade-union activities. The old crown court where they were tried was in use as a court up to 1955. In 1956 the Trades Union congress took over its ownership as a memorial to the martyrs.

DORCHESTER, a residential district, with some light manufacturing, located in the southern section of Boston (*q.v.*), Mass., U.S. It was founded in 1630 by a group of colonists from Dorsetshire, Eng., who had previously been gathered together under the leadership of the Rev. John White. In 1633 a town-meeting form of government was set up, reportedly the first in the colonies. The Dorchester Historical society has preserved several houses from this period and the Dorchester burying ground contains some of the oldest marked graves in the United States. The colonial town figured significantly in history when, on the night of March 4–5, 1776, the fortification of Dorchester Heights, under orders from Gen. George Washington, forced the British to evacuate Boston. In 1868 Dorchester was incorporated into Boston.

Modern Dorchester is bounded on the west by the Midland branch of the New Haven railroad and on the east by the Old Colony railroad and stretches from Boston's south end to the Neponset river. The area is an ethnically heterogeneous one; housing units are primarily three-storied, wooden-frame structures. Most of the residents of the area earn their livelihood in central Boston. The Boston sanatorium is in the southern section of Dorchester. Public transportation is provided by the Ashmont extension of the subway and by many bus lines. (R. C. Wo.)

DORCHESTER-ON-THAMES, a large village of Oxfordshire, Eng., lies 9 mi. S.S.E. of Oxford by road on the west bank of the river Thame, just above its junction with the Thames. Pop. (1961) 1,877. Facing the ancient Dyke hills, there rises across the Thames the double isolated mound known as Wittenham Clumps (historically Sinodun), an early Iron Age earthwork. Dorchester (Dorocina, Dorcic, Dorceastre, Dorchestre), built where a Roman road crossed the river, became a walled town containing the station of a Roman official. In 634 it was made the seat of a bishopric by Birinus, apostle of the West Saxons, who baptized King Cynegils there. The witan of Wessex was held at Dorchester three times in the 9th century, and in 958 Aethelstan held a council there. In the 11th century the town is described as small but remarkable for the majesty of its churches. In 1092 the bishopric was finally moved to Lincoln by Remigius, the 17th bishop, where it is recorded in Domesday Book. About 1140 Alexander, bishop of Lincoln, founded an Augustinian abbey at Dorchester, of which the church and guest house remain. The town declined in importance, but in 1939 it was made a see suffragan to Oxford.

The abbey church of SS. Peter and Paul and Birinus has a nave

of great length, primarily of the Transitional Norman period; a choir with fine Decorated arcades; north choir aisle of the late 13th century, south choir aisle (*c.* 1300) and south nave aisle (*c.* 1320). The massive western tower was rebuilt in 1602. The eastern bay of the choir is considered to have been added as a Lady chapel, and the north window is a magnificent example of a "Jesse window," in which the tracery represents the genealogical tree of Jesus, the complete execution of the design being carried out in glass. The ancient sedilia and piscina are very fine. Behind the sedilia are four late 12th-century glass roundels. The font is Norman carved lead. The Decorated windows on the south side of the church contain the finest collection of early armorial glass in Great Britain (*c.* 1300); there are monuments and brasses of great interest. (W. O. H.)

DORDOGNE, an inland *département* of southwestern France, comprises nearly the whole of ancient Périgord (*q.v.*), together with parts of Agenais and smaller portions of Limousin and Angoumois. Pop. (1954) 377,870. Area 3,561 sq.mi. It is bounded north by Haute-Vienne, west by Charente, Charente-Maritime and Gironde, south by Lot-et-Garonne and east by Lot and Corréze. From the western part of the crystalline plateaus of Limousin, the *département* slopes west and southwest to the lowlands of Aquitaine. It is crossed in its southern portion by the Dordogne and farther north by that river's right-bank tributaries the Vézère, Isle and Dronne. These rivers traverse the limestone platforms that occupy much of the *département* and are known as the Causses de Périgord, or Petits Causses, to distinguish them from the higher Grands Causses of Aveyron. Along the contact of crystalline and limestone rocks, in the east of the *département,* the softer intervening marls have been etched out into fertile depressions with rather clayey soils. Crossing the Causses, however, the rivers are deeply entrenched, and the valley sides often present glistening walls of white rock. The intervening plateau surfaces are dry and stony but are much lower than in the Grands Causses and have a milder climate. They are also less denuded of woodland, and, associated with their oak woods, pig rearing is important and truffles are a well-known product. Raising of a variety of livestock—cattle, sheep, pigs and poultry—is especially important. *Pâté de foie gras* is a famous product of Périgord. In the sheltered valleys and basins maize as well as wheat is grown, and fruit orchards are especially extensive. The flat valley floors are occupied by irrigated meadows. Vineyards were formerly widespread, but since the *Phylloxera* plague of the late 19th century they have been largely replaced by fruit trees. In the market towns food-canning and preserving industries are prominent and there are many local brick- and tileworks, but manufacturing is generally little developed.

The towns of Périgueux (*q.v.;* the capital), Bergerac, Montron and Sarlat give their names to the four constituent *arrondissements* of the *département,* which for ecclesiastical, educational and judicial administration comes under the jurisdiction of Bordeaux.

The *département* is rich in remains of prehistoric man, and the caves of Lascaux in the valley of the Vézère near Montignac, which were discovered in 1940, in particular provide remarkable wall paintings and other evidence of prehistoric cultures. Those of the Beune valley have been known longer, and Les Eyzies, at the confluence of the Beune and Vézère, is the tourist centre for archaeologists and has the National Prehistoric museum. There are several fine medieval castles, notably at Bourdeilles, Biron and Jumilhac-le-Grand, and examples of medieval town planning in the form of *bastides,* such as Monpazier, built for the resettlement of the area after the devastations of medieval warfare. The remains of the Cistercian abbey at Cadouin include a fine Romanesque church and flamboyant cloister. (Ar. E. S.)

DORDOGNE RIVER, a river of central and southwestern France, rises at a height of 5,640 ft. on the Puy de Sancy in the Massif Central and flows to the Garonne, with which it unites at Bec d'Ambès to form the Gironde estuary. It has a length of 472 km. (293 mi.) and the area of its basin is 23,870 sq.km. (9,216 sq.mi.). In its course it cuts across a large number of geologic formations, as do its two major right-bank tributaries, the Vézère and the Isle. The Dordogne descends rapidly from its source and enters deep gorges as it flows through the crystalline plateau country, rich in granites, until it reaches Beaulieu (*département* of Corrèze) where it enters a wide fertile valley and is joined by the Cère. Entering the *département* of Lot it turns west and flows through limestone country, often in gorges with the Causses (*q.v.*) above on both sides. It traverses the *département* of Dordogne, where it receives the Vézère. The lower course of the latter is through limestone, and its many caves have made it classic ground for the study of Paleolithic man. Below the town of Bergerac, the Dordogne enters the *département* of Gironde and is joined by the Isle at Libourne. The river is about 3,300 yd. wide at its union with the Garonne, 45 mi. from the sea. There are important bridges at Cubzac-les-Ponts. There is much river traffic after the confluence with the Vézère over the last 112 mi. of its course. The estuary of the Gironde is one of the most conspicuous features of the western coast of France and the highest tides ascend the Dordogne as far as Pessac, a distance of approximately 100 mi. from the ocean. (Ar. E. S.)

DORDRECHT, a town in the province of South Holland, Neth., is situated 12.5 mi. S.E. of Rotterdam by rail at the confluence of four large rivers: Merwede, Noord, Oude Maas and Dordtse Kil. Pop. (1957 est.) 77,624 (mun.). The part of Dordrecht on the riverside has maintained its picturesque medieval character with many courtyards, gates (*e.g.,* Groothoofdspoort) and old buildings, busy quays and numerous canals, quaint streets and curiously gabled houses. The great church with a massive tower dates from the 14th century and its beautiful interior has finely carved stalls and a notable pulpit. Large modern housing estates are spaciously laid out and there are three public parks. The town is a centre for aquatic sports. The town museums have an interesting collection of paintings, including pictures by some of the old masters, and a collection of antiquities belonging to old Dordrecht.

Roads and railways connect the town with all parts of the country. There are waterways to the Rhine, Antwerp, Rotterdam and, via Oude Maas, to the North sea. Dordrecht's many industries include shipbuilding and metallurgical, wood and chemical works. A great deal of trade is carried on from the harbour, where ore, coal, wood and oil are imported.

Dordrecht was founded by Count Dirk III in 1008, becoming a town about 1200. In 1572 it was the meeting place of the deputies who asserted the independence of the United Provinces. In 1618 and 1619 it was the seat of the important Synod of Dort (*q.v.*).

DORÉ, (PAUL) GUSTAVE (1832–1883), French artist, one of the most prolific and successful book illustrators of the late 19th century, was born at Strasbourg on Jan. 6, 1832. In 1847 he went to Paris and from 1848 to 1851 produced weekly lithographic caricatures for the *Journal pour rire,* as well as several albums of lithographs (1847–54). His later fame rested on his wood engraved book illustrations. Among his finest were an edition of the works of Rabelais (1854), *Contes drolatiques* of Balzac (1855), the large folio Bible (1866) and the *Inferno* of Dante (1861). Employing more than 40 woodcutters, he produced over 90 illustrated books. He also painted many large compositions of a religious or historical character, and had some success as a sculptor. He died in Paris on Jan. 23, 1883.

See W. B. Jerrold, *Life of Gustave Doré* (1891); H. Lehmann-Haupt, *The Terrible Gustave Doré* (1943).

DORGAN, THOMAS ALOYSIUS (pseudonym Tad), (1877–1929), U.S. journalist, boxing authority and cartoonist, was born in San Francisco, Calif., on April 29, 1877. At an early age he joined the art department of the *San Francisco Bulletin,* where he worked as a cartoonist and comic artist. In 1902 he was employed by William Randolph Hearst, becoming a political cartoonist of the *New York Journal.* Dorgan did not continue as a political cartoonist, however, but began to concentrate his interests on sports, particularly boxing. His sketches of fighters and commentaries were widely syndicated throughout the country, his pen name Tad (the initials of his name) becoming well known.

Dorgan also developed comic-strip characters, such as "Silk Hat Harry" and "Judge Rummy," which he used in his daily cartoons. He was responsible for the wide currency of many slang expressions, among them "The first hundred years are the hardest," "As

busy as a one-armed paper hanger with the hives," "23, skidoo" and "Yes, we have no bananas."

He died at Great Neck, L.I., on May 2, 1929.

DORIA, ANDREA (1466–1560), Genoese *condottiere* and statesman who was also the greatest admiral of his time, was born at Oneglia on Nov. 30, 1466, the son of Ceva Doria, of an ancient family which had given Genoa many political leaders and the fleet's commander in four major victories (Oberto at Meloria, 1284; Lamba at Curzola, 1298; Pagano at Portolongo, 1354; Luciano at Pola, 1379). Orphaned at an early age, he became a soldier of fortune and served first in the papal guard and then under various Italian princes before being appointed captain-general of the Genoese galleys in his 40s. As such he scoured the Mediterranean fighting the Turks and the Barbary pirates. After the Holy Roman emperor Charles V's forces had taken Genoa (1522) and deposed the pro-French faction there, Doria took service under the French king Francis I. Appointed admiral of the French Mediterranean fleet, he made the emperor's army raise the siege of Marseilles in 1524. When Charles took Francis prisoner at the battle of Pavia (1525), Doria went to serve Pope Clement VII. He returned to the French service in 1527 (when Francis had been set free) and helped to restore the pro-French faction in Genoa. Francis, however, not only failed to restore Savona to the Genoese but unwisely began to take measures against Doria's own security. Doria thereupon retired to Lerici, transferred his services to Charles V, recalled his cousin Filippino from collaboration with the French in the blockade of Naples with the Genoese fleet, took Genoa in Sept. 1528 and restored the republic there under imperial protection. Charles gave him the title of prince of Melfi.

Doria gave the Genoese constitution a new aristocratic bias and stopped the factions which divided the city. He refused the lordship of Genoa and even the dogeship, but exercised predominant influence in the councils of the republic until his death. He was given two palaces, many privileges and the title of *liberator et pater patriae*. As imperial admiral he commanded several expeditions against the Turks, taking Coron and Patras and helping the emperor to capture Tunis (1535). Charles found him an invaluable ally in the wars with Francis and used his services to extend his domination over the whole of Italy. Doria is said to have let the Turks defeat him at Preveza in 1538 on purpose to spite the Venetians, whom he detested. He accompanied Charles on the ill-fated Algerian expedition of 1541, of which he disapproved; he just managed to save the force from complete disaster. For the next five years there was hardly an important event in Europe in which he had not some share.

After the peace of Crépy between Francis and Charles in 1544 he hoped to end his days in peace. But he had many enemies, and in 1547 Giovanni Luigi Fiesco (*q.v.*) plotted to upset the power of his house. Doria's nephew Giannettino was murdered, but the conspirators were defeated, and Andrea punished them with great vindictiveness. He was implicated in the murder of Pierluigi Farnese, duke of Parma (*see* FARNESE), who had helped Fiesco. Other conspiracies followed, most important that of Giulio Cybò (1548), but all failed. Charles repeatedly tried to saddle Genoa with a citadel to be manned by Spaniards, but Doria resisted all attempts to win his approval. Nor did age lessen his energy; in 1550, at 84, he put to sea again to punish the raids of the Barbary pirates, but without much success. When war between France and the empire broke out again, the French seized Corsica, then administered by the Genoese Bank of San Giorgio. Doria then spent two years (1553–55) in the island, fighting the French with varying fortune. He returned to Genoa for good in 1555 and gave the command of the galleys to his great-nephew Giovanni Andrea Doria.

Andrea Doria died on Nov. 25, 1560, leaving his estates to Giovanni Andrea. One of the last great *condottieri*, he had many of the faults of his profession: he was greedy, conceited, vindictive, unscrupulous and authoritarian. Yet he was also fearless, untiring and endowed with outstanding tactical and strategic talents. He loved his native city, enriched it with works of art and gave it as good a government and as much independence as circumstances allowed.

See E. Petit, *André Doria* (1887); I. Luzzatti, *Andrea Doria* (1943).
(R. S. L.)

DORIANS, an important section of the classical Greek people, distinguished by their subdivision, within all their communities, into the tribes (*phylai*) of Hylleis, Pamphyloi and Dymanes, and by a well-marked dialect.

Dorians in historic times occupied the southern and eastern Peloponnese and the isthmus region, including Sparta, capital of Laconia and of conquered Messenia, Argos, Phlius, Epidaurus, Sicyon, Corinth and Megara; the southern Aegean islands, including Crete, Melos and Thera and the Dodecanese, where the three cities of Rhodes, with Cos and the mainland cities of Cnidus and Halicarnassus, formed the *hexapolis* ("six cities") of Asian Doris, with meetings for common worship at the Triopian promontory near Cnidus. Colonization brought Dorians from Corinth to Corcyra (Kerkyra, Corfu) and Syracuse; from Sparta to Taras (Latin *Tarentum*, modern Taranto); from Rhodes and Crete to Gela and Acragas (Agrigento); from Thera to Cyrene and from Megara to Megara Hyblaea and Selinus in Sicily, and to Byzantium and Chalcedon, Heraclea Pontica (Eregli), Chersonesus near modern Sevastopol in the Crimea, and other cities in the Black sea area (*see* articles on individual cities).

The distribution of Greek dialects in historic times confirms the Greek tradition that Dorians came into the south Aegean area at the end of the Bronze Age, when it was already occupied by other Greeks; for in inland Arcadia (*q.v.*), unconquered by Dorians, there survived a Greek dialect whose only close relations are with that of Cyprus. This Arcado-Cypriot dialect, therefore, was presumably the speech of the seafarers who brought Mycenaean culture to Cyprus about 1400 B.C., before Dorians overran the nearer southern islands and cut off Arcadia from the sea (*see* GREECE: *History*). The Doric dialect preserved the broad *ā* sound, as in Gr. *mātēr*, "mother," modified into long *ē* (our *a* in "mate") in Attic-Ionic, and other characteristics, such as the terminations of the verb in *-ti* for the 3rd person and in *-mes* for the 1st person plural, wherein comparison with other Indo-European languages shows that it, among Greek dialects, best preserved primitive forms. Kindred dialects were spoken in northwestern Greece.

Greek legend related that the Heraclidae or children of Heracles, persecuted after his death by his cousin and enemy, Eurystheus of Mycenae, took refuge in Thessaly with an old ally of their father, Aegimius, king of the Dorians, descended from the eponymous hero Doros, son of Hellen; and Aegimius adopted Hyllus, son of Heracles, as a brother to his own sons, Pamphylus and Dyman. Thence, after three generations ("80 years after the Trojan War" according to Thucydides) the Heraclid brothers Temenus, Aristodemus and Cresphontes, great-grandsons of Hyllus, set out with a Dorian host to recover their heritage. Avoiding the isthmus, where Hyllus had fallen in an earlier attempt, they built ships at Naupactus (the "place of shipbuilding") and invaded the Peloponnese from the northwest. Elis fell to the lot of their Aetolian allies; Messenia to Cresphontes; the Argolid, after a victory over Tisamenus, son of Orestes, to Temenus, and Sparta to Eurysthenes and Procles, the twin sons of Aristodemus, who died during the conquest. (Hence, according to Spartan official genealogy, the Spartan dual monarchy.) Southern Laconia was only "Dorized" after a struggle of several generations, in which the people of Helos, on the coast, who resisted desperately, were made serfs, giving their name to the helot class. The small district of Doris (*q.v.*) between Mts. Oeta and Parnassus was said to have its name from Dorians who stayed behind, and thus to be the mother-country of the southern Dorians, a claim recognized by Sparta for political reasons in the 5th century; while the coming of the Spartans from "windy Erineos" (one of the four towns of Doris) is mentioned by the 7th-century Spartan poet Tyrtaeus. From the Peloponnese, finally, the Dorians turned against Attica, conquering the northern part of the isthmus and founding Megara ("the halls"; one of the few old Greek cities to have a Greek name); but Athens survived, to preserve some elements of civilization and to organize refugee-settlements of the displaced populations in Ionia.

However much of romance may be included in this legend of the *Dorica*, it is noteworthy that the name of the Dymanes is of a northwestern type (cf. Acarnanes, Athamanes, etc.), while the Pamphyloi ("all tribes") may represent a "mixed multitude" organized into a war-band. The tradition of descent from Heracles will originally have been confined to the Hylleis, but the existence of the three tribes in all Dorian cities suggests that the Dorians entered the south either as an organized war-band, or already a nation.

In some cities additional tribes are found, *e.g.*, the Hyrnathioi at Argos, the Aigialeis ("coast dwellers"?) at Sicyon, said to be named after a son of the pre-Dorian king Adrastus; these may represent an incorporation of pre-conquest elements into a Dorian body-politic. At Corinth, as reorganized after the fall of the tyranny in the 6th century B.C., there were eight tribes; whether the Dorian three were among them is unknown. But in early historic times government in the Dorian states was everywhere in the hands of a Heraclid aristocracy, which had either abolished the monarchy as at Corinth or curtailed its powers as at Sparta. The tradition of the conquest added racial feeling to economic tensions; and when, in the coastal cities, "tyrants" arose to overthrow the aristocracies, this feeling was exploited. Cypselus of Corinth is said to have been a Heraclid through his mother, but to have claimed older pre-Dorian nobility on his father's side; Cleisthenes of Sicyon is said to have renamed his own non-Dorian tribe Archelaoi ("rulers") and given abusive names to the three Dorian tribes. An element of racialism was introduced into Greek political controversy. From a temple in Ionic Paros, somewhat later, there is an inscription: "Slaves and Dorians not admitted." The ethnological theory summarized by Herodotus (i, 56 *et seq.*), no pan-Dorian fanatic, rightly distinguishes two main racial factors in Greece, one immigrant and one aboriginal, and associates the introduction of the Greek language with the former; but he wrongly associates this Hellenic element exclusively with the Dorians, and confuses the speakers of other Greek dialects—brought into Greece, it is clear, by earlier migrations, of which all memory had been lost—with the non-Greek-speaking "Pelasgians" (*q.v.*), a name which Greek theorists used as a general term for "aborigines."

The question remains whether there was a well-marked Dorian character and way of life to be distinguished in Greek history. Some 5th-century Greeks clearly thought that there was: a character marked by greater discipline and sobriety and higher military qualities than that of the Ionians, who had emerged from Persian lordship only to fall under that of Athens. Herodotus reflects this view: Thucydides more than once quotes Dorians as holding it. Some modern writers, influenced by the 19th-century "Aryan" theory of the inherent superiority of certain races and especially by the famous book of the youthful K. O. Müller, *Die Dorier* (1824), have accepted it. More recent views have become more skeptical. Corinth and Rhodes were as commercial-minded, Syracuse and Taras as democratic (and as unstable) in their heyday, Argos and Corcyra as bloody in their revolutions, as any Greek states. That Ionia felt the full influence of the Orientalizing movement in art (as did Rhodes and Corinth) and life and that Ionia fell before eastern conquerors may be more plausibly ascribed to geography; that the Peloponnese escaped Persian invasion was due largely to the length of the Persian line of communications and to the victory at Salamis of the Athenian fleet. The fact is that for a strongly differentiated Dorian constitution, we have to look to just two quarters: to Crete and to Sparta, in both of which (and in Sparta hardly before 600, though some scholars would prefer an earlier date in the 7th century) Dorian aristocracies deliberately "froze" an archaic form of society, sacrificing their early artistic promise in the process, in order to secure their position against a larger population of serfs. The dominating factor is not racial, but social. In Sparta, indeed, at the very time when it was perfecting its "Spartan" way of life, there was even a movement to "play down" pan-Dorianism. The "bones of Orestes" the Achaean, stolen from Tegea, were re-buried with honour in Sparta; and the brilliant and unorthodox king Cleomenes I, when the priestess of Athena at Athens barred his entry into the temple with the words, in the manner of the Parian inscription, "It is not permitted for Dorians to enter here," replied "Madam, but I am not a Dorian, but an Achaean" (507 B.C.). It is fair to add that his more orthodox brother was named Dorieus.

Dorians contributed not a little to the culture of Greece: in choral poetry, the germ of drama; in early vase-painting, especially Corinthian and Laconian; in Doric architecture; in sculpture in Crete and at Argos. But the extravagances of the "Dorian theory" date from a time when Dorian upper classes were struggling to maintain their position; especially when, in the 5th century, while proud of their repulse of Xerxes during the Greco-Persian wars, they were also nervous at the concentration of the resources of the eastern Greek world, and the encouragement of democracy there, under the overlordship of Athens. *See* IONIANS; SPARTA; *see* also references under "Dorians" in the Index volume.

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DORIC ORDER: *see* ORDER.

DORION, SIR ANTOINE AIMÉ (1816–1891), Canadian statesman and judge, joint premier of United Canada for four days in 1858 and in 1863–64, was born of an old Liberal family at Ste. Anne de la Pérade, Lower Canada (Quebec), on Jan. 17, 1816. He went to Nicolet college and later studied law under M. Côme-Séraphin Cherrier, an eminent Montreal lawyer. Admitted to the bar in 1842, he became Cherrier's associate, and in 1863 was made a queen's counsel. He entered politics in 1854 as member of the legislative assembly for Montreal. At once he became the leader of a group of audacious and talented young men known as the *Rouges*, who were really the Canada East (Lower Canada) wing of the Liberal party. They were compromised in the eyes of the French-Canadian electorate by their association with anticlericalism and with the Liberals of Canada West who were often belligerent Protestants. It was evidence of Dorion's abilities that he succeeded at all.

He had a trenchant mind and an acid tongue to express it. He had little use for political traditions unless intrinsically valuable, and he disliked the casual conservatism represented by G. E. Cartier and J. A. Macdonald, who, he suspected, were quite capable of manipulating friends or funds in order to stay in office. He believed that the solution of the political difficulties of the province of Canada lay in a federation of the two sections, which in fact he proposed in 1856. Probably some similar solution was the basis of the Brown-Dorion administration of August 2–5, 1858. This unfortunate coalition weakened him with the French-Canadian voter; he was more successful in 1862 when, united with a Roman Catholic Scot from Canada West, he helped form the John Sandfield Macdonald-Sicotte government and, later, the Dorion-Macdonald administration, 1863–64.

He was a stern critic and opposed confederation with every power at his command, believing it dangerous for the liberties of French Canadians. But he accepted the *fait accompli* of 1867. He became minister of justice in the Liberal government of Alexander Mackenzie in 1873 and was appointed chief justice of Quebec in 1874 and knighted in 1878. Dorion's talents were effectively utilized on the bench. His penetrating and shrewd intelligence made him as effective a judge as he had been powerful an advocate, and his integrity was the guarantor of his impartiality. He died at Montreal, Que., on May 31, 1891, just a week before his old archenemy, J. A. Macdonald. (P. B. W.)

DORIS, a small district in central Greece, between Mts. Oeta (modern Oiti) and Parnassus, containing the headwaters of the Cephissus (modern Kifisos) river. This narrow valley, which nowhere exceeds 4 mi. in breadth and has only four small townships, owed its importance partly to its command over the road from Heraclea in Trachis to Amphissa, but chiefly to its prestige as the alleged mother country of the Dorian conquerors of the Peloponnese (*see* DORIANS). Its history is mainly made up of petty wars with Oetaeans and Phocians. In 457, the Spartans, admitting the claim of Doris to be the Dorian metropolis, sent an

army to help it against the Phocians, and again against the Oetaeans in 426. Except for mention of its cantonal league in 196, Doris passed early out of history.

DORISLAUS, ISAAC (1595–1649), Anglo-Dutch lawyer and diplomatist, assassinated for his part in preparing the trial of Charles I, was born at Alkmaar, Neth., the son of a minister of the Dutch Reformed Church. He was educated at Leiden, removed to England about 1627, and was appointed to a lectureship in history at Cambridge, where his attempt to justify the Dutch revolt against Spain led to his early retirement. In 1629 he was admitted a commoner of the College of Advocates. He made his peace at court in 1632. On two occasions he acted as judge advocate—in the Bishops' War of 1640 and in the army commanded by the earl of Essex in 1642. In 1648 he became one of the judges of the admiralty court, and was sent on a diplomatic errand to the states general of Holland. He assisted in preparing the charges against Charles I and in managing the king's trial. He went to The Hague in May 1649 to help in negotiations for an alliance between the Commonwealth and the Dutch republic, and was murdered there by royalist refugees on May 12.

DORKING, a market town and urban district of Surrey, Eng., lies 12 mi. E. of Guildford by road. Pop. (1961) 22,594. It is at the edge of the North downs in the sheltered wooded valley of the river Mole and is noted for the beauty of its countryside. Holmwood common (630 ac.) at the southern end and Box hill (1,429 ac.) in the northeast of the district belong to the National trust. Dorking is the centre of an extensive agricultural and residential area. It gives its name to a well-known breed of fowl distinguished by having five toes.

Several fine mansions are in the vicinity of the town, notably those of Leith Hill place (southwest), Polesden Lacey (3 mi. N.W.), which contains the Greville collection of works of art, and Deepdene, once a famous mansion, where Disraeli wrote most of *Coningsby*. Leith Hill place and Polesden Lacey belong to the National trust. The district has literary associations with George Meredith, who lived and is buried there, Fanny Burney (Frances D'Arblay) and T. R. Malthus, as well as Disraeli and others. Dorking has four railway stations, including Box hill station.

DORMAN, THOMAS (d. 1577?), English Roman Catholic theologian, was born at Berkhampstead, Hertfordshire, and studied at the Berkhampstead free school, at Winchester and at New college, Oxford, where he was elected a probationer fellow. He became a fellow of All Souls' college in 1554, during the Catholic revival under Mary, and was awarded the degree of bachelor of civil law in 1558.

Opposing the religious changes made after the accession of Queen Elizabeth I in 1558, Dorman left England. He became a student of theology in Louvain, Belg., and in 1565 was graduated as bachelor of divinity from the University of Douai, in France, which later also awarded him the doctorate. Dorman assisted in the establishment of the English college at Douai, founded in 1568 by William Allen.

In 1572 or 1577 Dorman died at Tournai, Belg.

DORMER, in architecture, a projection from a sloping roof, containing a window. Dormers may occur either on the face of the wall or high upon the roof; their roofs may be gabled, hipped, flat or with one slope. Wherever steep, high roofs occur, dormers are common, in order to light the space within.

Simple dormers, frequently in several rows, characterize the steep roofs of Teutonic countries, but in the late Gothic and early Renaissance periods certain dormers, whose fronts were on the wall line of the building, were built in masonry and richly decorated.

GIRAUDON

RENAISSANCE DORMER OF THE CHÂTEAU OF BLOIS, FRANCE, EARLY 16TH CENTURY

Similar elaborate dormers, usually with gabled roofs, were characteristic of the French châteaux from the time of Louis XII to that of Louis XIV, and of Tudor work in England and Scotland.

Examples of dormers, ornamented with pinnacles, tracery and buttresses, occur in the Palais de Justice at Rouen (end of the 15th century), Heidelberg castle (1556) and the châteaux of Blois and Chambord (time of Francis I) show characteristic Renaissance enrichment.

The term "dormer" arose from the windows' being those of sleeping rooms. The phrase "dormer beam" is the equivalent of the modern sleeper. *See* ROOF.

DORMOUSE, any of certain small rodents of the families Gliridae (often, Muscardinidae) and Platacanthomyidae, which contain a number of old world species. In their appearance and habits—arboreal life and the habit of sitting up on their hind legs with their food grasped in the forepaws—dormice are like squirrels, from which they differ in being completely nocturnal; some of their most distinctive rodent features are internal. They live (average span three years) among bushes or in trees, and make a neat nest for the reception of their young, generally four in number, produced twice a year (spring and fall). They are born blind, but in a very short period are able to care for themselves; their hibernation begins later in the season than that of the adults. The common name refers to their proverbial somnolence. The species inhabiting cold climates construct a winter nest in which they hibernate (often for six months), waking up at times to feed on an accumulated store of nuts and other foods. They become very fat prior to hibernation, and at such times the edible dormouse was considered a favourite article of food on the continent.

JOHN MARKHAM

COMMON DORMOUSE (MUSCARDINUS AVELLANARIUS)

In the more typical members of the Gliridae, forming the subfamily Glirinae, there are four pairs of cheek teeth, which are rooted and have transverse enamel folds. The typical genus *Glis* is represented by the European edible dormouse, *G. glis*, a gray species with black markings and about 8 in. long; the genus ranges from continental Europe to Japan. The common dormouse *Muscardinus avellanarius*, ranging from England to Russia and Asia, is of the size of a mouse. The fine, silky fur is tawny above and paler beneath, with a white patch on the throat. The third genus is represented by the continental lerot, or garden dormouse, *Eliomys quercinus*, which is a large chestnut coloured species with black cheeks. There are several local forms or races. A large number of African species belong to the genus *Graphiurus*.

The family Platacanthomyidae, spiny dormice, are represented by the Indian *Platacanthomys* and the Chinese *Typhlomys*, in which there are only three pairs of cheek teeth. (J. E. HL.; X.)

DORNER, ISAAC AUGUST (1809–1884), German Lutheran theologian, was born at Neuhausen, Württemberg, on June 20, 1809. After studying at Tübingen, he traveled in England and Holland. He was professor of theology successively at Tübingen (1837), Kiel (1839), Königsberg (1843), Bonn (1847), Göttingen (1853) and finally Berlin (1862). Dorner's best-known work is his treatise on the history of the doctrine of the Person of Christ (1835–39; Eng. trans., 5 vol., 1861–66). Others are *Das Princip unserer Kirche nach dem innern Verhältniss seiner zwei Seiten betrachtet* (1841) and *Geschichte der protestantischen Theologie* (1867; Eng. trans., 1871). His ultimate position as one of the "mediating" theologians is best seen in his *Christliche Glaubenslehre* (1879–81). The companion work *System der christlichen Sittenlehre* was published in 1886. Dorner founded and for many years edited the *Jahrbücher für deutsche Theologie*. He

died at Wiesbaden, July 8, 1884.

DORNOCH, the only royal and small burgh and the county town of Sutherlandshire, Scot. Pop. (1961) 933. It lies on the north shore of Dornoch firth, 62 mi. N.N.E. of Inverness by road. Its dry climate, sandy beaches and splendid golf links have made it a residential and resort town. The cathedral, built by Bishop Gilbert de Moravia (Moray) (d. 1245), was damaged by fire in 1570, during a raid, and neglected till 1835–37, when it was restored by William Burns. A further restoration took place in 1924. The one remaining tower of the bishop's palace, later called Dornoch castle, was rebuilt and is now a hotel. It was the scene of the last execution for witchcraft in Scotland (1722). The town received its charter from Charles I in 1628.

DOROTHEUS, a professor of jurisprudence in the Roman law school of Berytus (Beirut) in Syria, and one of the three commissioners appointed by the emperor Justinian to draw up a book of Institutes to serve as an introduction to the *Digest*, part of the *Corpus juris civilis*, already completed. His colleagues were Tribonian and Theophilus, and their work was accomplished in 533. Dorotheus later wrote a commentary on the *Digest*, which is called the *Index* and was published by him in 542. Fragments of this commentary have been preserved in the *Scholia* appended to the *Basilica*, from which it seems probable that the commentary of Dorotheus contained the substance of a course of lectures on the *Digest* delivered by him in the law school of Berytus.

DORSET, EARLS, MARQUESSES AND DUKES OF, English titles formerly borne by the families of Beaufort, Grey and Sackville. Osmund (d. 1099), bishop of Salisbury, an alleged son of Henry, count of Seéz, by a sister of William I, is said to have been created earl of Dorset about 1070, but the authority is a very late one and probably inaccurate. William de Mohun (fl. 1141), earl of Somerset, was sometimes also called earl of Dorset, since the two shires were once united under a single sheriff.

JOHN BEAUFORT (*c.* 1371–1410) earl of Somerset, the eldest son of John of Gaunt, duke of Lancaster, and of Catherine Swynford, was created marquess of Dorset in 1397, but he was reduced to his former rank of earl two years later. His brother THOMAS (d. 1426), afterward duke of Exeter, was created earl of Dorset in 1411 and John's son EDMUND (1406–1455), afterward earl of Somerset, obtained the same dignity in 1441, becoming marquess of Dorset two years later. Edmund's titles were inherited by his son HENRY (1436–64), but became extinct on Henry's execution in 1464 (*see* BEAUFORT).

THOMAS GREY (1451–1501) was created marquess of Dorset in 1475. He was the eldest son of Sir John Grey, Lord Ferrers of Groby (1432–61), by his wife Elizabeth Woodville, afterward queen of Edward IV. Thomas received the earldom of Huntingdon in 1471, but renounced it shortly afterward. He fought for Edward IV at Tewkesbury, and after Edward's death he and his brother Richard Grey supported their half-brother the young Edward V, thus incurring the enmity of Richard, duke of Gloucester (later Richard III). Richard Grey was arrested and beheaded at Pontefract in June 1483, while the marquess saved his life by flight. Dorset was one of the leaders of the duke of Buckingham's insurrection, and when this failed he joined Henry, earl of Richmond (afterward Henry VII), in Brittany, but he was left in Paris when the future king crossed to England in 1485. After Henry's victory at Bosworth the marquess returned to England and his attainder was reversed. He was suspected and imprisoned when Lambert Simnel revolted (1487) but he was soon restored to favour, took part in the French expedition of 1492, and helped suppress the Cornish rising in 1497. He died on Sept. 20, 1501.

THOMAS GREY (1477–1530), 2nd marquess of Dorset, the eldest son of the 1st marquess, fled to Brittany with his father in 1484. He spent several years in prison under Henry VII, but was highly favoured by Henry VIII, who gave him command in France in 1512 and made him warden of the Scottish marches in 1523. He was famous for his skill in the tournament and was one of the eight challengers at the Field of Cloth of Gold. He died on Oct. 10, 1530. His eldest son, HENRY GREY (1517–54) 3rd marquess of Dorset, was in 1551 created duke of Suffolk (*see* SUFFOLK, EARLS AND DUKES OF). A younger son, Lord Thomas Grey, was beheaded in 1554 for sharing in the rebellion of Sir Thomas Wyat; another son, Lord John Grey (d. 1569) was also sentenced to death for his share in this rising, but his life was spared by the efforts of his wife, Mary, daughter of Sir Anthony Browne. Under Elizabeth I, Lord John, a strong Protestant, was restored to the royal favour.

In 1604 THOMAS SACKVILLE (*q.v.*) was created earl of Dorset. He was succeeded by his son ROBERT (1561–1609), 2nd earl, and his grandsons RICHARD (1590–1624), 3rd earl, and EDWARD (1591–1652), 4th earl. Edward had attained much notoriety by killing Edward Bruce, 2nd Lord Kinloss, in a duel in 1613 and he fought for James I's son-in-law, Frederick V, elector palatine, in 1620. In the house of commons, where he represented Sussex in 1621–22, Sackville defended Francis Bacon and advocated an aggressive policy for the recovery of the Palatinate; twice he was ambassador to France (1621 and 1623), and he was interested in Virginia and the Bermuda Islands. Under Charles I he was a privy councilor and lord chamberlain to Henrietta Maria. At the outbreak of the Civil War, he joined the king at York, but he endeavoured to secure peace. At Oxford he was lord chamberlain to the king and lord president of his council (1644), but Charles did not altogether approve of his pacific attitude. He died on July 17, 1652. His wife Mary (d. 1645), daughter of Sir George Curzon, was governess to the sons of Charles I, the future Charles II and James II.

CHARLES SACKVILLE (1643–1706), 6th earl of Dorset, was the eldest son of RICHARD (1622–77), 5th earl, and of Frances, daughter of Lionel Cranfield, earl of Middlesex. He was born on Jan. 24, 1643, probably at Copt hall, Essex. He inherited in 1674 the vast estates of his maternal grandfather, whose title of earl of Middlesex was conferred on him in 1675, and succeeded to his father's title in 1677. He was educated at Westminster school and traveled on the continent from 1658 till 1660. After the Restoration he became member of parliament for East Grinstead, and was a prominent member of the famous circle of court wits. He was one of the group which produced a translation of Pierre Corneille's *Pompée* in 1663 and he took part with Sir Charles Sedley and Sir Thomas Ogle in a notorious drunken frolic at Oxford Kate's tavern in Covent Garden in June 1663. Like other young courtiers he served as a volunteer in the Dutch War in 1664. Nell Gwyn was his mistress before she bestowed her favours on Charles II, and, according to Samuel Pepys, he was living with her at a house at Epsom in July 1667. He was a gentleman of the bedchamber to Charles II but he opposed the policy of James II, and in 1688 supported William of Orange (afterward William III), who made him lord chamberlain in 1689. He died at Bath on Jan. 29, 1706.

The 6th earl was a munificent patron to many men of letters, including Dryden, Etherege, Butler, Shadwell and Prior. Dryden valued his friendship highly and dedicated to him the *Essay of Dramatic Poesy*, in which Dorset appears under the name of Eugenius. He was celebrated for his indolence, his mordant wit and his good nature. Rochester called him "The best good Man, with the worst natur'd Muse." He only left a small sheaf of poems but they have an individual quality. The most famous is the lively, sparkling ballad said to have been "Written at Sea, in the first Dutch War, 1665" beginning:

> To all you ladies now at land
> We men at sea indite.

His little satiric poems on Katherine Sedley are a piquant combination of the lyric and the satiric epigram and two of his satires in heroic couplets on Edward Howard anticipate to a remarkable degree the manner of Pope, who greatly admired Dorset's poetry and owes a considerable debt to it.

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The 6th earl's son LIONEL CRANFIELD SACKVILLE (1688–1765), 7th earl, was created duke of Dorset in 1720. He was twice lord steward of the household, twice lord lieutenant of Ireland and was lord president of the council from 1745 to 1751. His second vice-

royalty of Ireland (1750–55) was stormy and ended in dismissal. He died on Oct. 10, 1765, leaving three sons: Charles, the 2nd duke; John Philip (d. 1765); and George (*see* SACKVILLE, GEORGE, 1st Viscount).

CHARLES SACKVILLE (1711–69), 2nd duke, an associate of Frederick, prince of Wales, was a member of parliament for many years and a lord of the treasury under Henry Pelham; he died on Jan. 5, 1769. His nephew JOHN FREDERICK (1745–99), 3rd duke, was ambassador in Paris from 1783 to 1789 and lord steward of the household from 1789 to 1799; he died on July 19, 1799, and was succeeded by his only son GEORGE JOHN FREDERICK (1793–1815), 4th duke. When the 4th duke died unmarried in Feb. 1815, the titles passed to his kinsman, CHARLES SACKVILLE-GERMAIN (1767–1843), 5th duke, son and heir of the 1st Viscount Sackville. When he died on July 29, 1843, the titles became extinct. (X.)

DORSET, a southwestern county of England, bounded northeast by Wiltshire, east by Hampshire, south by the English channel, west by Devon and northwest by Somerset. Area 974.9 sq.mi.

Physical Features.—In the centre of the county the chalk hills of the western downs sweep southwest from Cranborne Chase through Blandford Forum, Milton Abbas and Frampton to Dorchester. There the chalk outcrop narrows and turns southeastward by Portisham and Bincombe to West Lulworth, whence it is continued eastward as the Purbeck hills. Within this run of chalk is a fringe of Reading Beds and London Clay which may be traced from Cranborne through Wimborne Minster, near Bere Regis and Puddletown, then southwest through West Knighton, Winfrith and Lulworth, and along the north side of the Purbeck hills to Studland. Bounded by this and occupying the eastern portion of the county is a low-lying region of sands, gravel and clay, probably an extension of the Hampshire basin. Denudation has revealed the Wealden Beds in the vale between Lulworth and Swanage, and also near East Chaldon. The town of Shaftesbury stands upon a hill of greensand, while the Upper Greensand also forms the high ground above Lyme Regis, Golden Cap and Pilsdon and Lewesdon Pens. It is thought that a stream following the syncline of the Frome valley, the Solent and the Spithead was at one time the chief feature of the drainage. Subsidence, however, resulted in the tributaries of this stream now finding their way independently to the sea. The Stour rises in Wiltshire and flows with a general southeasterly course to join the Hampshire Avon near its mouth at Christchurch in Hampshire. It receives the Cale and Lidden, which drain the Vale of Blackmore, in its upper course, and breaches the western downs in its middle course between Sturminster Newton and Blandford. The small river Piddle or Trent and the Frome flow across the eastern plain and reach Poole harbour within a few hundred yards of each other. In the northwest, the Yeo flows northward to join the Parret and so sends its waters to the Bristol channel. The Char, the Brit and the Bride drain the southwest. Lulworth cove is an excellent example of differential marine erosion. Chesil bank (*q.v.*), a unique shingle beach whose origin is the subject of conflicting arguments, connects the Isle of Portland (*see* PORTLAND, ISLE OF) with the mainland. The Dorset landscape, its downs, heaths and coastline, is of outstanding beauty.

The climate is mild, and in some sheltered spots, such as Abbotsbury, semitropical plants flourish.

The National trust's 326 ac. (1961) includes the Cerne giant, the figure of a man 180 ft. high holding a huge club, cut in the chalk above Cerne Abbas in Romano-British times; the cottage near Dorchester where Thomas Hardy (*q.v.*) was born; Clouds Hill, 9 mi. E. of Dorchester, where Thomas Edward Lawrence (*q.v.*), Lawrence of Arabia, lived on retiring from the Royal Air Force; the Hardy monument put up in memory of Vice-Admiral Sir Thomas Masterman Hardy (*q.v.*) by the road from Martinstown to Portisham where it commands a fine view over Weymouth bay; and several other small properties. (C. P. BN.)

Archaeology and History.—Acheulean tools have been found at Broom, Moreton and Corfe Mullen, and Mesolithic squatting sites are known in Purbeck and Iwerne Minster, but Dorset does not figure significantly in the archaeological record until the arrival of Neolithic peasants from northern France sometime before 2000 B.C. The existence of easy landfalls between Weymouth and Christchurch giving directly upon the chalk downs, or indirectly via the Frome, Piddle and Stour, made Dorset a gateway for continental immigrants seeking the lightly forested and well-drained calcareous soils of Wessex, which offered fewest obstacles to prehistoric agriculture. The county's geographical situation ensured that these movements would most often derive from Normandy and Brittany, while its accessibility by the western sea routes encouraged trade with Cornwall, Wales, Ireland and even Mediterranean lands. Overland its natural ridgeways ran directly to the great focus of prehistoric trade and pilgrimage upon Salisbury plain, whence contact was maintained with the Thames valley and East Anglia.

Characteristic Neolithic "causewayed camps" have been identified at Maiden Castle and Hambledon hill. Megalithic tombs occur as far east as Bere Regis, but collective burials in earthen long barrows are normal in the chalklands. The ritual circle of Maumbury (later an amphitheatre) probably belonged to Secondary Neolithic people of native stock; similar henges, as at Knowlton, may prove to belong to the partly contemporary Beaker folk, whose earliest groups (with bell-beakers) will have reached Dorset *c.* 1800 B.C. The patriarchal society of the copper and bronze-using pastoral communities of the ensuing centuries is characterized by single burials in round barrows, of which the Oakley down and Winterborne Abbas groups are outstanding. The splendours and the trade contacts of the chieftains of the Wessex Culture (*c.* 1600–1350 B.C.) are exemplified by the gold and amber objects of the Ridgeway no. 7 and Clandon barrows, and by beads of Mediterranean origin from Frampton.

Succeeding centuries saw a more even distribution of wealth, domestic objects as well as weapons being made of bronze. The Deverel-Rimbury Culture, named after two Dorset sites, probably began *c.* 1150 B.C., incorporating important indigenous elements as well as features brought by settlers from western France. Its major contribution, perhaps, was the extension of downland tillage by the use of the ox-plow. Deverel-Rimbury traditions were absorbed rather than extinguished by Celtic peoples with iron equipment who came from much the same region. Dorset may have been penetrated from Wiltshire by Iron Age A folk with characteristic haematite pottery, but at least one foreign group fortified Bindon hill as a beach head before 400 B.C. Abundant remains imply an increased population, living in family groups in hamlets or hutted farmsteads near their fields, but occasionally acting tribally to build single-ramparted hill-forts as refuges during intertribal war, as upon the eastern knoll of Maiden Castle. This farming economy persisted into late Roman times, but in the last two centuries B.C. there were important developments, the precise chronology and direction of which are still uncertain, but in which a historical tribe, the Durotriges, can be recognized. Characteristics were the use of slings in warfare, the development of multiple ramparts such as those of the enlarged Maiden Castle, a silver coinage, and various technical improvements in milling and potting, resulting from trade contacts and perhaps immigration from northwestern Gaul, and stimulated by parallel developments in the Belgic areas of southeastern Britain. The tribal territory evidently lay between the Hampshire Avon and the Axe, with a less definable northern frontier excluding Salisbury but including Ham hill and Ilchester.

This became the Roman canton, when the brief military phase was over after A.D. 43, administered perhaps partly from Durnovaria (Dorchester) and partly from Lendiniae (Ilchester). The former replaced Maiden Castle as the chief town; the latter presumably grew as a centre for the rich area of villa estates which had no prehistoric roots and no counterpart in the chalklands, where native-style farming persisted even though the farmstead itself might then be Romanized. Important harbours at Hamworthy and Radipole were linked by branch roads to the trunk road through Dorset, and local industries exploited Portland stone, Purbeck marble and shale, and the clays of the Poole basin. Excavation has suggested that the two chief towns were prosperous in the 4th century. The conversion of Bokerley dike, possibly

the boundary of an imperial cattle ranch in Cranborne chase, into a barrier against attack from the east, seems however to have been a reaction to the combined barbarian raid of 367–368, and before 400 the arterial road through the dike from London was blocked and never reopened.

Practically nothing is known of events between the withdrawal of imperial authority in the early 5th century and the incorporation of the region in the West Saxon kingdom after Penselwood (658), except that it remained British. Nor was ultimate absorption accompanied by wholesale slaughter or dispersal. The creation (705) of the diocese of Sherborne, doubtless followed by the institution of a parochial system, marked the consolidation of Dorset, Somerset and Devon. Probably early in this century Wessex was divided into shires, which already must have been subdivided for administration, presumably into hundreds (*see* HUNDRED). This newer part of Wessex, behind the barrier of Selwood, became the core of resistance to the Danes in the 9th century. Domesday Book (1086) shows that by late Saxon times the prehistoric pattern of upland settlement gave place to an essentially modern one upon the richer soils of the vales. A two-field system was normal in the chalklands and recent research into manorial boundaries suggests that at least some groups of manors were carefully planned in relation to the needs of agricultural communities, at a very early phase of the settlement.

A. F. KERSTING

RUINS OF CORFE CASTLE, DATING MAINLY FROM THE 13TH CENTURY, ON THE ISLE OF PURBECK, DORSET, ENG.

The name Dorset denotes "the settlers by Dorchester," which suggests the priority of the future county town, although Shaftesbury and Wareham (*qq.v.*) were larger, and the latter the residence of the sheriff, in 1086. The county has not often figured decisively in national history since the Conquest, but its ports guaranteed it a certain strategic importance, especially during Stephen's reign and the Civil War, when Corfe castle (*q.v.*), Sherborne and Wareham (in the 12th century) were locally prominent. Wareham was surpassed as a port by Weymouth and Melcombe and subsequently eclipsed by Poole, which supplanted Melcombe as the wool staple in 1433. As ships grew larger the Dorset ports declined, despite lucrative privateering and channel piracy, but in the 16th and 17th centuries trade with the Newfoundland fishing settlements brought renewed prosperity to Poole, Lyme and the united borough of Weymouth and Melcombe.

Industries have generally been of local importance, although the netting and cordage of Bridport and the extraction of Purbeck marble, Portland stone and china clay deserve mention.

Farming has been the principal activity. Some enclosure of commons had occurred by Elizabeth I's day, but open arable fields survived in many places well into the 19th century and are still cultivated in Portland, where grass balks divide the arable strips. In the middle ages Dorset's wool was not specially esteemed, but by the 17th century its sheep and dairying were famous. The flocks had dwindled toward extinction by mid-20th century. The hardships culminating in the suppressed protests of the labourers in 1833 and the Tolpuddle case in 1834 have passed into national history, but government planning helped to avoid agricultural depressions such as followed the Napoleonic Wars and World War I, as well as the bad harvests of the 1870s. (R. A. H. F.)

Population and Administration.—The population of the administrative county was (1961) 309,176, an increase of approximately 6% over the 1951 figure. The county contains eight municipal boroughs, the chief of which are Dorchester, the county town (pop. [1961] 12,266), Poole, a county and borough (88,088), Weymouth and Melcombe Regis (40,962) and Bridport (6,517). There are four urban districts and nine rural districts. Dorset and Poole each have a court of quarter sessions and there are nine petty sessional divisions. Dorset is divided for parliamentary purposes into three county divisions and the Poole parliamentary division, each returning one member. The dialect of the county, distinguishable from those of Wiltshire and Somerset, yet bearing many marks of Saxon origin, is admirably illustrated in the poems of William Barnes (*q.v.*). Many towns, villages and localities are readily recognized from their descriptions in the "Wessex" novels of Thomas Hardy.

Agriculture, Industries and Communications.—Fine timber grows in the richer soils, in some of the sheltered valleys of the chalk district and more especially upon the greensand, but many woods have been cleared. State forests in the early 1960s covered more than 15,700 ac. The chief crops are barley, oats and wheat, but mixed corn, beans, peas and mangels are widely grown. Cattle, sheep, pigs and poultry are reared.

A variegated coastline and the unspoiled scenic qualities of the countryside have attracted a tourist industry second in importance only to agriculture. Poole, Swanage, Weymouth, Bridport and Lyme Regis are the principal coastal resorts. Poole, the county's largest seaside town, manufactures pottery, bricks, tiles and chemicals. Shipbuilding and marine and general engineering are important at both Poole and Weymouth. Other Dorset manufactures are rope, twine and net at Bridport, silk at Sherborne, paper at Witchampton and gloves in several towns and villages in the north. The aircraft industry is represented at Blandford. Food processing and brewing are carried out throughout the county. Two minerals found in Dorset are of national importance, namely ball clay and firestone. Ball clay is both mined and worked open cast in Purbeck and east Dorset, much of the product being exported to the potteries of Staffordshire. The quarries of the Isle of Portland supply a much used white freestone while Purbeck marble was used for many of the most famous Gothic churches in England. Other minerals worked are sand, gravel, brick and pipe clay, chalk and shale oil.

Poole, Weymouth and Bridport are the chief ports. Portland harbour, under the admiralty, is a naval base used for training purposes. There is a large atomic energy research establishment at Winfrith.

Gillingham and Sherborne, in the north of the county, stand on the Southern region's Waterloo (London) to Exeter main railway line, and Lyme Regis is served by a branch of this system from Axminster. The Southern region's Waterloo to Weymouth main line serves Poole, Wareham and Dorchester, with branches serving Wimborne, Blandford and Swanage. Dorchester is also on the Western region's Paddington to Weymouth main line, branches of which serve Bridport and, for freight only, Portland. A number of intercounty omnibus companies provide a road transport link with neighbouring counties. (C. P. BN.)

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DORSEY, JAMES OWEN (1848–1895), American ethnologist and linguist known especially for his work on the Siouan Indians, was born in Baltimore, Md., on Oct. 31, 1848. After studying at the Theological Seminary of Virginia, he was ordained a deacon of the Protestant Episcopal Church in 1871 and began work that same year as a missionary among the Ponca in Dakota territory. Already adept in classical linguistics, he quickly learned the Ponca language.

Having returned to Maryland because of illness, he became acquainted with Maj. J. W. Powell, director of the U.S. Geological survey, who, in recognition of his linguistic talent, sent him to Nebraska to make linguistic and ethnological studies of the Omaha Indians. When Major Powell created the Bureau of American Ethnology in 1879, he chose Dorsey as one of the first members of the staff. Dorsey remained in this capacity until his death and, despite continued ill-health, was a prolific worker. The bulk of his research was among tribes of the Siouan stock, such as the Ponca, Omaha, Osage, Kansa and Dakota. He also studied the Athapascan, Takelman, Kusan and Yakonan stocks of Oregon. He edited the *Dakota-English Dictionary* and *Dakota Grammar, Texts, and Ethnography*, prepared by S. R. Riggs, which have remained classics in their field.

Dorsey made many important contributions to American Indian ethnology and to linguistic theory. Among his memoirs published by the Bureau of American Ethnology in its *Annual Reports* are *Omaha Sociology* (1884), *Osage Traditions* (1888), *A Study of Siouan Cults* (1894) and *Siouan Sociology* (1897). Because of his untimely death in Washington on Feb. 4, 1895, many of his papers were unfinished and remain in the archives of the Bureau of American Ethnology. (M. W. St.)

DORSTEN, a town of Germany which after partition of the nation following World War II was included in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. It is situated on the Lippe river and the Wesel-Datteln canal, 30 km. (18.6 mi.) N. of Essen by road. Pop. (1961) 36,323. Dorsten is the northernmost town of the Ruhr and was badly damaged by bombing in World War II. A Franciscan monastery (1488), the old town hall (1567; now a local museum), a boys' school (1642) and an Ursuline nunnery with girls' school (1642) survived and the town was later rebuilt. There are collieries, coal-gas works, an iron foundry, quartz works, factories making wire and furniture, and coco weaving. Dorsten, a village in Roman times, was granted civic rights by the archbishop of Cologne in 1251 and was fortified in the 14th century. As a monastic centre it was a stronghold of the bishops. In 1815 it became part of Prussia. Its industrial importance dates from the coming of the railway in 1899 and the first coal mine was opened in 1911.

DORT, SYNOD OF, an assembly of the Reformed Church of the Netherlands called at Dordrecht (Dort) in 1618–19 to settle theological dispute between the supporters of Jacobus Arminius and the supporters of the Bezan form of Calvinism, led by Franciscus Gomarus. The Arminian merchant oligarchy, largely indifferent to theological dogmas and interested in a speedy settlement with Spain, was also opposed politically to the Calvinistic clergy and middle class, who wished to move more vigorously against Spain. The Synod of Dort was originally intended to bring agreement on the doctrine of predestination among all the Reformed Churches, but in practice this Dutch synod, because of the political forces at work, was mainly concerned with problems facing the Reformed Church of the Netherlands.

The theological antecedents of the synod—the conflict between the Arminian Remonstrants (so called because their theological views were contained in the Remonstrance, presented to the states-general in 1610) and the Gomarist Counter-Remonstrants concerning the ground, extent and consequences of the doctrine of predestination—are described elsewhere (*see* ARMINIANISM). The grand pensionary, Johann van Oldenbarnevelt (who had arranged the truce with Spain in 1609), urged the toleration of both parties, but the Dutch clergy, largely Calvinistic, opposed his religious and political aims and were supported by the head of the army, Prince Maurice of Nassau. When these political and theological passions had coincided, the states-general rejected Oldenbarnevelt's policy of toleration and called the Synod of Dort, whose many sessions lasted from Nov. 13, 1618, until May 9, 1619.

The delegates to the synod were all Gomarists: there were 37 ministers, 19 lay elders and 5 university professors (including Gomarus), together with 18 commissioners for the states-general. In response to the Dutch invitations 26 theologians came from most of the Reformed Churches of Germany and Switzerland and also from England. Brandenburg declined to send delegates, and those appointed by the Reformed Church of France were prevented by Louis XIII from attending. A clergyman associated with Prince Maurice, J. Bogerman, was appointed president of the synod.

The opening sessions dealt with a new Dutch translation of the Bible, a catechism and the censorship of books. Thereafter, Simon Episcopius, leader of the Arminian or Remonstrant party, and 12 other Remonstrants were cited to attend. After arriving they refused to recognize the authority of the synod as binding on their consciences and protested against not being allowed to criticize either the Calvinistic Belgic Confession or the teaching of the Gomarists. Eventually the Arminians were expelled from the synod and the Remonstrant theology was declared to be contrary to Scripture. The political as well as theological tensions of the synod can be seen in the Remonstrants' being accused not only of bad theology but of being "disturbers of their country."

The synod finally produced 93 canons which expounded in detail the errors rejected as well as the doctrines affirmed in the Five Articles dealing with the field of controversy. The doctrines affirmed were predestination not conditional on belief; Christ not dying for all; total depravity; irresistible grace; the impossibility of falling from grace. The foreign delegates left on May 9, 1619, after signing the canons, and in its closing sessions the synod dealt with matters of discipline in the Dutch Church. These canons of Dort remained for 200 years as the theological basis of the Reformed Church of the Netherlands, alongside the Belgic Confession and the Heidelberg Catechism, and represent the extreme form of Bezan Calvinism.

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DORTMUND, a city of Germany which after partition of the nation following World War II was in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. Located at the head of the Dortmund-Ems canal, 32 km. (20 mi.) E. of Essen, it is the largest town in the *Land* and a major industrial centre of the Ruhr. Pop. (1961) 641,480.

The town centre, more than 90% of which was destroyed during World War II, has been reconstructed on new lines with two broad arteries running north–south and east–west. Other new roads were cut, the old rampart streets widened and a new civic centre was built. By the early 1960s the Reinoldikirche and Marienkirche (both 13th century, the latter containing an altarpiece by Konrad von Soest) and the Propsteikirche had been restored and the Petrikirche partially restored. The city owns four moated castles. The synagogue (1956) is architecturally interesting. Dortmund's Westfalenhalle (1952) is one of Europe's largest halls and is used for congresses, exhibitions, tournaments, sporting events and similar affairs. There are many learned institutions, including the Max Planck institute for industrial physiology and for the physiology of nutrition, the institute for spectrochemistry and spectroanalysis, Münster university's department of social studies and an academy of social studies, an institute for journalistic research, a mountaineering school and a teachers' training college. Fritz-Henzler-Haus combines under one roof the people's college for adult education and the many-sided "house of youth." There are several museums.

Dortmund lies practically on three *Autobahnen:* Cologne-Hanover; Ruhrschnellweg; and Cologne-Leverkusen-Kamen. Fast trains in the Ruhr area are electrified and trans-European expresses connect Dortmund with Ostend and Paris. There is also a helicopter service to Paris via Brussels. The Dortmund-Ems canal is a vital artery of Dortmund's economy. Steel, coal and beer are Dortmund's principal products. In the early 1960s it produced about 20% of the Federal Republic's output of crude steel and 25% of the Ruhr production of crude iron. Seven of the 24 large breweries in west Germany are in Dortmund. There is a large wholesale fruit and vegetable market. Dortmund is also the headquarters of bridge-building firms employed all over the world.

Dortmund is mentioned first as Throtmannia, about 885, when

it was already of some importance because of its position on the *Hellweg*. It achieved prosperity as a result of joining the Hanseatic league in the 13th century. It had trade connections as far as England, Scandinavia, Poland and Russia and in the 14th century its merchants were so wealthy that the English crown was several times in pledge to them. Its prosperity declined, however, and by 1803, when it lost its rights as a free city, it was a little agricultural town of 4,000 persons. With 19th-century industrial advances it rose rapidly, as population figures show: 1871, 44,420; 1910, 214,226; 1939, 542,000. This rise was halted only by World War II. (B. A. H.-F.)

DOSITHEOS (1641–1707), patriarch of Jerusalem, an important church politician and theologian of the modern Greek church, was born on May 31, 1641, in Arachoba near Corinth. From the beginning of his career attached to the patriarchal throne of Jerusalem, he became metropolitan of Caesarea in 1660 and patriarch of Jerusalem in 1669. He died on Feb. 8, 1707, in Constantinople.

Dositheos understood his office as patriarch to mean responsibility for the whole Orthodox church. By correspondence and by extensive journeys he concerned himself with the state of the church in the Balkans, Georgia and the Ukraine. His relations with the tsar Peter the Great (to whom he wrote many letters) were strained because of Peter's church reforms, and his attempts to make Peter intercede for the churches of the east in connection with the peace treaty with Turkey in 1702 were fruitless. Dositheos strove to raise the standards of monasticism in Palestine. In 1680 he founded a Greek printing press in Jassy, Rumania, to encourage the study of theology. His extensive writings, largely compilations from the Greek Fathers, were directed against the Roman Catholic Church and the church union of Brest-Litovsk (1596; *see* ROMAN CATHOLIC CHURCH: *The Catholic Eastern Rites: Byzantine Rite*). In 1672 he called the synod of Jerusalem, which supported his "confession of faith" against the Calvinism of Cyril Lucaris (*see* JERUSALEM, SYNOD OF). Twentieth-century Greek theologians consider Dositheos' work to be in part too much of its time and to be lacking in original theological thought.

See A. Palmieri, *Dositeo, patriara greco di Gerusalemme* (1909); E. Hammerschmidt, "Usia, Hypostasis und verwandte Begriffe in den Bekenntnisschriften des Petros Mogilas und des Dositheos von Jerusalem," *Oriens Christianus*, vol. 42 (1958). (F. v. L.)

DOS PASSOS, JOHN RODERIGO (1896–), U.S. novelist, author of the trilogy *U.S.A.*, was born in Chicago, Ill., on Jan. 14, 1896. His mother's family was from Maryland and Virginia. His father, a lawyer, was the son of a Portuguese immigrant, and from this source came some of Dos Passos' early radical sympathies and his involvement with the Sacco-Vanzetti case. After graduating from Harvard in 1916, he visited Europe and traveled in Spain. During World War I he successively enlisted for volunteer ambulance service in the French army, joined the Red Cross in Italy and entered the medical corps of the U.S. army as a private. His early novels, *One Man's Initiation* (1917) and *Three Soldiers* (1921), dealt with this experience. His next important book was *Manhattan Transfer* (1925). This was a panoramic view of New York city life, highly experimental in technique, while *The 42nd Parallel* (1930), the first volume of *U.S.A.*, carried forward the experimental technique and the panoramic vision to a major chronicle of the American nation from 1900 to the 1930s. The second volume of the trilogy, *Nineteen-Nineteen* (1932), was the story of the war years. *The Big Money* (1936), the last and perhaps best volume of the three, dealt with the frenzied finance of the post-World War I period. His later works include other novels, another but less successful fictional trilogy, *District of Columbia* (1939–1949), and a series of travel books, historical studies and documentaries, but critical opinion is agreed that Dos Passos' major contribution to American literature is *U.S.A.* (M. GE.)

DOSSERET, in architecture, an impost block; the block of stone sometimes used in the Byzantine style above the capital (*q.v.*) of a column. It has the form of a truncated pyramid, with the large side up, and therefore furnishes ample bearing for carrying the arches and vaults above it.

DOSSO DOSSI (GIOVANNI DE LUTERO or LUTERI) (d. 1542), Italian painter, the leader of the Ferrarese school in the 16th century. There is doubt over the date of his birth, which has been put as early as 1479 and as late as 1490; he is first recorded in 1512, in Mantua, but by then he must have been in Venice and absorbed the art of Giorgione (d. 1510) and also have seen some of the early works of Titian. His style was founded on the romantic approach to landscape which reached its highest expression in Giorgione's "Tempest" (Accademia, Venice), but Dosso added something of Titian's richness and a personal quality of fantasy which was partly his birthright as a Ferrarese of the generation following Cosimo Tura, Francesco del Cossa and Ercole de' Roberti. He settled in Ferrara in 1517 and he must have come once more under the influence of Titian, whose early mythologies were painted for Dosso's own patron Alfonso I of Ferrara. There is no evidence that Dosso ever went to Rome but he was certainly acquainted with Raphael's work by 1520, and the tension of Raphael's later style was the final influence on Dosso. In his later works there is an unearthly light falling on melancholy figures arranged in a romantic dreamland. Dosso was the friend of the great Ferrarese poet Ariosto, who celebrated him as one of the nine greatest living painters, along with Raphael, Titian, Michelangelo and others (*Orlando Furioso*, canto xxxiii, stanza 2); and Dosso's most famous work, the "Circe" (Borghese gallery, Rome), has been seen as almost an illustration to Ariosto. There are the remains of some frescoes in the Castello at Trent, and representative paintings at Hampton Court, Middlesex, at the National gallery, London, at Dresden and elsewhere. His brother Battista (d. 1548) was also a painter and occasionally worked with him. Dosso died in the summer of 1542, in all probability in Ferrara.

See G. Vasari, *Lives*, Eng. trans. by G. de Vere, vol. v (1913); H. Mendelsohn, *Das Werk der Dossi* (1914); R. Longhi, *Officiana Ferrarese* (1956). (P. J. MY.)

DOST MOHAMMED KHAN (1789–1863) was the founder of the Mohammedzai (Barakzai) dynasty of Afghanistan. The 20th of the 21 sons of Sardar Payenda Khan, chief of the Barakzai clan, he passed his childhood, after Payenda Khan's execution, first with his Kizilbash mother's relatives and later with his eldest brother Fath Khan. He rose to prominence in 1809 when Fath Khan was appointed vizier to Mahmud Shah. In 1816 the two brothers were sent to defend Herat against an invading Persian army and there Dost Mohammed was said to have insulted one of the royal princesses by robbing her of her jewels. Mahmud's eldest son Kamran, who was jealous of the vizier, thereupon hastened to Herat, seized Fath Khan and blinded him. Dost Mohammed escaped to Kashmir.

On hearing this news the remaining Barakzai brothers rose in arms against the shah and when Fath Khan was tortured to death Dost Mohammed invaded Afghanistan from Kashmir (1818). He seized Peshawar and Kabul and drove Mahmud and Kamran to a last stronghold in Herat. The Barakzai brothers then divided the greater part of Afghanistan among themselves. At the formal partition of 1826 Dost Mohammed received Kabul, Ghazni and Jalalabad and thus became the most powerful of the brothers.

In the meantime, in the confusion of civil war, the amir of Bukhara had occupied the northern Afghan provinces and the Sikhs had seized the trans-Indus districts, including Peshawar. Having consolidated his position in Kabul Dost Mohammed was determined to recover this territory from the Sikhs and to this end declared a *jehad* (crusade) in 1836. Assuming the title of Amirud Mumini (the leader of the faithful) he advanced on Peshawar but was defeated by the cunning of the Sikh ruler, Ranjit Singh, who undermined the loyalty of his army by intrigue.

After his return from Peshawar Dost Mohammed formally assumed the title of amir and in 1837 received the British delegation led by Capt. (later Sir Alexander) Burnes which came to seek his help against the threat of Russian penetration. Failing to receive from the British the help he had hoped for against the Sikhs Dost Mohammed received the Russian envoy Capt. P. Vitkevitch.

This led to the recall of the British mission and the first war between the British and the Afghans. Dost Mohammed escaped

in 1839 first to Balkh and then to Bukhara where for a time he was imprisoned. Thence he escaped in 1840, raised an army and attacked the British at Parwandara. Although he had the upper hand in this battle he astonished the Afghans by surrendering the next day to the British authorities in Kabul. For the remainder of the war he was detained as a prisoner in Calcutta.

Restored to the throne in 1843 Dost Mohammed sent aid to the Sikhs in the second Sikh War (1848–49) but after the battle of Gujrat (*q.v.*) determined to concentrate on the consolidation of his own kingdom. He signed treaties of friendship with the British in 1855 and 1857 and remained neutral during the Indian mutiny. In the meantime he incorporated Kandahar in his kingdom, recovered the lost provinces in the north and in 1863 recaptured Herat which was held by Sultan Ahmed, his son-in-law. He died in Herat in June a few days after this event.

Dost Mohammed was a strong ruler and was greatly admired by his own people. He had come to power at a critical period in Afghan history and it was largely due to his wisdom and energy that the country emerged from its difficulties strong and united. *See* also AFGHANISTAN: *History*. (MD. A.)

DOSTOEVSKI, FËDOR MIKHAILOVICH (1821–1881), Russian novelist of international reputation who is generally acknowledged to be one of the profoundest creative artists of the 19th century. His father, the son of a priest in a small Ukrainian town, had been destined for the church but ran away from home, studied medicine in Moscow, took part in the Franco-Russian campaign of 1812 as an army doctor and later became a staff doctor at the Mariinskaya hospital for the poor in Moscow. He married a Moscow merchant's daughter, Marya Nechaeva, in 1819. Fëdor Dostoevski, his second son, was born in Moscow on Nov. 11 (new style; old style, Oct. 30), 1821. He went to a Moscow boarding school and after his mother's death in 1837 was taken with his elder brother Mikhail to St. Petersburg to enter the army engineering college. On the way he came for the first time face to face with the grim realities of Russian life when, during one of their stops at a posting station, he watched a government courier belabour his coachman with his fists to make him drive faster. "This revolting scene," Dostoevski wrote in 1876, "remained in my memory for the rest of my life," and indeed it provided the impetus for his revolutionary activities ten years later. Another encounter which left its mark on his writings took place immediately on his arrival in St. Petersburg, when he met the romantic poet Ivan Shidlovski, an idealist torn between the promptings of the flesh and the spirit, who was to appear in different guises in his stories and novels, particularly as Mitya Karamazov (in *The Brothers Karamazov*).

Dostoevski spent three unhappy years at the college, devoting most of his free time to reading Russian and foreign writers, including E. T. A. Hoffman, Schiller, Goethe, Shakespeare, Balzac, Victor Hugo, the French classical dramatists and George Sand and Dickens. In June 1839 his father, who had retired in 1837 to his small estate near Moscow, was murdered by his peasants, whom he had treated with great brutality. Dostoevski never referred to his father's murder but there can be no doubt that it greatly influenced his attitude toward the problem of serfdom and, subsequently, his idea of the Russian peasant as the sole repository of all Christian virtues.

Dostoevski's first literary work, a free translation of Honoré de Balzac's *Eugénie Grandet*, was published in a St. Petersburg periodical in the summer of 1844. In Oct. 1844 Dostoevski resigned his army commission. He was working on his first novel, *Bednye lyudi* (Eng. trans. *Poor Folk*, 1915 and 1956), which, after several revisions, he completed in April 1845. The novel brought him instantaneous success, being acclaimed by Vissarion Belinski (*q.v.*), the most influential critic of the day, as a literary masterpiece that showed "a profound understanding and an artistic recreation of the tragic aspect of life." It was, indeed, this tragic aspect of life, particularly of the poor and downtrodden low-civil servant, which became in one form or another the theme of the stories written in the first period of his literary career. Some of his heroes, like those of "Dvoinik" (1846; Eng. trans. "The Double"), "Gospodin Prokharchin" (1846; Eng. trans. "Mr. Prokharchin") and "Slaboe serdtse" (1848; Eng. trans. "A Weak Heart") were driven to despair and madness, while others, like those of his only supernatural story *Khozyaika* (1847; Eng. trans. "The Landlady") and *Belye nochi* (1848; Eng. trans. "White Nights"—all published in *Otechestvennye zapiski*, "Home Annals") took refuge in a life of futile day-dreaming and soul-destroying self-absorption and inactivity. What made these stories so different from many of the type that became fashionable after the publication of Nikolai Gogol's *Shinel* (1842; Eng. trans. *The Overcoat*) was Dostoevski's uncanny insight into the darkest nooks and crannies of man's heart and mind.

The Revolutionary.—Belinski's enthusiastic praise of his first novel, which as he acknowledged a few years before his death had given him "one of the most enthralling moments" of his life, made Dostoevski an intimate of the critic's circle of friends and, though he had been brought up in a conservative and deeply religious environment, a convert to their radical and atheistic ideas. Belinski's cold and even hostile reception of Dostoevski's subsequent stories brought about a breach between them. It did not, however, make Dostoevski give up the ideas he owed to Belinski. On the contrary, having parted from Belinski and his followers, including the young Ivan Turgenev, whose teasing he particularly resented, he joined first the more radical circle of utopian socialists led by Mikhail Petrashevski, and in Nov. 1848, a yet more revolutionary group which went so far as to acquire a printing press to publish illegal literature. As this time Dostoevski was in financial straits, being obliged to exist on meagre advances from his publisher, for he had renounced his claim to his father's estate for a lump sum that he spent as soon as he received it.

He was also suffering from violent nervous attacks, the first symptoms of epilepsy, though his epileptic fits only began two years later, and was writing his uncompleted novel "Netochka Nezvanova," the first two parts of which were published in *Otechestvennye zapiski* in Jan. and Feb. 1849. But all this did not stop his political activities. On April 1, 1849, he made a long speech at one of Petrashevski's Friday "at homes" demanding freedom from censorship, the abolition of serfdom and reform of the law-courts. On April 15 he read Belinski's posthumously circulated "Letter to Gogol," which the government had banned as "pernicious." On April 23, at 5 A.M. he was arrested and incarcerated in the Aleksis Ravelin of the Peter and Paul fortress, where, incidentally, he wrote "Malenki geroi" ("A Little Hero"), an amazingly serene story, considering the circumstances, and unpublished until 1857.

At his interrogation Dostoevski conducted himself with singular courage, trying to exonerate the other members of the Petrashevski group and reaffirming his own views on the need to free the serfs, abolish the censorship and relax the laws governing the free discussion of political events. In fact he showed no signs of believing in meek submission to the will of the authorities, the principle he propagated with such militant fervour toward the end of his life.

The Convict.—The trial of the Petrashevski group began on Sept. 30, 1849, and ended on Nov. 16. Dostoevski, whom the authorities considered "the most important" of the accused, was found guilty by the military court and sentenced to death. The death sentence, however, was reduced by the prosecutor-general to eight years' hard labour and by the emperor himself to four years' hard labour to be followed by service in the army as a private. Neither Dostoevski nor his fellow-prisoners were informed of their reprieve. On the morning of Dec. 22, 1849, they were taken to their place of execution, the Semënovski parade-ground, and only after all the preliminaries of the execution had been carried out was their reprieve read out to them. Twenty-four years later, after Dostoevski had become one of the most fanatic supporters of the autocratic regime of the tsar, he recalled with pride the scene on the Semënovski parade-ground. "We members of the Petrashevski group," he wrote, "stood on the scaffold and listened to our death-sentences without any feeling of repentance. The majority of us would at that moment have deemed it dishonourable to renounce our convictions . . . for we

considered the cause for which we had been sentenced, the ideas which had held sway over our minds, not only as requiring no repentance but . . . as a martyrdom for which a lot would be forgiven us."

On the night of Dec. 24, 1849, Dostoevski, with two other condemned men, was put in chains and sent off to Siberia. He arrived at the Omsk convict prison on Jan. 23, 1850. He was transferred on March 2, 1854, to Semipalatinsk, where he was to serve as a private in the 7th Siberian line regiment. In Semipalatinsk he was permitted to live in his own rooms and it was there that he was befriended by Baron Wrangel, a young official who was the local public prosecutor. It was in Semipalatinsk, too, that Dostoevski met and fell violently in love with Marya Dmitrievna Isaeva, wife of a low-grade civil servant and mother of a boy of nine. After her husband's death, Marya, who was herself in love with a young impecunious schoolmaster, at last agreed to marry Dostoevski for her son's sake. Their marriage (a disastrous mistake, as was to be expected) took place on Feb. 6, 1857. By that time Dostoevski had regained commissioned rank and a year later he resigned from the army on a plea of illness, his epileptic attacks making it impossible for him to carry out his duties. He had resumed his literary work as soon as he left prison and by the time he left Siberia on July 2, 1858, he had written two stories: *Dyadyushkin son* (Eng. trans. *Uncle's Dream,* 1958) and *Selo Stepanichkovo i ego obitateli* (Eng. trans. *The Friend of the Family,* 1887), the first an innocuous farce describing the goings-on in a Siberian provincial town with just a reminiscence of his unhappy heroes of the past in the person of a poor consumptive schoolmaster in love with a beautiful society girl and the second a much more virile satire on a sanctimonious rogue lording it over the household of a weak-willed, though morally and spiritually admirable landowner.

Return to St. Petersburg. Major Works.—On his return to St. Petersburg in Dec. 1859, Dostoevski was no longer a believer in the ideas of his Petrashevski period, but neither had he become the violent militant reactionary of the 1870s. In the statement outlining the policy of the monthly periodical *Vremya* ("Time"), which he published with the help of his brother Mikhail in 1861, he merely pointed out that "being an entirely separate national entity," the aims of the Russians should be "to create a new form [of political life] . . . deriving from the Russian soil and the spirit of the Russian people." "The Russian idea," he declared, anticipating some of his later beliefs, "might in time become the synthesis of all the ideas Europe has been developing with such courage and pertinacity among her different nationalities." Nor had his religious ideas as yet taken the extreme form that provoked Turgenev to declare that Dostoevski was "the most malignant Christian" he had ever met. On the contrary, writing from Semipalatinsk in 1854 to a woman correspondent, he confessed that he was "a child of my age, a child of unbelief and doubt, and I remain to this very day and [I know that] I shall remain so to my very grave." "You cannot imagine," he went on, "the terrible torment the desire to believe has caused and still causes me, for it is a desire that grows all the stronger in my heart the more arguments I have against it." He still harped on his religious doubts ten years later. "The main question that will be dealt with in all the parts [of the proposed novel 'Zhitie velikogo greshnika'—'The Life of a Great Sinner']," he wrote to the poet Appolon Maikov, "will be the same as those which consciously and unconsciously tormented me all my life—the existence of God." It is a question that also torments the heroes of his great novels who, like himself, have the worm of doubt buried in their breasts.

In the 20 years between his return to St. Petersburg and his death in 1881 Dostoevski wrote six long novels: *Unizhennye i oskorblënnye* (1861; Eng. trans. *The Insulted and the Injured*), *Prestuplenie i nakazanie* (1866; Eng. trans. *Crime and Punishment,* 1911, also 1951), *Idiot* (1868–69; Eng. trans. *The Idiot,* 1914 and 1953, also 1955), *Besy* (1871–72; Eng. trans. *The Possessed,* 1931, and *The Devils,* 1953), *Podrostok* (1874–75; Eng. trans. *A Raw Youth*) and *Bratya Karamazovy* (1879–80; Eng. trans. *The Brothers Karamazov*). Of these *The Insulted and the Injured* belongs to his minor creations, but is full of interesting autobiographical features, such as his own unhappy love for his first wife, Marya, his ambivalent attitude toward his rival, his first literary triumphs and failures and his dislike of the nobility, which had become sharpened by his experiences in prison where he had first realized how deep was the hatred of the common people for the nobleman. *Crime and Punishment* put him in the forefront of Russian writers. It is his first great novel on the theme of redemption through suffering. *The Idiot,* one of his most powerful and perceptive novels, was on its publication practically ignored by the Russian critics, chiefly, no doubt, because at that time of political ferment it dealt with a subject of universal rather than topical significance—the place of the righteous man in society. *The Devils,* on the other hand, provoked a storm of comment just because it was a political pamphlet in the shape of a novel that dealt with a political murder that had taken place a short while before and with the political ideas that were convulsing Russian public opinion. *A Raw Youth* was also coolly received. It is, in fact, the least successful of Dostoevski's long novels, perhaps because he felt a little constrained in writing it, since he intended it as a peace offering to the poet and publisher Nikolai Nekrasov, an old "enemy" from the days of Belinski. It was published in *Otéchestvenniye zapiski* ("Fatherland Annals"), which Nekrasov and Mikhail Saltykov-Schedrin had taken over after 1866, making it the most progressive left wing journal of the intelligentsia. Quite different was the reception of *The Brothers Karamazov,* undoubtedly his greatest novel, in which he achieves a profundity of thought that surpasses anything written in his own, or, indeed, any, time since. Published when Dostoevski's fame had reached its zenith in Russia, it was recognized at once as the greatest achievement of his genius.

Other Works.—Of Dostoevski's other works *Zimnie zametki o letnikh vpechatleniyahk* (1863; Eng. trans. *Winter Notes on Summer Impressions,* 1955), was written after his first journey abroad in 1862, which had brought him face to face with less pleasing aspects of the Industrial Revolution in London and of the bourgeois regime of Napoleon III in Paris, aspects which he analyzed with a brilliance that proved him one of the profound thinkers of his age. Mention should also be made of another nonfictional work, *Zapiski iz mërtvogo doma* (1862; Eng. trans. *The House of the Dead,* 1911), remarkable reminiscences of prison life. The novel *Zapiski iz podpolya* (1864; Eng. trans. *Letters [Notes] From the Underworld,* 1913; 1953), was written in the winter of 1863–64, after a summer abroad with his mistress, Polina Súslova, from which he returned to live in Moscow with his dying wife; its bitterness and tragic cynicism reflect the circumstances of his life at this time. His second short novel, *Igrok* (1866; Eng. trans. *The Gambler,* 1915 and 1956), was finished in one month to frustrate the plot of a dishonest publisher to possess himself of the copyright of all his works unless he submitted a new novel by a certain date. Though for that reason alone one of his weakest novels, it contains revealing autobiographical matter, such as his passion for gambling and his even greater passion for Polina, the young student who became his mistress in 1862 but threw him over for a young Spaniard in Paris and who was the prototype of his proud and independent heroines, particularly Nastasya Filippovna in *The Idiot.* Of a much more subtle autobiographical significance is his third short novel, *Vechny muzh* (1870; Eng. trans. *The Eternal Husband,* 1888), a study of jealousy and masochism in which he returns to one of the main themes of *The Idiot,* namely the impossibility of finding an adequate solution of the "eternal" problems of human relationships, since they do not conform to the established laws and conventions of social behaviour but depend on psychological factors beyond the control of reason. This also forms the main theme of Dostoevski's most powerful short stories, "Krotkaya" (1876; Eng. trans. *A Gentle Creature,* 1950), a penetrating study of the suicide of a young married woman, and "Son smeshnogo cheloveka" (1877; Eng. trans. "The Dream of a Ridiculous Man," 1945, 1950), a space-fiction story of the inhabitants of some remote planet beyond the solar system who are corrupted by a man who arrives from the earth and in whose heart the seeds of evil are too deeply sown for him to be converted by a

society that knows no evil.

That Dostoevski was, of course, a fully "committed" writer, is best proved by his work for the three monthly periodicals he wrote for and edited: *Vremya* (1861–63), banned by the authorities because of a rather lukewarm article on Russo-Polish relations published during the Polish insurrection, *Epokha* ("Epoch," 1864–65), which foundered on the death of his elder brother Mikhail, who looked after the circulation and the financial side of the paper, and finally *Dnevnik pisatelya* (1876–80; Eng. trans. *The Diary of a Writer,* 1949), in which Dostoevski recorded his own thoughts and ideas on current affairs and conducted political warfare against the Russian liberals and revolutionaries and in which he also occasionally published his short stories.

Second Marriage. Last Years.—Three years after the death of his first wife (in 1864) Dostoevski married (on Feb. 15, 1867) Anna Snitkina, the young stenographer he had engaged when he had to write *The Gambler.* Soon after he was forced to flee from his creditors and he and his wife stayed in Germany, Switzerland and Italy (from April 1867 to July 1871). During this time two daughters were born: Sofya in March 1868 (she died two months later) and Lyubov in Sept. 1869. It was due to his wife's good management that on their return his financial affairs improved, his debts were settled and he was even able to buy a house in the watering place of Staraya Russa, where his family spent the summers. Because of his deteriorating health, he himself spent most of the summers between 1874 and 1880 at the German spa of Ems. In Russia two more children were born: his first son Fëdor in July 1871 and his second, Aleksei, in Aug. 1875. Aleksei, of whom Dostoevski was deeply fond, died at the age of three.

The last years of Dostoevski's life were years of growing revolutionary agitation in Russia, culminating in two attempts on the life of Alexander II, numerous attempts on the lives of high officials of state and the murder of a student in Moscow by the young terrorist Nechaev, which formed the main subject of *The Devils.* It was not till 1872, however, that Dostoevski went over openly to the conservative camp by accepting the editorship of the reactionary weekly *Grazhdanin* ("The Citizen"). In his own monthly *Dnevnik pisatelya,* four years later, his conservative views took a definite chauvinistic tinge with his passionate advocacy of the belief that it was the destiny of Russia "to reconcile the European contradictions" by uniting the European nations under her aegis. This belief he reaffirmed in his famous speech on June 8, 1880, on the occasion of the unveiling of the Pushkin memorial in Moscow. In his view Russia and the Orthodox Church were alone destined to lead the nations of Europe and, indeed, the world, into the paths of righteousness. As for the problem of evil in general, "It is clear," he wrote in *Dnevnik pisatelya,* "that evil is buried more deeply in humanity than the cure-all socialists think, that evil cannot be avoided in any organization of society, that a man's soul will remain the same, that it is from a man's soul alone that abnormality and sin arise, and that, finally, the laws that govern man's spirit are still so unknown, so uncertain and so mysterious that there are not and cannot be any physicians or even judges to give a definitive cure or decision, but that there is only He who says, Vengeance is mine, I will repay." This, in fact, is the creed that inspired all Dostoevski's great novels.

Dostoevski died in St. Petersburg on Feb. 9, (N.S.; O.S. Jan. 28), 1881.

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Nearly all the novels and stories were translated into English, notably by Constance Garnett (*The Novels of Fyodor Dostoevsky,* 12 vol., 1912–20) and by David Magarshack (various translations mentioned in the article above and dated after 1950). Two works not mentioned are *Pages From the Journal of an Author* (*i.e., Dnevnik pisatelya*), trans. by S. S. Koteliansky and J. Middleton Murry (1916) and *Stavrogin's Confession,* trans. by S. S. Koteliansky and Virginia Woolf (1922, re-issued with a study of Dostoevski by Sigmund Freud, 1949). *See* also *Letters of Fyodor M. Dostoevsky to His Family and Friends,* trans. by E. C. Mayne (1914, 2nd ed. 1917); *Dostoevsky: Letters and Reminiscences,* trans. by S. S. Koteliansky and J. Middleton Murry (1923); A. G. Dostoevskaya, *Dostoyevsky Portrayed by His Wife,* trans. by S. S. Koteliansky (1926); Aimée (Lyubov) Dostoievski, *Fyodor Dostoyevsky, a Study* (1921). Criticism: D. S. Merezhkovski, *L. Tolstoi i Dostoevski,* 2 vol. (1901–02; Eng. trans. *Tolstoi as Man and Artist, With an Essay on Dostoievski* (1902); J. Middleton Murry, *Fyodor Dostoevsky: a Critical Study* (1916, 2nd ed. 1923); J. Lavrin, *Dostoevsky* (1920; rev. ed. 1934); A. Gide, *Dostoïevsky* (1923; Eng. trans. 1925); E. H. Carr, *Dostoyevsky* (1931; rev. ed. 1962); H. Troyat, *Dostoïevsky* (1940; Eng. trans. *Firebrand, the Life of Dostoevsky,* 1947); A. Yarmolinsky, *Dostoevsky: His Life and Art* (1934; rev. ed. 1957); V. Seduro, *Dostoyevski in Russian Criticism 1846–1956* (1957); D. Magarshack, *Dostoevsky, a Life* (1962); R. Hingley, *The Undiscovered Dostoyevsky* (1962). (D. MK.)

DOTHAN, a city in the extreme southeastern part of Alabama, U.S., seat of Houston county, is about 95 mi. S.E. of Montgomery. It is primarily a farm trade centre of the wire-grass region, with small diversified industries producing cigars, toys, hosiery, garments, farm implements, fertilizers, lumber products and oils from cottonseed and peanuts. During the mid-19th century longleaf pine timber attracted settlers to the region and they soon discovered the excellence of the soil for diversified agriculture.

Originally settled as Poplar Head, the name was changed to Dothen and renamed Dothan for the place quoted in the Bible (Gen. xxxvii, 17) at the suggestion of a Methodist preacher, J. Z. S. Connelly. Incorporated in 1885 with a population under 200, it grew steadily after the coming of the first railroad in 1889. A branch of the University of Alabama is located there.

For comparative population figures *see* table in ALABAMA: *Population.* (H. WE.)

DOU, GERARD (GERRIT DOW or DOUW) (1613–1675), Dutch painter, who was a pupil of Rembrandt and later headed the school of Leiden, was born at Leiden on April 7, 1613. His first training was in the workshop of his father, a glazier, and subsequently with the engraver Bartholomeus Dolendo and the glass-painter Pieter Couwenhorn. He studied with Rembrandt from Feb. 1628 until 1631, and in his early style the influence of Rembrandt is everywhere apparent—in the thick impasto, the draftsmanship, the subject matter and the treatment of light and shadow. After Rembrandt left Leiden for Amsterdam in 1631, his influence on Dou gradually weakened, and Dou began to evolve a personal manner. He continued to paint on wood, and on a small scale, but the portraits and studies of heads of his Rembrandtesque phase gave way to a predominance of domestic genre subjects, rich in accessory details. His technique became at once freer and smoother, with an enamellike surface that is comparable, among his contemporaries, only to certain of the painters of still life. Still life, indeed, plays an important role in Dou's work: for example his kitchen scenes are often crowded with vegetables, poultry and utensils. His most characteristic device is the painted "frame within the frame"—the grayish stone window which enhances the jewellike effect of the scene it contains. After 1650 he painted many candlelight subjects. Among the most accomplished works in this genre, they belong to the widespread type that included, earlier in the century, the work of the Utrecht school and of Georges de la Tour. Dou's laborious and glossy style becomes, in the hands of his numerous followers, an empty and tedious accomplishment, but in his own best works there is evidence of taste and character which assures him a place among the Dutch masters. He was buried in Leiden on Feb. 9, 1675. Among his pupils was Frans van Mieris the elder. (R. E. W. J.; X.)

DOUAI, a town of northern France in the *département* of Nord, is situated in flat country on the Scarpe river, which flows north through the centre of the town, 38 km. (24 mi.) by road south of Lille. Pop. (1962) 46,091. Although severely damaged in World Wars I and II and largely rebuilt, Douai still has many buildings dating from the 16th–18th centuries. Boulevards and gardens mark the site of the old fortifications, but the Porte de Valenciennes, the Porte d'Arras, and the Tour des Dames (14th and 15th centuries) survive. There are many wide boulevards flanked by high buildings—in strong contrast to the surviving medieval streets. The Hôtel de Ville (partly 15th century), east of the river, has a lofty belfry with a new carillon of 49 bells. Farther east is the church of Notre Dame (12th and 14th centuries and badly damaged in 1944). Its splendid early 16th-century altarpiece of wooden panels painted by Jean Bellegambe (1470–1534) of Douai is now with the rest of the polyptych of Anchim abbey in the museum. There, too, are Gallo-Roman artifacts,

Flemish and Dutch pictures and other works of art. After 1958 the museum was housed in a Carthusian monastery of the 16th and 18th centuries. The Palais de Justice on the river bank was formerly the town house of the abbey of Marchiennes. In July a procession takes place in which the images of the legendary giant Gayant, his wife and children are borne through the town. Douai is the coal mining centre of the north of France; chemical products, railway equipment, springs, mining equipment, glass, wire and electricity are made; there are iron and engineering works and cotton spinning. Cereals, potatoes, and sugar beet are the chief agricultural products of the region.

Douai, the site of which was occupied by a castle (Castrum Duacense) as early as the 7th century, belonged in the middle ages to the counts of Flanders, passed by marriage to the dukes of Burgundy in 1384, to Austria in 1477 and to Spain on the accession of Philip II in 1556. Captured by Louis XIV of France in 1667, it was ceded to France by the treaty of Aix-la-Chapelle the following year. Douai was important as the centre of the political and religious propaganda of exiled English Roman Catholics. In 1562 Philip II of Spain founded a university there in which several English scholars were given chairs, and in connection with this William Allen (*q.v.*), in 1568, founded the celebrated English college, where the Douai Bible was prepared. The college moved to Rheims in 1578 and returned to Douai in 1593; it had trained more than 300 priests before the end of the 16th century. There were also an Irish and a Scots college, and houses of English Benedictines and Franciscans. All these survived until 1793 when the university was suppressed. In 1819 the English Benedictine college was reestablished and survived until 1905. The modern university was moved to Lille in 1887. In World War I Douai was in German hands from Oct. 1914 to Oct. 1918, and in World War II from May 1940 to Sept. 1944.

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(M. ME.)

DOUBLE BASS: *see* VIOLIN FAMILY.

DOUBLEDAY, FRANK NELSON (1862–1934), U.S. publisher, was born at Brooklyn, N.Y., on Jan. 8, 1862. He was educated at the Polytechnic Institute of Brooklyn and at the age of 15 was employed by Charles Scribner's Sons. He became manager of *Scribner's Magazine* when it was started in 1886. In 1897, with S. S. McClure, he formed a new publishing business, which later became Doubleday, Page & Co. when Walter Hines Page joined it in 1900. Doubleday built Country Life Press at Garden City, N.Y., in 1910 and established a chain of more than 30 book shops. In 1927, Doubleday, Page & Co. absorbed George H. Doran Company and was known as Doubleday, Doran until 1946, and thereafter as Doubleday & Co. Rudyard Kipling gave Doubleday the nickname of "Effendi." Other Doubleday authors were Conrad, O. Henry, Tarkington, Ferber, Selma Lagerlöf and William McFee. Under the pseudonym Charles T. Whitefield, Doubleday wrote *A Plain American in England* (1910). He died at Coconut Grove, Fla., on Jan. 30, 1934. (A. M. RU.)

DOUBLE ENTRY: *see* BOOKKEEPING.

DOUBLE JEOPARDY, a common law and constitutional protection against the use, by the state, of certain multiple forms of prosecution. The term applies to a number of significantly different situations. It prevents the state from convicting a person twice for the same crime based upon the same conduct. If a person robs a bank, he cannot twice be convicted of robbery for the same offense. Nor can he be convicted of two different crimes based upon the same conduct unless the two crimes are defined so as to prohibit conduct of significantly different kinds. Thus a person cannot be convicted of both murder and manslaughter for the same killing, but he can be convicted of both murder and robbery if the killing arose out of the robbery.

The defense of double jeopardy also prevents the state from subjecting a person to a second trial for the same crime after that person has been acquitted of that crime. Nor can the state voluntarily dismiss a case after trial has begun in order to start over again.

There is variation in the law relating to whether a conviction, acquittal or prior trial in one state bars a subsequent prosecution in another state. But it would appear that prior trial in a state or federal court will not limit the power of the other to try the defendant for the same offense.

See CRIMINAL LAW: *Criminal Procedure: Double Jeopardy.*
(F. J. R.)

DOUBLE STAR: *see* BINARY SYSTEM; STAR.

DOUBLE-STOPPING, the playing of two or more notes simultaneously on a string instrument of the violin family. When the notes are "stopped" by the left hand on two adjacent strings, only a single movement of the bow is necessary, but if more than two notes are "stopped," the player is often obliged to "spread" the notes, producing an arpeggio effect.

Double-stopping was notably used in J. S. Bach's unaccompanied violin sonatas and in the 19th-century virtuoso violin music of Niccolo Paganini.

DOUBS, a frontier *département* of eastern France, formed in 1790 from part of Franche-Comté and the principality of Montbéliard (*qq.v.*). It is bounded east and southeast by Switzerland, north by Belfort and Haute-Saône, west and southwest by Jura. Pop. (1962) 384,881. Area 5,260 sq.km. (2,031 sq.mi.). The northwest of the *département* is part of the fertile lowland corridor that leads from the Rhône-Saône valley to the Rhine through the Gate of Burgundy. It is drained southwest to the Saône river by the Doubs and Ognon, following parallel courses. To the southeast the scarp edge of the Jura plateau rises sharply from this plain to occupy the southeastern part of the *département* to the Swiss frontier, where the Mont d'Or reaches 4,806 ft. It is deeply trenched by the Doubs river and its tributaries, with zigzagging courses and picturesque gorges and waterfalls. The scenery in the upper valley of the Doubs is especially fine. The convent of Notre Dame de la Consolation has a magnificent site, and farther upstream Morteau is a summer resort near a fine gorge section with a 90-ft. waterfall (Saut du Doubs).

Much of the drainage of the porous limestone plateau is underground, and the peculiar features of limestone scenery, such as swallow holes and intermittent streams, are in evidence. A once-heavy cover of forest has been extensively cleared for farmland. The winters on the plateau are long and severe and the precipitation is heavy. The emphasis is upon pastoral farming, especially dairying, and large quantities of Gruyère cheese are made at cooperative dairies (*fruitières*). Survivals of old metalworking industries are found in some of the valley market towns and watchmaking, introduced from Switzerland in the 18th century, employs large numbers in the *département*. Besançon is the chief centre of this widespread activity and also has important rayon manufactures. Montbéliard and the industrial town of Audincourt nearby have become great engineering centres, with the Peugeot works, and Montbéliard also has textile factories. The Rhône-Rhine canal, following the Doubs valley, traverses the *département* for 135 km. (84 mi.) of its length. Apart from the important route approaching Belfort and the Rhineland by way of Besançon and Montbéliard in the Doubs valley, the railway from Dijon to Neuchâtel in Switzerland crosses the south of the *département* by Pontarlier, which commands the gap by which the Doubs emerges from the high Jura mountains onto the plateau. It is a tourist and winter sports centre. Nearby are the remains of the Augustine abbey of Montbenoît.

Besançon (*q.v.*), former capital of Franche-Comté, is the prefecture of the *département*. It is a cathedral and university city, the headquarters of an archbishopric and an *académie* (educational division) and has a court of appeal. The *département* is divided into three *arrondissements*, centred upon Besançon, Montbéliard and Pontarlier. (AR. E. S.)

DOUBS RIVER, in eastern France, rises in the Jura at the foot of the Noirmont ridge, at a height of over 3,000 ft., and flows into the Saône. It is 267 mi. long, but, because it doubles back upon itself, the distance from source to mouth in a direct line is only 56 mi. Its basin has an area of 3,022 sq.mi. The river begins by flowing northeast, traversing the Lake of St. Point and passing Pontarlier. Thenceforth its course lies chiefly through wooded

limestone gorges of great grandeur. After skirting the town of Morteau, below which it expands into the Lake of Chaillexon and descends over the Fall of the Doubs (88 ft.), the river for about 28 mi. forms the frontier between France and Switzerland. It flows in the latter country for some distance and then turns abruptly westward. Thus far the Doubs has been flowing between the ranges of the Jura, but when it comes against the shattered southern face of the old block of the Vosges its course is rapidly altered. After turning westward it finds its way through this complicated country by turning north, and finally, at Voujeaucourt, southwest. Below that town the river is joined by the canal from the Rhône to the Rhine, to accommodate which its course was canalized as far as Dôle. The Doubs passes Clerval and Baume-les-Dames to Besançon. The lower section of its course is in the great structural depression between the Côte d'Or and the Jura. After passing Dôle it leaves the high ground and enters the plain of the Saône. There it receives the waters of the Loue, which also has a complicated course, finding its way, like the Doubs, between the outer folds of the Jura—sometimes parallel with them and sometimes cutting across them, and finally falling into the great structural depression with the lower Doubs and Saône. The Doubs reaches the Saône at Verdun-sur-le-Doubs. The river is navigable for only about 8 mi. above its mouth.

(Ar. E. S.; X.)

DOUGHBOY, in the 17th century, signified "dumpling." During the American Civil War it was applied to the brass buttons on uniforms and thence to infantrymen. At a period not exactly ascertained, the word was supposed to come from the doughlike appearance of a uniform soiled by moistened pipe clay. Again, infantrymen were said to march in "dough" during wet weather. "Adobe" furnishes a similar derivation, although it may be a popular etymology or wholesale transference of a foreign word to an English meaning and spelling. "Doughboys" was a favourite designation for United States soldiers during World War I.

DOUGHERTY, PAUL (1877–1947), U.S. painter of marine subjects, was born at Brooklyn, N.Y., on Sept. 6, 1877. He studied law, but upon graduating in 1898 went to Europe for five years to study art.

He won many prizes, and among his more important pictures are "October Seas," "The Road to Cayey" and "Lake Louise," in the Metropolitan museum, New York city; "The Land and the Sea," in the Corcoran gallery, Washington, D.C.; and "Sun and Storm," in the National gallery, Washington. He died on Jan. 9, 1947, at Palm Springs, Calif. He was a brother of the actor Walter Hampden. (D. H. W.)

DOUGHTY, CHARLES MONTAGU (1843–1926), English writer and the greatest of all Arabian travelers, was the younger son of the Rev. C. M. Doughty of Theberton hall, Suffolk. He was born on Aug. 19, 1843, and was educated at London and Cambridge universities. He indulged his taste for scholarly pursuits while traveling widely in Europe and the Levant. From Damascus in 1876 he began the wanderings in Arabia that made him famous. Marching with the Mecca pilgrims in the *hajj* caravan (*see* Mecca) as far as Madâin Sâlih, where he studied its Nabatean monuments and inscriptions which he later published, he spent two years in Arabia. He visited Khaibar, Taima, Hail, Buraida and Anaiza, whence he traveled with the butter caravan of 1878 to Taif and Jidda. His *Travels in Arabia Deserta* appeared in 1888, but won little recognition at the time, though it came to be regarded as one of the great literary epics of travel. Concerned more with producing, out of his unique experience, a monument of what he considered pure English prose than with recording information, Doughty attempted direct Elizabethan style and rejected all later growths in syntax and vocabulary. Although irksome to some, his majestic style conveys the feeling of his remote and lonely adventuring. Doughty himself attached more importance to his epic poetry, to which he devoted the rest of his life. In general it is too rough, but it contains passages of sublime poetic inspiration. His epics and poetic dramas included *The Dawn in Britain*, 6 vol. (1906), *Adam Cast Forth* (1908), *The Cliffs* (1909), *The Clouds* (1912), *The Titans* (1916) and *Mansoul* (1920). Doughty died at Sissinghurst, Kent, on Jan. 20, 1926.

See D. G. Hogarth, *The Life of Charles M. Doughty* (1929).

(H. St. J. B. P.)

DOUGLAS, the name of a Scottish noble family, of which the duke of Hamilton, marquess of Douglas, is now heir male, while the unentailed estates have passed to the earls of Home (Douglas-Home), and of which the other two most notable bearers are the marquesses of Queensberry and the earls of Morton. The marquessate of Douglas and the earldom of Angus, the historic titles held by the two chief branches of the family, the Black and the Red Douglas, are merged in the Hamilton dignities. The name (Gaelic *dubh glas*, "dark water") comes from Douglasdale, the home of the family in Lanarkshire, still in the possession of the earls of Home. The first chief of whom anything certain is known was William de Douglas or Dufglas (d. *c.* 1214), whose name frequently appears on charters from 1175. His elder son Archibald (d. *c.* 1240) inherited his estates, while the second son Brice (d. 1222) became bishop of Moray.

Archibald's son was William (*c.* 1200–*c.* 1272), called "Long Leg." His son Sir William (d. *c.* 1298), called "le Hardi," was the first member of the family formally to assume the title of lord of Douglas. He did homage to the English king Edward I (1291) but when John Balliol rebelled (1295) Sir William held Berwick castle against the English, surrendering it when they sacked the town (1296). After a short imprisonment he was restored to his Scottish but not to his English estates. He joined William Wallace's rising (1297) but submitted to the English almost immediately, and died in the Tower of London *c.* 1298.

His son, "the Good" Sir James (*c.* 1286–1330), was educated in Paris and returned home to find an Englishman, Robert de Clifford, in possession of his estates. He joined Robert the Bruce, attending his coronation at Scone (March 1306) and sharing his wanderings in the Highlands after their defeat at the battle of Methven (June 1306). The following year they separated, Sir James returning to the south of Scotland, when he three times attacked his own castle at Douglas, finally destroying it. His assault made on Palm Sunday, March 19, 1307, is known as the "Douglas Larder." His many successful raids on the English won him the dreaded name of the "Black Douglas." Through the capture of Roxburgh castle (1313) by the stratagem of disguising his men as black oxen, he secured Teviotdale; and at the battle of Bannockburn (June 1314) he commanded the left wing with Walter the Steward. He invaded Yorkshire (1319) with Thomas Randolph, earl of Moray, defeating an army assembled by William de Melton, archbishop of York, at Myton-upon-Swale. Bruce rewarded him for his capture (1322) of the pass of Byland, Yorkshire, with the "Emerald Charter"; by this he and his heirs were granted "high justice" throughout the family estates, and were freed of all feudal dues except military service. Shortly before peace was finally concluded, he nearly captured Edward III in a daring night attack on the English camp in Weardale (Aug. 1327). Before his death (1329) Bruce asked Sir James to carry his heart to the Holy Land in redemption of his unfulfilled crusading vow; Sir James set out (1330), bearing the embalmed heart in a silver casket, but he fell fighting against the Moors in Spain on Aug. 25, 1330. The Douglases have since borne a human heart in their coat of arms. Sir Archibald (*c.* 1297–1333), half-brother of Sir James, was appointed regent of Scotland (April 1333) and, with Sir William (d. 1333), son of Sir James, was killed at the battle of Halidon Hill on July 19, 1333. The inheritance then passed to his brother Hugh (1294–*c.* 1347), a churchman, called "the Dull," who resigned his lands (1342) to David II for regrant to a series of named heirs.

William (*c.* 1327–84), 1st earl of Douglas, the second but first surviving son of Sir Archibald, was educated in France and returned to Scotland in 1348. He killed his kinsman and godfather, Sir William (*c.* 1300–53), the knight of Liddesdale, in Ettrick forest (1353) and acquired part of Liddesdale. His marriage (1357) with Margaret, sister and heiress of Thomas, 9th earl of Mar, brought him the estates and earldom of Mar (1374), and he was created earl of Douglas in Jan. 1358. He joined David II in proposing a treaty (1363–64) with England, which would substitute for Robert the Stewart (afterward Robert II) an English

prince as heir to the Scottish throne; David was seeking a remission of his ransom, William the return of his family's English estates. On the accession (1371) of Robert II he was nevertheless reconciled and was appointed warden of the marches. He died at Douglas in May 1384. By his wife's sister-in-law, Margaret Stewart, countess of Angus in her own right and widow of the 9th earl of Mar, he had a son, GEORGE (*c.* 1378–*c.* 1402), afterward 1st earl of Angus.

JAMES (*c.* 1358–1388), 2nd earl of Douglas and Mar, son of the 1st earl, married (1371 or 1373) Isabel, daughter of Robert II. He invaded England (1388), besieged Newcastle for three days, and captured the pennon of Sir Henry Percy (Hotspur) in single combat. Percy sought revenge in the battle of Otterburn (Aug. 1388), celebrated in English ballad as "Chevy Chase." The Scots were victorious, and Percy and his brother were captured; but James was killed. He left no legitimate male issue, but his natural sons WILLIAM (d. *c.* 1421) and ARCHIBALD (*c.* 1297–1333) founded the families of Douglas of Drumlanrig (*see* QUEENSBERRY, EARLS, MARQUESSES AND DUKES OF) and Douglas of Cavers. His sister Isabel (d. 1408) became countess of Mar, inheriting the lands of Mar and his unentailed estates.

The earldom and entailed estates of Douglas reverted by the patent of May 1342 to ARCHIBALD (*c.* 1325–*c.* 1400) 3rd earl of Douglas, called "the Grim," an illegitimate son of the "Good" Sir James. He became warden of the west marches (1368) and lord of Galloway (1369), and increased his estates by marriage (1362) with Joan, widow of Sir Thomas Moray, lord of Bothwell, and by purchasing the earldom of Wigtown (1372). He was twice sent on missions to the French court (1369, 1371). His daughter MARJORY (d. *c.* 1420) married (Feb. 1400) David, duke of Rothesay (d. 1402), King Robert III's son and heir, while his illegitimate son, SIR WILLIAM DOUGLAS of Nithisdale (d. 1392) married (*c.* 1387) Egidia, daughter of Robert II. Archibald died at Threave, near Douglas, probably on Christmas eve, 1400.

Archibald the Grim was succeeded by his eldest son, ARCHIBALD (*c.* 1370–1424), the 4th earl, who married (1390) Margaret, eldest daughter of John, earl of Carrick (afterward King Robert III). As master of Douglas (1400) he defeated, near Preston, Percy and George Dunbar, earl of March, who had joined the English, disappointed at his failure to marry his daughter to the duke of Rothesay. Douglas acquired the lands which March thus forfeited; when the rest were restored (1409) he retained the lordship of Annandale. Archibald was, with the regent, Robert, duke of Albany, suspected of compassing Rothesay's death (March 1402) while he was in their custody at Falkland; but both were declared guiltless by parliament. In a raid upon England Archibald was captured by Percy at the battle of Hamildon Hill (Sept. 1402); he fought with his captors against Henry IV at the battle of Shrewsbury (1403) and was taken prisoner by the king. He was allowed to visit Scotland several times after 1405, negotiating between the Scots and English for the release of the Scots king James I, who had been captured by the English (1406) while sailing to France. Archibald was finally freed in 1413. He commanded a contingent of 10,000 Scots sent to help the French king Charles VII against the English; he was made lieutenant-general of the French army and received the peerage-duchy of Touraine with remainder to his heirs male. He was killed fighting against John, duke of Bedford, at the battle of Verneuil on Aug. 17, 1424, and was buried in Tours cathedral.

ARCHIBALD (*c.* 1390–1439), 5th earl of Douglas, succeeded to his father's honours but never got the revenues of Touraine. He fought against the English in France, taking part in their defeat at the battle of Baugé (March 1421), and shortly afterward was created comte de Longueville by Charles VII. He was a regent (1437) for the young king James II, and as lieutenant-general of Scotland summoned a parliament (1438). He died of fever at Restalrig on June 26, 1439. The lordship of Bothwell, acquired by Archibald, the 3rd earl, was settled on his widow Eupheme, countess of Stratherne in her own right; at her death (1468) it reverted to the crown.

Archibald's two sons, WILLIAM (*c.* 1424–1440), the 6th earl, and DAVID, though little more than boys, defied the government, were tried for high treason and beheaded in Edinburgh castle in the young king's presence, on Nov. 24, 1440. This judicial murder broke up the dangerous power wielded by the Douglases. The lordship of Annandale fell to the crown and Galloway to their sister MARGARET, the "Fair Maid of Galloway." Despite the attainder, the Douglas lands passed to their great-uncle, JAMES (1371–1443), 7th earl of Douglas, called "the Gross," of Balveny, who was the 2nd son of Archibald, the 3rd earl. Lord of Abercorn and Aberdour, he was created earl of Avondale (1437). He made no attempt to avenge his kinsmen and died in March 1443.

His son WILLIAM (*c.* 1425–1452), 8th earl, restored the power of the Black Douglases. By his marriage with his cousin, the Fair Maid of Galloway (1444) he regained Galloway and Wigtown, and was granted Bothwell by James II with whom he at first stood in high favour. But *c.* 1450 he joined Alexander Lindsay, earl of Crawford, in an alliance against the court party. He was summoned to Stirling castle and, in breach of safe conduct, was stabbed to death by the king himself on Feb. 22, 1452.

JAMES (1426–1491), the 9th and last earl, at first attempted to avenge his brother's murder but, deserted by his allies, was obliged to submit to the king (Aug. 1452). To keep the family estates together, he obtained a dispensation to marry his brother's widow. He openly accused the king of the murder (1454) and led 40,000 men against him. Meanwhile another branch of the family, known as the Red Douglas, had risen to importance (*see* ANGUS, EARLS OF), and GEORGE (d. *c.* 1462), great-grandson of the 1st earl of Douglas, supported the king against his chief. James, again deserted by his allies, fled to England; he was attainted (June 1455) and his wife divorced him. The lordship of Douglas was granted to the earl of Angus. James, who had long intrigued with the Yorkist faction in England, was favoured by Edward IV who sent him (1461) to make a treaty with John, earl of Ross and lord of the Isles, against the Scottish king who had given asylum to the fugitive English king Henry VI. He was captured while raiding southern Scotland (1484) and relegated to Lindores abbey, Fife, where he died in May 1491.

Other sons of the 7th earl were ARCHIBALD (d. 1455), who became earl of Moray through his marriage with Elizabeth Dunbar, coheiress of James, earl of Moray (d. 1429), HUGH (d. 1455), created earl of Ormond (1445), JOHN (d. 1463) lord of Balveny and HENRY who took orders. Moray, Ormond and Balveny were defeated by the earl of Angus at Arkinholm on the river Esk (1455); Moray was killed, Ormond captured and executed, while Balveny fled to England, whence he returned to capture and execution *c.* July 1463.

WILLIAM (1589–1660), 11th earl of Angus, was created marquess of Douglas by Charles I (1633). In the Civil War he joined (1644) James Graham, marquess of Montrose, and although he escaped after the battle of Philiphaugh (Sept. 1645), he was captured soon afterward and imprisoned in Edinburgh castle (1646–47). He died on Feb. 19, 1660. His eldest son ARCHIBALD (*c.* 1609–55) predeceased him; another son, WILLIAM (1634–94), created earl of Selkirk (1646) married (1656) Anne (*c.* 1632–1716) duchess of Hamilton, and was created 3rd duke of Hamilton (1660). By failure of the elder branch (1761) the dukes of Hamilton (*q.v.*) became heirs male of the house of Douglas. GEORGE (*c.* 1636–1692), 5th son of the 1st marquess was created earl of Dumbarton (1675).

JAMES (1646–1700), 2nd marquess of Douglas, succeeded his grandfather. His eldest son, JAMES (1671–92), earl of Angus, raised the Angus regiment, known later as the Cameronians or 26th Foot, and was killed at its head in the battle of Steinkirk (Aug. 3, 1692). The younger son, ARCHIBALD (1694–1761), 3rd marquess, was created duke of Douglas (1703). He supported the government in the rising of 1715, fighting against James Edward, the Old Pretender, at the battle of Sheriffmuir (Nov. 13). When he died on July 21, 1761 the dukedom became extinct. The heir presumptive to the Douglas estates was his sister, LADY JANE DOUGLAS (1698–1753), who secretly married (1746) Colonel, afterward Sir John Stewart of Grandtully, by whom she had twin sons, alleged to be spurious, born in Paris in July 1748. When Lady Jane died, the duke refused to acknowledge the elder boy as his nephew; but

he revoked (1760) a will devising the estates to the Hamiltons. Thus this nephew, Archibald James Edward Douglas of Douglas (1748–1827), obtained the estates, after a house of lords decision against the Hamilton claim (1769); he was armorially invested as chief of the name (1771) and was created 1st baron Douglas of Douglas (July 1790). Archibald was succeeded as Baron Douglas by three of his sons; but as they left no male issue the Douglas estates passed (1857) to the earls of Home, Cospatrick Alexander, 11th earl of Home, having married (1832) a granddaughter of Archibald, 1st baron Douglas, Lucy Elizabeth, at whose death (1877) the Douglas chiefship became dormant.

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DOUGLAS, DAVID (1798–1834), Scottish botanist, for whom the Douglas fir is named, was born at Scone, Perthshire. After being a gardener at the botanical gardens of Glasgow, he went to Oregon in 1823 as a collector to the Royal Horticultural society. In 1825 he went to British Columbia where he discovered many new plants, trees and birds, and in 1827 reached Hudson bay. From 1830 to 1834 he explored California and the Fraser river region. He died in the Sandwich Islands July 12, 1834. He introduced into Britain many trees, shrubs and plants.

DOUGLAS, GAVIN (1475?–1522), Scottish poet and bishop, the first British translator of the *Aeneid*, who also played a part in political events at a troubled period of Scottish history. Born *c.* 1475, he was the third son of Archibald "Bell-the-Cat," 5th earl of Angus. He studied at St. Andrews university and possibly in Paris. In 1496 he obtained a grant of the teinds (tithes) of Monymusk, Aberdeenshire, and two years later James IV promised him the parsonage of Glenquhom when it should fall vacant. He also obtained the parsonage of Lynton and the rectory of Haugh (Prestonkirk), East Lothian; and *c.* 1501 he became provost of the collegiate church of St. Giles, Edinburgh. The records testify to his energy and influence in ecclesiastical affairs, and the period of his provostship was also that of his literary activity.

The battle of Flodden (Sept. 1513) proved fatal to Douglas' career and reputation. In Aug. 1514 Margaret Tudor, James IV's queen widowed at Flodden, married Archibald, 6th earl of Angus, and Gavin Douglas' nephew. This marriage, regarded as in itself reprehensible, invested the powerful house of Douglas with almost royal dignity and identified it with the Anglophile party in Scotland. Gavin Douglas, who was close to the queen at least from the time of the disaster at Flodden, presumably favoured the match. Margaret, writing to Pope Leo X in June 1514 in the name of her infant son, nominated Douglas abbot of Aberbrothock as a man worthy of "the highest ecclesiastical authority, even the primacy," and "foremost in rank among the nobles of this kingdom, second to none in literature and morals." After her marriage she nominated him archbishop of St. Andrews, but the archbishopric went to Andrew Forman, bishop of Moray and the pope's nominee, and Douglas lost more than he gained by the queen's favour.

The lords of the council deprived Margaret of the regency in Sept. 1514, summoned Angus before them on constitutional charges, and invited the duke of Albany, cousin of James IV, to return from France as governor of Scotland. In the eight months before Albany's return, a state of anarchy developed. The queen withdrew from Edinburgh to Stirling. Angus seized James Beaton, archbishop of Glasgow and chancellor, an opponent of the Douglas marriage, and set the great seal in the hands of Gavin Douglas. Henry VIII, whose overtures as protector and governor of Scotland were resisted by the lords of the council, tried secretly to persuade Margaret to take refuge in England with her children. Douglas played a part in these negotiations, with the promise of ecclesiastical advancement as a reward. The queen wrote to Adam Williamson, a Scottish priest acting in the English interest from London, that "there is nane that I may trust bot my husband and his uncle quhilk ar rycht glad thereto yf it mycht be."

In Jan. 1515 the queen nominated Douglas to the vacant see of Dunkeld, and the pope confirmed this in the following month, in the face of opposition from the earl of Athole, who had installed his brother Andrew Stewart in the bishop's palace. But before Douglas' consecration took place, Albany arrived in Scotland and assumed the regency. Douglas' use of foreign influence to obtain preferment aroused suspicion, and the interception of correspondence relating to the affair brought him to disaster. Albany laid the letters before the lords of the council, and Douglas was imprisoned in the castles of Edinburgh and later St. Andrews. The queen meanwhile retired to England. The pope intervened on Douglas' behalf; he was released in 1516 and ultimately consecrated bishop.

Douglas made his peace with Albany, and in May 1517 accompanied him to France on an embassy which brought about the treaty of Rouen. Albany stayed on in France, and the strife among the Scottish nobles rose to boiling point in a plot of the Hamiltons to seize the earl of Angus. Gavin Douglas unsuccessfully mediated between the two factions. Armed conflict broke out in the streets of Edinburgh in 1520—the celebrated brawl known as "Cleanse-the-Causeway"—and the Douglases triumphed. Gavin distinguished himself briefly by saving the life of the captured Archbishop Beaton, who was prominent in the Hamilton cause. Thereafter the behaviour of Angus, whose indifference and scandalous amours had estranged the queen, became more and more outrageous. Albany, with the encouragement of Margaret and supported by a strong French force, returned to Scotland in Nov. 1521; and Angus, with Gavin Douglas and others, was forced to flee into England. Douglas was deprived of his bishopric, and remained in exile in England until his death in the London plague in Sept. 1522. His closing years were lightened by the friendship of Polydore Vergil.

Douglas' literary activity belongs to the peaceful years 1501–13. In the *Testament and Complaynt of the Papyngo* (1530), David Lindsay refers to Douglas as author "abufe vulgare Poeitis prerogatyve" of "worthy workis in nowmer mo than fyve." He is credited with *aureas narrationes* by John Bale in his *Illustrium Majoris Britanniae Scriptorum Summarium* (1548), and with *De Rebus Scoticis, Comoedias aliquot* and a translation of Ovid's *Remedium Amoris* by Thomas Tanner (*Bibliotheca Britannico-Hibernica*, 1748). But only four works survive that are certainly or probably his: the poem *Conscience*, a punning conceit written in four seven-lined stanzas, *The Palice of Honour*, *King Hart* and the *Eneados*.

The Palice of Honour, to which Douglas refers at the end of his *Eneados*, was written in 1501. It is a dream allegory of more than 2,000 lines in a difficult nine-lined stanza with a ballade. On the theme "where does true honour lie," it is appropriately dedicated to James IV and reflects a higher theoretical virtue than Douglas was to exemplify in his career. The poet's dream describes the diverse ways to honour, in a series of processions and progresses—Sapience, Minerva, Diana, Venus and others, with their trains—and the palace of honour itself, founded on moral virtue. The appeal of the poem lies in harmonious rhetoric, rich imagery and description both of beauty and of horror. Its weaknesses are those of overabundant detail and an excess of fine language. This is the earliest Scottish poem to bear the marks of the new learning: the ancient world is seen not through medieval fable but through the eyes of the Greek and Latin authors.

King Hart was ascribed to Douglas in a later hand in the Maitland Folio manuscript (1580; in the Pepysian library, Cambridge). The poem is an allegory of over 900 lines in eight-lined stanzas, describing vigorously and graphically the youth of Hart (the human soul) in his "cumlie castell," his thralldom to Lady Plesaunce, the ultimate assaults of age, conscience and reason, and the death of King Hart. The morality is familiar enough; but it is set out in freshly imaginative detail and with a controlled power absent from *The Palice of Honour*. If it is not Douglas' work, there is no other Scottish poet of the period to whom it may reasonably be ascribed.

The XIII Bukes of the Eneados, Douglas' longest and last work, was the first direct translation of the whole *Aeneid* made in Britain. It includes a version of the 13th book added to Vergil by the 15th-century humanist Maffeo Vegio, and an original prologue

to each book. Douglas undertook his translation at the request of the sailor Henry, Lord Sinclair, "fader of bukes, protectour to sciens and lair," and in revulsion from "ane buke of Inglys gross" —the translation (1490) from French by William Caxton, who "knew never thre wordis at all quhat Virgill ment." Despite the contentions of earlier critics, Douglas' approach to Vergil was not humanistic. He recognizes his greatness as a poet, and he represents as much of that greatness as he can "in the langage of Scottish natioun," "kepand na sudroun [English] bot our awin langage." His respect for his original, his concern with the technique of translation and his sensitiveness to linguistic differences, give him superficially a closer resemblance to a neoclassical translator such as Dryden than to medieval paraphrasers of Vergil. But he is medieval in the casual freedom with which he brings his original up to date, in his sense of kinship with the Latin poet and in the absence of both humanistic "classical" diction and renaissance gravity of tone. He "shocks us by being closer to Vergil than we . . . . To the present day a reading of his version is the best possible preparation for a re-reading of the Latin" (C. S. Lewis, *English Literature in the 16th Century*, Clarendon Press, Oxford, 1954). But the *Eneados* is important in other respects. Douglas' prologues are notable pieces of original writing, containing vigorous discussion of Vergil's poetic merits in the tradition of medieval criticism (i, v, vi, ix), moralizing with personal undertones that move and endear, and three splendid season poems (vii, xii, xiii)— almost the first and certainly the best examples of that poetry of the "good old Bards" whose "Images are native, and Landskips . . . domestick" (*Miscellaneous Works of that celebrated Scotch Poet Allan Ramsay*, 1724).

BIBLIOGRAPHY.—No manuscript of *The Palice of Honour* survives. The earliest editions were printed in Edinburgh *c.* 1540 and in London *c.* 1553. It was edited by J. G. Kinnear for the Bannatyne club (1827). The *Eneados* survives in five manuscripts: the Cambridge manuscript (*c.* 1525; Trinity college), the Elphynstoun manuscript (*c.* 1525) and the Ruthven manuscript (*c.* 1535) in Edinburgh University library, and the manuscripts in Lambeth palace and the library of the marquis of Bath at Longleat. The first (and corrupted) printed edition was published in London in 1553. It was edited from the Cambridge manuscript by G. Dundas, 2 vol., for the Bannatyne club (1839). New collected edition by D. F. C. Coldwell *et al.*, Scottish Text Society (1957–).

For criticism of Douglas, *see* C. S. Lewis, *English Literature in the Sixteenth Century* (1954); Agnes Mure Mackenzie in J. Kinsley (ed.), *Scottish Poetry: A Critical Survey* (1955); and J. M. Ross, *Scottish History and Literature* (1884). Douglas' indebtedness to Chaucer is discussed in P. Lange, *Chaucers Einfluss auf die Originaldichtungen des Schotten Gavin Douglas* (1882). *See* also J. A. W. Bennett, "The early fame of Gavin Douglas's 'Eneados,'" *Modern Language Notes*, lxi (1946); W. Beattie, "Gavin Douglas's 'Palice of Honour,'" *Times Literary Supplement* (Feb. 23, 1946); B. Dearing, "Gavin Douglas's 'Eneados,'" *Publications of the Modern Language Association of America*, lxvii (1952). (J. Ky.)

DOUGLAS, SIR JAMES (1803–1877), governor of Vancouver Island, 1851–64, of British Columbia, 1858–64, and known as "the father of British Columbia," was born in Demerara, British Guiana, on Aug. 15, 1803. He received his schooling in Lanark, Scot., and entered the service of the North West company, arriving in Canada in 1820. His career as Hudson's Bay company fur trader commenced in 1821. He rose from clerk to chief trader in 1834 and chief factor in 1839. As John McLoughlin's chief assistant at Ft. Vancouver, he carried out important trading missions in the Alaskan panhandle and in California. On McLoughlin's retirement in 1845 he became senior member of the board managing the company's operations west of the Rocky mountains. In 1843 he started construction of Ft. Victoria near the southern end of Vancouver Island and in 1849, after the extension of the international boundary line to the Pacific and the British withdrawal from Oregon, moved the company's western headquarters there from Ft. Vancouver.

At first passed over for the position of governor when a British colony was established on Vancouver Island under the auspices of the Hudson's Bay company in 1849, he received the appointment in 1851.

In the spring of 1858, faced with a rush of 10,000 miners to gold fields on the Fraser river and the prospect of American settlement being followed by territorial claim, he extended his authority to the mainland as imperial officer in order to maintain a British foothold on the Pacific. The British government approved his action, created a second colony, British Columbia, and offered him the governorship on condition that he sever his connection with the Hudson's Bay company. Against overwhelming odds, and with the aid only of a small force of Royal Engineers, a few Royal Navy ships, a judge and some magistrates, he maintained British rule and British law. (*See* BRITISH COLUMBIA: *History.*) He was knighted in 1863 and retired in 1864. He died in Victoria on Aug. 2, 1877.

See Margaret A. Ormsby, *British Columbia: a History* (1958); E. E. Rich (ed.), *The Letters of John McLoughlin*, vol. 3 (1944). (M. A. O.)

DOUGLAS, JAMES (1837–1918), Canadian mining engineer, industrialist and philanthropist who contributed greatly to the industrial growth and welfare of Arizona and the U.S. southwest, was born Nov. 4, 1837, at Quebec, Que. He was educated in Canada at Queen's university, Kingston, Ont., where he was later chancellor, and in Scotland, studying theology and medicine.

With T. Sterry Hunt, he invented the Hunt-Douglas process for treatment of copper materials. In 1875 he became superintendent of the Chemical Copper company, Phoenixville, Pa., where he installed the first commercial copper electrolytic refining plant. Six years later he was employed by Phelps, Dodge and Company of New York to examine copper mines in Arizona, leading at that time to the acquisition of mines at Bisbee and Morenci and, afterward, of other mines and also the El Paso and Southwestern railroad. He was made a Phelps, Dodge partner and later president when the firm was incorporated in 1908, and from 1916 was chairman until his death, in New York, on June 25, 1918. He encouraged the mining of radium ores, and presented more than three grams of radium to General Memorial hospital, New York, stimulating later cancer research by that institution.

Douglas was the author of many technical papers and of several historical books on Canada. (C. E. D.)

DOUGLAS, (GEORGE) NORMAN (1868–1952), British writer, especially read for his evocation of southern Italy, where he lived for many years, latterly on the island of Capri. He was born at Tilquhillie, Aberdeenshire, on Dec. 8, 1868, the son of an old family of Deeside lairds, which had intermarried with German aristocrats. The most important part of his schooling was at the *Gymnasium* at Karlsruhe, where he showed a precocious gift both for languages and natural science. He entered the foreign office in 1893 but spent only about three years on diplomatic service in Russia, after which he traveled widely, in India, Italy and north Africa. He died on Capri on Feb. 11, 1952.

Douglas was for a time assistant editor of the *English Review*. His first notable book was *Siren Land* (1911) and his first popular success the satirical novel, set in Capri, *South Wind* (1917). The charm of all his books, whether fiction, topography, essays or autobiography, lies in their uninhibited expression of a personality at once bohemian and aristocratic, a mind stored with odd learning yet easy and gay, an attitude to life cantankerous and amoral, yet with an odd sturdiness and simplicity about it. His prose is somewhat near the perfection of the conversational style. Perhaps the richest of his books is *Old Calabria* (1915), the most self-revealing his informal autobiography *Looking Back* (1933). (G. S. F.)

DOUGLAS, STEPHEN ARNOLD (1813–1861), U.S. political leader who debated the slavery issue with Abraham Lincoln in 1858 and ran against him for president in 1860. He was born in Brandon, Vt., on April 23, 1813. Left in infancy to the care of a widowed mother and a bachelor uncle, he became a cabinetmaker's apprentice in Middlebury and Brandon. He attended schools at Brandon and in Canandaigua, N.Y., and began the study of law. In 1833 he went west and finally settled in Jacksonville, Ill., where he was admitted to the bar in March 1834. Early in his career he took an active interest in politics and his rise was remarkably rapid. He affiliated with the party of Andrew Jackson and soon became a leader in the Illinois Democratic party. In Feb. 1835 he was elected public prosecutor of the first judicial circuit; in Dec. 1836 he became a member of the state legislature.

In 1837 he was appointed by Pres. Martin Van Buren registrar of the land office at Springfield, which had just become the state capital. In the 1840 election he did much to carry the state for Van Buren; and for a few months he was secretary of state of Illinois. He served as a judge of the supreme court of Illinois from 1841 to 1843. In 1843 he was elected to the national house of representatives.

In congress, though one of the youngest members, he at once sprang into prominence by his clever defense of Andrew Jackson for alleged contempt of court in New Orleans. He was soon recognized as one of the ablest and most energetic of the Democratic leaders. An enthusiastic believer in the manifest destiny of his country, he remained throughout his career a devoted advocate of western development. He was a thoroughgoing expansionist, heartily favouring the measures that resulted in the annexation of Texas and the Mexican War. Taking an active share in the Oregon controversy, he opposed yielding "one inch" of the territory to Great Britain. He early proposed the extension to the west of United States settlements under military protection. He advocated the construction, by the aid of government land grants, of a transcontinental railway and was the chief promoter (1850) of the Illinois Central railway. In the 1850s he argued on behalf of a free homestead policy for western settlers. As chairman of the committee on territories, at first in the house and then in the senate, to which he was elected in 1847, he introduced the bills for admitting Texas, Florida, Iowa, Wisconsin, California, Minnesota and Oregon into the Union, and for organizing the territories of Oregon, Minnesota, New Mexico, Utah, Washington, Kansas and Nebraska.

In the bitter debates concerning the keenly disputed question of slavery in the territories, Douglas was particularly prominent. Closely related to his belief in national expansion and his support of western development was his doctrine of "popular sovereignty" —the idea that the people of the territories should decide the question of slavery for themselves. Against slavery itself he never publicly expressed any moral antipathy; his first wife and children were by inheritance the owners of slaves, although he himself never was. He did more, probably, than any other man to secure the adoption of the Compromise of 1850. The organization of the Utah and New Mexico territories with popular sovereignty was a victory for Douglas' position. Nevertheless his bill for organizing the territories of Kansas and Nebraska, reported in Jan. 1854, and which in amended form was signed by the president on May 30, reopened the whole slavery dispute—wantonly, his enemies charged, for the purpose of securing southern support to his presidential ambitions—and caused great popular excitement. It repealed the Missouri Compromise, and declared the people of the territories "free to form and regulate their domestic institutions in their own way, subject only to the Constitution of the United States." The passage of his Kansas-Nebraska act, one of the most momentous in its consequences ever passed by the federal congress, was largely a personal triumph for Douglas, who showed marvelous energy, adroitness and resourcefulness and genius for leadership. He was, however, bitterly condemned and vilified by many anti-slavery people. His hostility to the Know-Nothing party and his plea for religious toleration also caused him trouble. In 1852 and again in 1856 he was a strong candidate for the presidential nomination in the Democratic national convention.

In 1857 the decision of the U.S. supreme court in the Dred Scott case indirectly struck at Douglas' popular sovereignty principle by declaring that congress had no power to prohibit slavery in the territories and that the territories were open to slavery. Douglas, however, denied any contradiction and continued to argue the validity of his principle. The same year he broke with Pres. James Buchanan and the "administration" Democrats and lost much of his prestige in the South, but partially restored himself to favour in the North by his vigorous opposition to the method of voting on the Kansas Lecompton constitution and the admission of Kansas into the Union as a slave state. (*See* KANSAS: *History.*) Shortly afterward he engaged in Illinois in a close contest for the senatorship with Abraham Lincoln, the Republican candidate, whom he met in a series of debates. Although his followers did not poll as large a vote as Lincoln's, Douglas won re-election by a vote in the legislature of 54 to 46. In one of the debates, at Freeport, Ill., he expressed his famous "Freeport Doctrine," that the territories could still determine the existence of slavery through unfriendly legislation and the police power, in spite of the supreme court decision. As a result, southern opposition to Douglas became more intense and he was not reappointed chairman of the committee on territories.

In 1860 in the Democratic national convention in Charleston, S.C., the adoption of Douglas' "popular sovereignty" platform brought about the withdrawal of several southern states from the convention. The convention adjourned to Baltimore, Md., where additional southern delegations withdrew and where Douglas was nominated for the presidency by the northern Democrats. He campaigned vigorously but hopelessly, boldly attacking disunion and advocating "popular sovereignty" as the only measure that could save the Union, but in the election he received an electoral vote of only 12, against Lincoln's 180, although his popular vote was 1,375,157.

Douglas urged the South to acquiesce in Lincoln's election, and he and his second wife, Adèle Cutts, were among the foremost to welcome the Lincolns to Washington. On the outbreak of the American Civil War he denounced secession as criminal, and was one of the strongest advocates of maintaining the integrity of the Union at all hazards. At Lincoln's request he undertook a mission to the border states and to the northwest to rouse the spirit of unionism; he spoke in western Virginia, and in Ohio and Illinois. Partly as a result of his exertions on behalf of the Union, he died on June 3, 1861, at Chicago, where he had made his home since his election to the senate. He was buried on the shore of Lake Michigan.

In person Douglas was conspicuously small, being hardly five feet in height, but his large head and massive chest and shoulders gave him the popular sobriquet "The Little Giant." As a resourceful political leader, and an adroit, ready, skilful tactician in debate, he has had few equals in American history. His generosity in defeat, his courage and his capacity for inspiring warm personal friendships were among his most attractive qualities. It was regretted that his death came just when a new and great era of usefulness seemed opening before him.

BIBLIOGRAPHY.—The most sympathetic biographies are those by Allen Johnson (1908) and George Fort Milton (1934). Other biographies are by H. M. Flint (1860), J. W. Sheahan (1860), W. G. Brown (1902), W. Gardner (1905), C. E. Carr (1909), H. P. Willis (1910), Louis Howland (1920) and Gerald Capers (1959). *See* also an autobiographical sketch in the *Illinois State Historical Society Journal*, vol. v (Oct. 1912), and an appraisal by Allan Nevins in the *Illinois State Historical Society Journal*, vol. xlii (Dec. 1949). (Ro. W. J.)

DOUGLAS, a municipal borough (1895), seaport and capital of the Isle of Man since 1869, lies on a picturesque sandy bay on the eastern side of the island, 80 mi. N.W. of Liverpool and 90 mi. N.E. of Dublin. Pop. (1961) 18,837. Low hills encircle the town, penetrated by the valley of the combined Dhoo and Glass rivers, from which the town takes its name. The narrow, twisting streets of Old Douglas have nearly all vanished and the town has spread toward the west and north. Among notable buildings are the Tower of Refuge, built (1832) on the dangerous Conister or St. Mary's rock in Douglas bay by Sir William Hillary, founder of the Royal National Lifeboat institution, Castle Mona (1804), the legislative buildings (1894), the Manx National museum and Noble's hospital (1912). Popular attractions include theatres, dance halls, gardens, golf links, sports grounds and an athletics stadium. The Tourist Trophy motorcycle races and international cycle races are held in June and the Manx Grand Prix race in September.

Immediately below and to the north of Douglas head, at the mouth of the rivers, is the harbour, which can be entered by vessels drawing 15 ft. at spring tides, and 7 mi. S.W. of the town is a civil aerodrome. There is daily communication by sea with Liverpool and by air with London, Liverpool, Manchester and Blackpool, and there are services to other towns in the summer. An electric railway connects Douglas with Ramsey and with the summit of Snaefell (2,034 ft.), and a narrow-gauge steam railway

runs to Peel, Ramsey and Port Erin.

A small fishing village in the 16th century, Douglas grew rapidly in the 18th century as a result of the smuggling trade. By 1850 the town was becoming an increasingly popular watering place, this development being encouraged by the creation of the Isle of Man Steam Packet company. The town's primary occupation is the tourist industry, which caters for more than 500,000 visitors a year, but there are also light precision engineering works, knitting and carpet-weaving factories, breweries and mineral water works. (E. F. Ls.)

DOUGLAS, a civil parish in Lanarkshire, Scot. Pop. (1961) 3,422. It is on Douglas water, 9 mi. S.S.W. of Lanark by road, and it is the original home of the Douglas (*q.v.*) family. Of the old castle, Sir Walter Scott's *Castle Dangerous,* only a tower exists; the working of collieries nearby led to its demolition in 1938–48. The modern castle is the seat of the earl of Home. Only choir and spire remain of the 12th-century church of St. Bride, patron saint of the Douglases, which has old French stained glass. The vault beneath the choir was, until 1761, the burial place of the family, and it contains a silver case said to hold the ashes of the heart of the "good Sir James" (1286–1330). In 1879 the choir was restored and the tombs (including that of Sir James Douglas) repaired. On the hill of Auchensaugh, 2½ mi. S.E., the Cameronians assembled in 1712 to renew the Solemn League and Covenant. James, earl of Angus, raised the Cameronian (26th) regiment at Douglas in 1689, and there is a monument commemorating this event.

DOUGLAS FIR (*Pseudotsuga taxifolia* or *menziesii*), one of the most important timber trees in North America, is in the pine family (Pinaceae) and is also called red fir, yellow fir, Douglas spruce, Oregon, red and Puget Sound pine, and false hemlock. It resembles the firs and hemlocks, but is more closely related to the spruces It ranges from central British Columbia to Montana, southern California, western Texas and northern Mexico, with isolated stands in South Dakota. The species attains maximum development in western Washington and Oregon, where it grows in pure stands or mixed with other conifers. Trees in Washington, Oregon and California are commonly 6 ft. in diameter and 200 ft. tall, but rarely exceed half that size in the Rockies. Douglas fir has displaced southern yellow pine as first place producer of lumber in North America. It constitutes a high percentage of the standing saw timber in the United States, and its cut represents a good portion of the total annual lumber production of the country. The symmetrical young trees constitute a portion of the Christmas tree trade in the U.S.

JOHN MARKHAM

BRANCH OF DOUGLAS FIR (PSEUDOTSUGA MENZIESII) WITH CONES

Douglas fir cones are pendent, two to four inches long, and fall intact. A three-toothed bract subtends, and extends to one-half inch beyond, each cone-scale. The related big-cone spruce (*P. macrocarpa*) of southern California has cones to seven inches long, but is of little commercial value. Three other species occur in China, Japan and Taiwan. *See* also CONIFERS.

See W. A. Eliot, *Forest Trees of the Pacific Coast* (1938). (I. L. W.)

DOUGLAS-HOME, SIR ALEXANDER FREDERICK (1903–), British statesman, prime minister from Oct. 19, 1963, to Oct. 16, 1964, took office when he was the 14th earl of Home and a member of the house of lords. Since 1902 the British prime minister had always been a member of the house of commons, and to conform with this practice he disclaimed all his peerages—four Scottish, one U.K. and one English—on Oct. 23, 1963, under the Peerage act (1963) and thus became qualified to stand for election to the house of commons. He had been made a knight of the Thistle in Oct. 1962 and was therefore known as Sir Alec Douglas-Home. On Nov. 8, 1963, he was declared elected Unionist member of parliament for Kinross and West Perthshire and took his seat on Nov. 12. From Oct. 23 to Nov. 8, 1963, the prime minister had not been a member of either house.

Born on July 2, 1903, he was educated at Eton and at Christ Church, Oxford, and entered politics at the election of 1929. As Lord Dunglass, the courtesy title he held until he succeeded his father as earl of Home in July 1951, he twice served in the house of commons as a Unionist—for South Lanark (1931–45) and for Lanark (1950–51). From 1937 to 1939 he was parliamentary private secretary to Neville Chamberlain and thus identified himself with Chamberlain's appeasement policy. He became undersecretary for foreign affairs in Churchill's "caretaker" government of May–July 1945, and was minister of state for Scotland (1951–55). He was commonwealth relations secretary (1955–60) and also leader of the house of lords (1957–60). As foreign secretary (July 1960–Oct. 1963) he signed the test-ban treaty (Aug. 5, 1963) in Moscow as the U.K.'s representative.

His emergence as prime minister followed a period of crisis in the Conservative party. Harold Macmillan's announcement (Oct. 10, 1963) that he was not well enough to remain prime minister precipitated a fierce struggle for the succession, lasting until Oct. 18, when Macmillan resigned, advising the queen to invite Lord Home to form a government. Douglas-Home's year in office was overshadowed by the approaching election and by a growing economic crisis. In July 1964 he presided at the Commonwealth Prime Ministers' conference, managing to achieve some compromise between extremist views on racial issues. After the campaign, in which the Conservatives were narrowly defeated by Labour, Douglas-Home resigned. In 1965 he also resigned his leadership of the Conservative Party. (J. F. B.)

DOUGLASS, FREDERICK (original name, FREDERICK AUGUSTUS WASHINGTON BAILEY) (1817–1895), U.S. journalist, one of the most distinguished of American Negro orators, and anti-slavery leader, was born in Tuckahoe, Md., probably in Feb. 1817. His mother was a Negro slave of exceptional intelligence, and his father was a white man. At the age of eight he left his grandmother's care and spent a year on the plantation of Col. Edward Lloyd, of which his master, Capt. Aaron Anthony, was manager. He then was sent to Baltimore to the family of Hugh Auld where Mrs. Auld befriended him and secretly taught him to read; he soon learned to write free passes for runaway slaves. Upon Captain Anthony's death in 1833 he was returned to the plantation to serve Thomas Auld, Anthony's son-in-law. After being hired out for a year to Edward Covey, he was sent to William Freeland of St. Michael's, Md. Although treated kindly, he attempted an escape in 1836, and was subsequently returned to Hugh Auld, who apprenticed him as a ship caulker. He learned his trade and in Sept. 1838, masquerading as a sailor, escaped by rail to New York city. In the interests of safety, he soon moved to New Bedford, Mass., changed his name from Frederick Augustus Washington Bailey to Frederick Douglass, and for three years worked as a day labourer.

An extemporaneous speech before an antislavery meeting in Nantucket, Mass., in Aug. 1841 led to his appointment as an agent of the Massachusetts Anti-Slavery society, and for the next four years he delivered antislavery addresses in New England and the middle states. To quiet the suspicion that he was an imposter, he published the *Narrative of the Life of Frederick Douglass, an American Slave* in 1845. To avoid recapture he went abroad; his lectures in 1845–47 did much to enlist British sympathy for the abolitionist cause. In the interim a sum of £150 was raised by subscription to secure his legal manumission. From 1847 to 1860 he continued lecturing and conducted an antislavery weekly at Rochester, N.Y., known as *The North Star*, later *Frederick Douglass's Paper*. A follower of Garrison at first, he allied himself after 1851 with the more conservative Constitutional abolitionists led by James G. Birney. He disapproved of John Brown's attack upon Harpers Ferry in 1859, and declined to take any part in it. During the Civil War he was an early advocate of the use of Negro troops by the Union army. In 1871 President Grant appointed him assistant secretary of the Santo Domingo commission. Subsequently he was marshal of the District of Columbia (1877–81), recorder of deeds for the district (1881–86), and American minister

and consul general in Haiti (1889–1891).

Douglass was widely known for his eloquence, and was one of the most effective orators whom the Negro race has produced in America. He died in Anacostia Heights, D.C., on Feb. 20, 1895. His autobiography, *The Life and Times of Frederick Douglass,* appeared in 1882. For a portrait *see* NEGRO, AMERICAN.

DOUHET, GIULIO (1869–1930), Italian army officer and pioneer exponent of strategic air power, sometimes called "the Mahan of air power," was born at Caserta on May 30, 1869. Douhet was trained as an artillery officer but served from 1912 to 1915 as commander of Italy's first aviation unit, and then with an infantry division. For his severe criticism of the conduct of the war he was court-martialed, imprisoned and put on the retired list. The Italian defeat at Caporetto in 1917 tragically justified Douhet's criticisms. Recalled to active service as head of the aviation service, by 1921 he had attained the rank of major-general.

Douhet wrote a number of books, of which the most widely known, *Command of the Air,* was published in 1921. He contended that an enemy's war effort could be completely disorganized by strategic bombing. His theories implied creation of an independent air force, progressive diminution of other arms and unification of the armed forces. Douhet's advocacy of such ideas created controversy throughout the world. He died in Rome on Feb. 15, 1930, too early to see his theories put to the test in World War II. *See* STRATEGY: *Development of Strategy.*

See Louis A. Sigaud, *Douhet and Aerial Warfare* (1941). (D. CR.)

DOUMER, PAUL (1857–1932), French statesman and 13th president of the third republic, was born at Aurillac on March 22, 1857. In 1888 he entered the chamber of deputies, where he sat among the Radicals. As minister of finance in Léon Bourgeois' cabinet (1895–96) he vainly tried to introduce income tax. In Jan. 1897 he was appointed governor of Indochina, an office he filled with great distinction. In 1902 he returned to France, refused to support the ministry of Émile Combes and formed a Radical dissident group. He was elected president of the chamber in Jan. 1905 and unsuccessfully stood for the presidency of the republic in 1906. During World War I, in which four of his sons were killed, he played an important part in the senate committee on military affairs. He again was minister of finance in 1921–22 and 1925–26. In Jan. 1927 he was elected president of the senate. In May 1931 he was elected president of the republic, taking office on June 13. He was assassinated by a Russian fanatic, Pavel Gorgulov, on May 6, 1932. Doumer left the reputation of a strong patriot and of a man of high moral integrity. He wrote *L'Indochine française* (1903) and *Le Livre de mes fils* (1905).

See A. Dansette, *Histoire des présidents de la République* (1953). (J. C. DE C.)

DOUMERGUE, GASTON (1863–1937), French statesman, the 12th president of the third republic, was born at Aigues-Vives, Gard, on April 1, 1863. He studied law and, after holding minor judicial offices in Indochina and Algeria, was elected deputy for Nîmes in 1893. In the chamber he sat among the Radicals. Having been minister for the colonies under Émile Combes (1902–05), he became minister of commerce in Ferdinand Sarrien's cabinet (1906), retained this portfolio in Georges Clemenceau's government and was subsequently minister of education (1908–10). In 1910 he entered the senate.

On the fall of Louis Barthou's administration in Dec. 1913, Doumergue formed a cabinet, in which he took charge of foreign affairs, but after the general elections of May 1914, which resulted in a majority opposed to the three-year military service law, he had to resign. On the outbreak of World War I, however, he became minister for the colonies again in René Viviani's government of national defense, and he retained this portfolio in Aristide Briand's government (Oct. 1915–March 1917). In Jan. 1917 he was sent on a mission of inquiry about conditions in Russia. In Feb. 1923 he was raised to the presidency of the senate. As such he supported the Ruhr policy of Raymond Poincaré.

On June 13, 1924, Doumergue was elected president of the republic against Paul Painlevé, candidate of the *cartel des gauches.* He remained in office until 1931, when he retired to his country place. In Feb. 1934, under very difficult internal circumstances, he agreed to form a coalition government, but he failed to achieve the constitutional reform that he had planned and resigned in the following November.

Doumergue died at Aigues-Vives on June 18, 1937.

See P. Lafue, *Gaston Doumergue, sa vie et son destin* (1933). (J. C. DE C.)

DOURA-EUROPUS (DURA-EUROPUS), a ruined city of Syria, in the Syrian desert on the right bank of the Euphrates, about 50 mi. below the modern town of Dayr az Zawr. It was laid out on a rectangular plan on the rocky plateau now called Salihiye. Apart from a few brief references in classical literature, nothing was known of the city until it was excavated first under the direction of F. Cumont (1922–23) and later of M. Rostovtzev (1928–37). Even its location was unknown until the investigations that followed the accidental discovery of wall paintings there by a British officer in 1921.

Of the old Babylonian town of Doura on this site virtually no trace remains. It was rebuilt about 300 B.C. by the Seleucids and given the alternative name of Europus after the native city in Macedonia of its reputed founder, Seleucus Nicator. For two centuries it served as a military colony on the main road between Antioch and Seleucia on the Tigris. About 100 B.C. it fell to the Parthians, under whose control it throve as a caravan city on the trade route from the Persian gulf through Palmyra to the Mediterranean. Being a commercial city, it was usually regarded as neutral by the Romans on the nearby imperial boundary. In A.D. 165, however, it was annexed to the Roman empire, and used for nearly a century as a cantonment and frontier fortress. Shortly after A.D. 256 it was overrun and destroyed by the Sasanians. A century later Ammianus described it as a ruined site over which herds of deer were hunted.

By virtue of the richness and variety of its remains and the detailed picture they give of the everyday life of the place, Doura-Europus may be compared with Pompeii. Both cities were overwhelmed by a sudden catastrophe, and the dry sands at the one site like the volcanic ash at the other ensured the remarkable preservation of what was buried—even wood, leather and papyrus. The inscriptions, reliefs and architecture provide abundant evidence about the fusion of Greek and Semitic culture. The temple of Zeus Theos stood at the same time as those of Adonis and Atargatis; further, a synagogue and a church, both of the 3rd century, were found buried under the final, hastily constructed reinforcements of the city wall. These last two buildings, both of which contain extensive wall paintings, are of the highest importance for the study of Jewish and early Christian art and architecture. (WM. C. B.)

DOURO (Sp. DUERO; Port. DOURO; ancient DURIUS), the third longest river (478 mi.) of the Iberian peninsula, draining the largest catchment area (30,539 sq.mi.). The Douro rises in the Urbión mountains (7,310 ft.) in Spain and crosses the Numantian plateau in a pronounced curve. As far as Aranda it is narrowly confined by its banks; then it widens out across the broad monotonous Tertiary plains of Old Castile. Beyond Zamora the river narrows as it cuts through the hard slates and quartzites of the western Meseta. Along the international frontier it plunges about 1,250 ft. within 30 mi. in a series of gorges and rapids. The remaining 124 mi., from the Portuguese frontier at Barca d'Alva to the sea, are navigated by small boats. Although a series of rapids above Ferradosa were blasted away in 1820 to permit navigation, this section is used only by very small craft. Between Pêso da Régua and Oporto there is a considerable barge trade (the *barco rabelo)* taking the wine from the vineyards of the port wine district to Vila Nova de Gaia; from Pedorido to Oporto there is also some coal traffic. The mouth of the river is partially blocked by a sand bar, which explains the growth of the artificial port of Leixões to the north of the estuary. Navigation on the Portuguese stretch is complicated by rocks, shifting channel beds and winter floods during which the river may rise suddenly 10 or 20 ft. above its normal level.

After 1930 the Spanish basin was developed for irrigation and hydroelectric power. By the mid-1950s, 14 new dams had been built capable of storing 1,978,500,000 cu.m., producing 597,000,000

kw.hr. and irrigating 97,000 ac. The largest dam is the Ricobayo on the Esla. The major tributaries, the Esla and Pisuerga, come from the northern zone of higher rainfall; the southern tributaries such as the Adaja and Tormes, coming from the drier Cordillera Central, are less important. Whereas irrigation is the most important asset of the Spanish section, in Portugal the Douro has very high hydroelectric-power potentials which in the 1960s were being developed to a limited extent. (J. M. Ho.)

DOURO LITORAL, a province of northern Portugal, coincides roughly with the administrative district of Oporto. Pop. (1950) 1,237,170. Area 1,209 sq.mi. It comprises a narrow coastal plain 1–2 mi. wide, stretching about 20 mi. from the Ave valley to south of the Douro river. Inland it rises to a low undulating plateau with a complex series of erosion surfaces carved out of the granitic rocks. Silurian slates outcrop in a northwesterly-southeasterly belt from near Arouca to the Vallongo hills (1,000–1,250 ft.), forming a more sparsely populated and forested tract. Farther inland the northwest-southeast valleys, notably the Tâmega, break up the higher granitic massifs, some of them fractured as horsts, others with dissected erosional forms. These high plateaus culminate in the eastern mountains of Montemuro (4,534 ft.), south of the Douro, and Marão (4,642 ft.) on the borders of Tras-os-Montes e Alto Douro. The Douro and its tributary the Tâmega are the chief rivers.

The mild and moist climate with a mean annual rainfall of about 40–60 in., together with the generally fertile gray podsol soils over the deeply weathered granites, have encouraged an intensive use of land. Mixed farming with a rapid succession of winter and summer cereals, vegetables and tree crops permits large peasant families to live on holdings of even less than one acre, fragmented into tiny parcels.

Population densities average 400 per square mile, although around Oporto they rise to 1,000 or more in street villages strung along the roads and even more thickly dispersed among the fields. Timber and its associated resin industry is, with the production of *vinho verde* (an acid, green wine), often the only source of a cash income for the peasants in the remoter valleys.

Oporto (*q.v.*; pop. [1960] 303,424), the second city of Portugal, dominates commercially the whole of the north and as far south as the Mondego valley. Situated on a series of granitic hills on the lower north bank of the Douro, it originated, like most of the old nucleated settlements of the region, on an Iron Age *castro*. "Portucale," from which Portugal was later derived, was first used in the district. A cathedral and university town, Oporto grew rapidly in the 19th century with new industries, chiefly textile mills.

Although Oporto is the commercial capital of the famous port wine trade, the bonded warehouses are actually situated on the south bank at Vila Nova de Gaia (pop. 45,739). A sand bar at the mouth of the Douro restricts navigation to smaller craft, so that Oporto's port of Leixões (erected 1890 and further developed in 1916) handles the bulk of the coastal traffic. Adjoining it is Matozinhos (33,370), one of the chief sardine-packing centres of the country. Foz do Douro is a coastal suburb of the city and Espinho farther south is a seaside resort. (J. M. Ho.)

DOVE, ARTHUR GARFIELD (1880–1946), U.S. painter, one of the earliest nonobjective artists, was born at Canandaigua, N.Y., on Aug. 2, 1880. He began his career as a magazine illustrator, but after meeting Alfred Stieglitz he gave up conventional painting and turned to abstract art. In 1910 he had his first exhibition with Stieglitz in New York. His art employed soft masses of an organic character, muted in colour, similar to the amorphous shapes of Kandinsky. Despite their nonobjective character, his paintings often suggest the cursive qualities of landscape and the forms of nature. In explanation of his art, Dove said that he would like to take wind and water and sand and work with them, but, failing that, he used colour and force lines and substance, as music uses sound. Dove also created many fine collages, incorporating fragments of commonplace subjects in a symbolic expression combining homely sentiment with touches of irony. He died in Huntingdon, N.Y., on Nov. 23, 1946.

See F. S. Wight, *Arthur G. Dove* (1958). (S. Hu.)

DOVE: *see* PIGEON.

DOVEKIE (DOVEKEY), the common name in North America for the little auk (*Plautus alle*), 8 in. long, breeding on rocky coasts and islands of the North Atlantic. (*See* AUK.) The name also is applied by sailors to the black guillemot. *See* GUILLEMOT.

DOVER, a seaport, municipal and parliamentary borough of Kent, Eng., and one of the Cinque Ports (*q.v.*), is 72 mi. E.S.E. of London by road. It is situated on the Straits of Dover, the neck of water 18 to 25 mi. wide between England and France. Pop. (1961) 35,248.

The only one of the Cinque Ports which is still a great port, Dover is the nearest English port to the European continent. The town lies in a valley of a dissected chalk upland whose main axis is from northwest to southeast, breaching the high chalk cliffs that fringe the coast on either side. Through the valley runs the river Dour. The pronounced physical relief of the district has imposed on Dover the pattern of its development. In the 4th century it was guarded by a fort sited near the harbour and forming part of the defenses of the Saxon shore (Litus Saxonicum). The dominant building is the castle on the eastern height, 375 ft. above sea level. Within its precincts are a Roman pharos or lighthouse, the ancient fortress church (St. Mary in Castro), some remains of the Saxon stronghold and the massive keep and subsidiary defenses (such as the Constable's, Avranche's and other towers) of the Norman building. The constableship is held jointly with the lord wardenship of the Cinque Ports.

Remains were discovered in 1854 of a round church of the Templars (Holy Sepulchre), 32 ft. in diameter, which was restored. The remains of the foundation of St. Martin's priory, of the 12th century, include the great gate, the house refectory with campanile and the spacious strangers' refectory. These are all incorporated in Dover college, a boys' public school which was instituted in 1871. In High street may be seen the noble hall and truncated fabric of the Maison Dieu, founded by Hubert de Burgh in the 13th century for the reception of pilgrims of all nations. From the time of Henry VIII until 1830 it was used as a crown victualing office, but was subsequently purchased by the corporation and adapted as part of a town hall, a new part being added and opened in 1883. In 1949 a small portion of the latter was converted into a museum to replace the war-damaged former premises in Market square. Next to the Maison Dieu stands Maison Dieu house, which was built in 1665 as the residence of the agent victualer to the king's navy. It was bought by the corporation in 1904 and used as offices until 1949, when it was evacuated in order that it might be restored and adapted for use as a public library, the original premises of which had been destroyed during World War II. It was opened for this purpose in 1952.

The popularity of sea bathing in the 19th century developed Dover as a seaside resort. At the end of the century some labour was also supplied for the exploitation of the Kent coal field. Since World War II new housing estates have been provided and the sea-front area has been redeveloped, an imposing feature being The Gateway, a large block of municipal flats.

Dover claims to be a Saxon borough "by prescription" in that the burgesses acted in a corporate capacity without any formal charter of incorporation. Its privileges of independent jurisdiction and free courts were granted in return for ship service rendered to the king by the burgesses at this important point on the neck of the narrow seas. These privileges are set forth on the first page of the Kentish section of Domesday Book: "The burgesses gave to the king twenty ships once a year for fifteen days and in each ship were twenty men. This they did in return for his having endowed them with sac and soc." (*See* J. B. Jones, *Annals of Dover*, 2nd ed. [1938].)

Dover is a bishopric suffragan in the diocese of Canterbury and also a garrison town. (B. A. C.)

The Port.—Dover is the premier passenger port in Great Britain and the principal cross-channel port operating regular passenger-accompanied car and cargo services to and from Boulogne, Calais, Dunkerque and Ostend. General foreign and coastal trade is also handled at the port. The port authority is the Dover Harbour board, an autonomous public trust constituted in 1861

as successors to the warden and assistants of Dover harbour, a body created under a charter granted by James I in 1606. The area of the harbour is approximately 850 ac., including a water area of 650 ac.

The outer harbour was completed in 1909 and in 1923 was transferred by the government to the Dover Harbour board. It is bounded by the eastern arm, the southern breakwater and the Prince of Wales pier. The eastern arm is 2,800 ft. in length and provides berths with 27 ft. depth of water at low water, ordinary spring tides (L.W.O.S.T.). The southern breakwater is a protective mole 4,270 ft. in length. The Prince of Wales pier is 3,000 ft. in length, with about 1,600 ft. of berthing accommodation for vessels up to 25-ft. draft at L.W.O.S.T. There are two entrances to the outer harbour—the eastern, 670 ft. in width, and the western, 740 ft. in width.

The western docks comprise the Admiralty pier, the train ferry dock, tidal basin, Granville and Wellington docks. The Admiralty pier, originally constructed in 1871, was extended in 1897–1900 and widened at the shoreward end in 1909–13. This pier, 4,140 ft. in length, provides berths with up to 26 ft. depth of water at L.W.O.S.T. Immediately adjacent to the pier are the Dover marine passenger and freight train ferry services between Dover and the continent. The tidal basin forms the entrance to the Granville and Wellington docks. The Wellington dock consists of eight acres of water. The Granville dock has a water area of 4½ ac., with depths of 23 ft. at spring tides and 17 ft. at neap tides. Both docks have modern cargo-handling equipment and transit accommodation.

The eastern docks comprise the Camber and the land area between the cliffs and the sea-retaining wall, running from the entrance to the shoreward end of the eastern arm. The Camber, a tidal basin, has an area of 25½ ac. affording berthing accommodation up to 21 ft. at L.W.O.S.T. The land area of these docks, about 21 ac., is devoted to industrial purposes. At the Camber, the Dover harbour board's car ferry terminal, completed in 1953, enables the motorist to drive straight on or off the cross-channel vessels operating regular services to the continent. Bunkering facilities are available. Within the harbour area there is an industrial dockside estate. (J. W. Sn.)

Besides the mail service and harbour trade, Dover has a trade in ship supplying together with timber importing. Industries include metal foundries, cardboard-box, fountain-pen, mineral-water, paper, toy and tar-macadam manufacturing, as well as several flour mills. In 1949 a program was approved by the South Eastern gas board making the Dover gasworks the central manufacturing station for a considerable portion of east Kent.

History.—Before the Roman invasion a permanent settlement existed on the site of Dover. Caesar regarded it as sufficiently important to make it his first point of attack in Aug. 55 B.C. Although the landing was successful the expedition as such failed. He returned in May 54 B.C. and, by effecting a landing farther to the east between Deal and Sandwich, began the period, which lasted nearly 100 years, during which Britain was in a tributary state to Rome. Among relics of Roman occupation are the pharos and *bredenstone* and, until the 18th century, a Roman bath. Watling street started from the town. Dover (Dubris) was one of the ports for continental traffic in Roman times. By the time of William I it had considerably increased in size and importance, ranking among the principal towns of England. It became the main link between the English and continental possessions of the Conqueror and during his reign was defended with a wall, gates and towers.

An important naval victory was won off Dover by the ships of the Cinque Ports against the French in 1217.

Dover harbour provided the headquarters of the Dover patrol during World War I. The functions of the patrol were, primarily, to keep the narrows of the English channel open to traffic and also to hunt submarines. At the beginning of the war the Dover patrol force operated with the army in checking the German advance through Belgium by their gunfire, and vessels at Dover were also called on to undertake bombardments of the dockyard at Ostend and the submarine base at Zeebrugge. Blocking operations were carried out during 1918 when Zeebrugge was attacked, but a similar attempt on Ostend failed. The air service at Dunkerque was also one of the arms of the patrol and was invaluable both on the coast and in assisting the army. Without the breakwater and harbour facilities at Dover, the protection of the straits would have been impossible and the evacuation of the wounded most difficult.

During World War II Dover suffered from constant hit-and-run air raiding, but most of the damage sustained was the result of enemy shelling from Cape Gris Nez. A great deal of reconstruction has taken place since the war.

See also references under "Dover" in the Index volume.

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DOVER, a town in Delaware, U.S., is on St. Jones creek (also known as Dover river), in the geographical centre of the state. It is the seat of Kent county and has been the capital of the state since 1777. It had its origin in an order of William Penn (1683) to lay out "the town of Dover, in the county of Kent" and erect a courthouse and jail for the county. The town was laid out in 1717 around an open square (the green) bisected by the King's road running north and south through the town. This is now State street, lined with pleasantly shaded 19th-century residences. The old state house on the green was erected in 1792 to accommodate the legislature and state as well as county offices. The green was the centre of the political and public life of the county and (from 1777) of the state until 1933, when a new group of red brick Georgian colonial buildings was started to the east to house the legislature, the archives and other departments of the state government.

Dover is the trade centre for the surrounding agricultural area of Kent county. Its industries are almost all small or local, an exception being a company established in 1855 which was a pioneer in the canning industry and whose specialities, boned chicken and plum pudding, became nationally known. In 1929 Dover adopted a modified form of council-manager government. It operates its own electric generating plant. Wesley junior college on State street was founded in 1874 as the Wilmington Conference academy (Methodist). The hall of records, repository of official state records and other historical material, has on display William Penn's title deeds to Delaware, granted to him by James, duke of York, in 1682. The Delaware state museum on Governor's avenue, opened in 1950, occupies the old Presbyterian church, erected in 1790. Early in World War II a military air base was established east of the town and hundreds of pilots were trained there during the war. Inactivated in 1946, the base was taken over by the Military Air Transport service in 1952 and became an air cargo terminal. For comparative population figures *see* table in Delaware: *Population.* (H. C. Re.)

DOVER, a city of southeastern New Hampshire, U.S., the seat of Strafford county, is located 10 mi. N.W. of Portsmouth. The Cocheco river, with a 33-ft. fall providing abundant water power, passes through the town and empties into the nearby Piscataqua river. The original settlement, once called Bristol, was established in 1623 by Edward and William Hilton and Thomas Roberts at Dover point, 5 mi. S.E. of the present city. A second settlement was made by Thomas Wiggin at Dover neck in 1633. Life originally centred around the point and its shipbuilding interests, but during the 18th and 19th centuries, as manufacturing grew, the city developed about its present site. Modern industries include textiles, shoes, printing, chemicals, plastics, electronic products, lumber and cement blocks. The town existed as an independent entity for a brief period before 1642 when it voluntarily submitted to the jurisdiction of Massachusetts. During the 50-year period following 1675 the settlement was jeopardized by Indian attacks, the worst of which came on June 28, 1689. Dover was chartered as a city in 1855. The University of New Hampshire is located at Durham, 5 mi. S.W. For comparative population figures *see* table in New Hampshire: *Population.* (R. C. Gl.)

DOVER, TREATY OF. There were two Anglo-French

treaties of Dover in 1670, and they were concerned with two different projects: the one, which was secret, with the conversion of England to the Roman Catholic faith, which was favoured by Charles II; and the other, which was formal, with an Anglo-French military and naval alliance designed to subjugate the United Provinces of the Netherlands, which was desired by Louis XIV. The secret treaty, in the negotiation of which Charles's sister Henrietta Anna, duchesse d'Orléans (*q.v.*), was deeply involved, was concluded on June 1 (new style; May 22, old style). By it, Charles II was to receive £200,000 in money and the support of 6,000 French troops, if needed, so that he might declare himself a Roman Catholic, and a further £300,000 a year to enable him to join a war against the Dutch. Among other clauses it was stipulated that England would support any claims that Louis might get to the Spanish succession. To allay suspicion, the formal treaty was concluded through the ordinary diplomatic channels on Dec. 31 (N.S.; Dec. 21, O.S.), omitting all mention of religion. The conversion clause never came into effect, for Louis XIV was really interested only in war, and Charles II's ambition was not so much the restoration of the Catholic religion as the establishment of monarchical power which he thought it would secure and which he came to promote instead by a policy of religious toleration. *See* CHARLES II; DUTCH WARS. (I. F. B.)

DOVE RIVER, England, is for most of its 40-mi. course the boundary between Derbyshire and Staffordshire. It rises about 1,800 ft. above sea level in the rugged gritstone moorlands around Axe Edge near Buxton. It flows southward through hilly pastoral country with drier limestone hills on the east or Derbyshire side. South of Hartington these form a scarp through which the river cuts a picturesque gorge. The valley has several local names. Beresford dale, by Hartington, is associated with Izaac Walton and Charles Cotton, whose fishing house stands near Pike pool. Dovedale, the five-mile stretch above the confluence with the Manifold near Ilam, is an especially fine wooded limestone gorge with caves and swallow holes, and is mostly National trust property. South of Ilam the country opens out into the midland plain, there floored by Triassic marls and smeared with glacial deposits. At Rocester it is joined by another right-bank tributary, the Churnet, and from there flows east through wide alluvial meadowlands to its junction with the Trent 150 ft. above sea level at Newton Solney near Derby. (JN. P.)

DOW, CHARLES HENRY (1851–1902), U.S. newspaperman and stockbroker who became the founder and first editor of the *Wall Street Journal*. He is best remembered for the Dow-Jones stock averages (*see* PRICES, STATISTICS OF: *United States*) and for the Dow theory of investments, a complex system for analyzing the stock market which other writers developed after his death from the "folksy" and common sense columns and editorials he wrote.

Little is known of Dow's early life. He was born on a Connecticut farm on Nov. 6, 1851; his father died when young Charles was six years old; he was mainly self-educated. At the age of 20 or 21 he became a reporter on the *Springfield* (Mass.) *Republican;* a few years later he worked on the *Providence* (R.I.) *Journal*. A trip to Colorado in 1879 to write about the silver boom led to Dow's meeting a group of New York financiers who encouraged him to move to New York. This he did in 1880, working first on a newspaper and later for a news service specializing in financial news. In 1882 he and Edward D. Jones formed their own company; they collected news during market hours and Charles M. Bergstresser, later a partner, wrote the bulletins which were distributed by messenger boys in the financial district. The *Wall Street Journal* was founded in 1889.

Dow was a general partner in the brokerage firm of Goodbody, Glyn and Dow from 1885 to 1891, and was a member of the New York Stock exchange. He died in Brooklyn, N.Y., on Dec. 6, 1902. (K. L. T.)

DOW, HERBERT HENRY (1866–1930), U.S. chemist, was a pioneer in the chemical manufacturing industry. Born on Feb. 26, 1866, in Belleville, Ont., in Canada, where his family had moved from New England, he grew up in the U.S., his family having returned there soon after his birth. He received his B.S. degree from the Case School of Applied Science in 1888.

From the time he wrote his thesis on Ohio brines, Dow concentrated on deriving the maximum value from brines. In preparing to present his thesis to a scientific society, he studied brines in Michigan, Ohio, Pennsylvania and West Virginia, and discovered that the brines of Canton, O., and Midland, Mich., were heavy in bromine. While professor of chemistry and toxicology at the Homeopathic Hospital college, Cleveland (1888–89), he patented a method for extracting bromine from brine, and in 1889 organized a company to use the method at Canton. Improvement in methods followed the failure of this company, and the Midland Chemical company was formed in 1890. His processes allowed the removal of bromine from the brine by electrolysis without evaporation. The company was the first to make successful use of the newly devised direct-current generator in the chemical industry. A chlorine extracting company, formed in 1895 at Navarre, O., was moved to Midland in 1896 and absorbed in the Dow Chemical company, founded in 1897; in 1900 he bought the Midland Chemical company.

Dow moved from one field to another in his concentration on brine, making insecticides and pharmaceuticals. Studies of alloys of magnesium produced Dowmetal. His process for producing magnesium sulfate (Epsom salts) introduced the automatic handling of ocean brines. Dow produced the first synthetic indigo in the U.S. and was the first important producer of iodine, initially from Louisiana brine and later from California petroleum brine. Dow eventually was granted more than 100 patents as his company became one of the important chemical manufacturers. He died at Rochester, Minn., on Oct. 15, 1930.

DOWDEN, EDWARD (1843–1913), Irish critic, biographer and poet, outstanding for his work on Shakespeare, was born on May 3, 1843, at Cork. Educated at Queen's college, Cork, and Trinity college, Dublin, he became professor of English literature at the latter in 1867, and lectured at Oxford (1890–93) and Cambridge (1893–96). His *Shakespere: His Mind and Art* (1875) was the first book in English to attempt a unified and rounded picture of the whole work of Shakespeare. As in the interpretations of the German critics Hermann Ulrici and Georg Gervinus, to whom Dowden acknowledges a debt, Shakespeare is studied in terms of successive periods. The works are seen as an expression of a single character and temperament subject to a dominant law in the writer's mind. Dowden's interests are therefore psychological and ethical, but like many of his contemporaries he sentimentalized the poet, particularly the Shakespeare of the final romances. Primers, introductions to Shakespeare and works on the poems followed; and he edited some of the first Arden texts: *Hamlet* (1899), *Romeo and Juliet* (1900) and *Cymbeline* (1903). Dowden is also of interest for his *Poems* (1876), his *Studies in Literature* (1878) and other biographies, especially his *Life of Shelley* (1886). He edited Shelley's works in 1900. He was among the first to appreciate the U.S. poet Walt Whitman. He died in Dublin on April 4, 1913. (G. A. O.)

DOWDING, HUGH CASWALL TREMENHEERE DOWDING, 1ST BARON (1882–), British air marshal who directed the fighter command in the battle of Britain (1940), was born at Moffat, Dumfries, on April 24, 1882. He was educated at Winchester and at the Royal Military academy. During World War I he commanded squadrons in France and was made companion of the order of Bath and companion of the order of St. Michael and St. George.

In 1919 Dowding was appointed to a permanent commission in the Royal Air Force as a group captain. He first commanded various groups at home, and between 1922 and 1926 served as chief staff officer of inland area and of the Iraq command. During 1926–29 he was director of training at the air ministry, then air officer commanding in Transjordan and Palestine. He commanded fighting area in the air defense of Great Britain (1929–30) before he was appointed member of the Air Council, Research and Development (1930–36). During this period many new types of aircraft were evolved or introduced.

Dowding then held the important post of air officer commanding in chief, fighter command; he was still in command at the begin-

ning of World War II and during the battle of Britain. It can safely be said that it was largely due to his great skill and resolution as a commander, strategist and tactician that this outstanding victory against great odds was won. He then went to the U.S. on a mission for two years, retiring from the R.A.F. in 1942. A barony was conferred on him in 1943. (E. B. Bn.)

DOWER, at common law, was the life interest of a widow in one-third of the legal estates in real property owned by her husband at any time during the marriage. Originally there were varieties such as dower *ad ostium ecclesiae* ("at the church door") and dower *ex assensu patris* (by the heir with his father's consent), where immediately before the marriage the wife was endowed of specified lands; and sometimes land held in knight service was exonerated from dower by the widow's taking dower *de la pluis beale* ("of the most fair") of her husband's socage land. But by the 16th century these forms were of little importance compared with dower at common law, or subject to local customs under which dower might extend to a quarter, a half or even the whole of the land. Except where the wife had been endowed of specific lands, she was entitled to have her land assigned "by metes and bounds" by the heir within her quarantine; *i.e.*, the 40 days during which Magna Carta (1215) permitted her to remain in her husband's house after his death. The right to dower might be barred by the wife before marriage accepting a jointure (a life estate in specified lands) in lieu of dower, or by the complicated uses to bar dower invented in the 18th century. By the Dower act, 1833, dower in Great Britain was restricted to realty still owned by the husband at his death and not devised by his will; and it could also be barred by a declaration in his will or by deed. Dower thus ceased to be a nuisance to conveyancers. As a small measure of compensation to widows, the act extended dower to equitable interests. The Administration of Estates act, 1925, abolished dower.

Dower at common law continues in a number of common-law jurisdictions, often in a modified form. The modern tendency, however, is either to abolish it or to replace it by other less arbitrary means of providing for widows. (R. E. My.)

United States.—In the United States, in such states as did not enact statutes to the contrary, dower continues as at common law. Some statutes are in effect which declare the principles of the common law. In most states, however, the common-law doctrines of dower were greatly modified by statute. In some states dower either was abolished or a different right or interest was substituted. Even where it has been abolished, the term is often popularly used. Where dower is abolished, the interest substituted may be in one of several forms, perhaps a certain portion of the husband's property, or of the community property of both or of a life estate in a portion of his realty. *See* also Husband and Wife; Marriage, Law of.

DOWIE, JOHN ALEXANDER (1847–1907), U.S. evangelist and faith healer, founder of the Christian Catholic Church, was born in Edinburgh, Scot., May 25, 1847, but moved with his family to Australia as a boy. He returned to study theology in Edinburgh before entering the Congregational ministry in Australia in 1872. A remarkable healing experience led to his developing a deep interest in spiritual healing and eventually to his founding the International Divine Healing association; indeed, healing characterized his entire subsequent ministry. In 1888 he went to the United States, settling eventually in Chicago, where he had notable success as evangelist and healer, opened various "Divine Healing Homes" and began the publication of *Leaves of Healing*. Finally, in 1896, he founded the Christian Catholic Church, which, save for its healing emphasis and practice of triune baptism, differed little from the more millennial-minded orthodox Protestant churches. In 1901 he established Zion City, about half-way between Chicago and Milwaukee, Wis., on the shore of Lake Michigan, with about 5,000 of his followers, and there introduced various industries and ruled the community as a theocracy. In the same year he proclaimed himself as Elijah the Restorer, and later as First Apostle of the church. But unwise expenditures put a heavy strain on the finances of the movement, and Dowie's health began to fail. He appointed Wilbur Voliva as temporary head; later Dowie was removed and Voliva elected overseer. Dowie died on March 9, 1907.

The Christian Catholic Church survived the debacle, and most of the church properties were saved, but control of the community and its industries was lost. The annual Passion Play is the church's most outstanding activity, though work is actively carried on in other cities of the U.S. and in a dozen countries around the world. (C. S. B.)

DOWLAND, JOHN (1563–1626), English composer and lute virtuoso, enjoyed a great reputation in Europe in his own lifetime. Nothing is known of his early life or training and there is little evidence to substantiate the theory that he was born in Ireland. From 1580 to 1584 he was in Paris in the service of two successive English ambassadors there and, according to his own account, it was at this time that he first came under the influence of various exiled Catholics. Soon after, he returned to England and married, and in 1588 received the degree of bachelor of music at Oxford. Disappointed in his hopes of obtaining a place among Queen Elizabeth I's musicians (he attributed this to his religious beliefs, which seems strange when one considers that William Byrd and other Catholics were high in royal favour), he set out in 1594 on a long European journey that took him through Germany to Venice and Florence. He appears to have met with great success at all the courts he visited and to have made the acquaintance of several distinguished musicians. Though he did not reach Rome, where he had intended to study with Luca Marenzio, he claimed to have been offered a "large pension of the Pope" but to have become alarmed at finding himself among enemies of his country. Whether or not this was true (he may merely have been concerned to forestall any reports of the treasonable company he had been keeping), he returned to England for a short period. In 1598 he was appointed lutenist to Christian IV of Denmark at a salary rivaling those of the highest officers of state. In spite of this and additional munificent gifts, Dowland managed to get into financial difficulties and also overstayed his leaves of absence in England. In 1606 he was finally dismissed from the Danish service and settled in London where, in 1612, he was appointed one of King James's "musicians for the lutes"—a post he retained until his death.

Although Dowland's contemporary reputation rested very largely on his powers as an executant (the poet Barnfield wrote of "Dowland . . . whose heav'nly touch upon the lute doth ravish human sense"), his compositions have secured him his place in musical history. Of these, his songs with lute accompaniment have hitherto attracted most attention; 85 are contained in his four "books of ayres" (1597, 1600, 1603 and 1612) and three more in *A Musicall Banquet* (1610), compiled by his son Robert. They confirm Dowland as the greatest, as well as the earliest, of the English school that produced such a wealth of lute songs in the first quarter of the 17th century. Others were to rival him in the brisk, light vein, but no one equaled the intensity of his more serious songs, which reflect a deep personal melancholy. His *Lachrimae* (1605) bear witness to the same temperament, being a collection of "seaven passionate pavans" for five viols and lute. The first of these (*Lachrimae Antiquae*) is a reworking of a pavan that had also appeared as *Flow my tears* in the second book of ayres; the remaining six are thematically related to it, and the collection also contains 14 further dances. Of Dowland's solo lute music between 70 and 80 pieces have been preserved in English and continental sources—an output as remarkable for quality as for quantity.

See P. Warlock, *The English Ayre* (1926); complete songs in *The English School of Lutenist Song Writers,* ed. by E. H. Fellowes (1920–32). (J. J. N.)

DOWLAS, a plain cloth, similar to sheeting but usually coarser. In the 16th and 17th centuries dowlas was a linen fabric, made in England, Scotland and France, and used for rough towels, workmen's shirts and the like. It now refers to a coarse cotton fabric with a glazed finish, made in imitation of linen dowlas and used for some household and apparel purposes. It has largely been replaced by calico (*q.v.*).

DOWN, a maritime county of Northern Ireland, occupying

the most easterly part of the island, is bounded on the north by Belfast lough, east by the Irish sea, south by Carlingford lough, west by County Armagh and northwest by County Antrim. Its area is 952 sq.mi.

Physical Features.—The county is generally undulating with three areas of high ground: the Mourne mountains (Slieve Donard, 2,796 ft.) in the south; the Ballynahinch mountains (Slieve Croob, 1,755 ft.) in the centre; and the lower Castlereagh and Holywood hills in the north. To the northwest of Slieve Croob lies the valley of the Lagan, which rises in these mountains. To the west the land falls to the Newry basin and the river Bann, and eastward it slopes gently down to the low-lying Ards peninsula, which encloses Strangford lough, a large tidal inlet noted for the number of its islands, its beauty and its bird life. Besides Strangford and Carlingford loughs and other glacial effects, the last great Ice Age left a belt of low whale-backed hills known as drumlins, extending westward from central Down; these give variety and richness to the landscape.

The foundation of the county is Silurian rock throughout, with much slate and sandstone; it is a continuation of the southern uplands of Scotland. The Caledonian granite which appears in southern Armagh continues northeastward to Slieve Croob, furnishing excellent building stone. South of it, the Eocene granite of the Mourne mountains forms a group of rocky summits divided by valleys, of which the Silent valley is one of the main sources of Belfast's water supply. Basalt dikes abound in the lower parts of the county. At the head of Strangford lough basalt has protected Triassic sandstone, and basalt, protecting chalk and Triassic formations, also extends through the northwestern part of Down.

The climate is temperate, equable, humid and rather cloudy with plentiful, though often localized, rainfall varying from 65 in. in the Mournes to less than 35 in. a year in the east and north. Although the soil on the southern slopes of the hills in the north is very fertile, producing two or even three crops a year, the predominating soil is a shallow loam mixed, particularly in hill areas, with stones, which are used for the characteristic field boundary walls. Clay is mostly confined to the east coast and the northern parts of Castlereagh rural district, and sandy soil is found mainly around Dundrum bay. Moorlands are confined to the lower mountain slopes.

History.—Down contains many relics of ancient man, particularly megalithic monuments. In the Giant's Ring, south of Belfast, a cromlech stands enclosed by a broad rampart 12 ft. high and more than 600 ft. in diameter, and near Newcastle there is a well-preserved souterrain. There are also early Christian remains, for it was at Saul near Downpatrick that St. Patrick began his mission in Ireland in 432, and at Bangor a great monastic school flourished from the 6th century. The saint's drinking well and bath houses are preserved at Struell in the vicinity of Downpatrick, and a boulder marks his reputed grave in the grounds of Downpatrick cathedral (*see* DOWNPATRICK). Dromore (*q.v.*) is the ancient ecclesiastical capital of Down. In the late 12th century Down was invaded by John de Courci, who made a considerable area subject to his control; the mounds which formed the bases for his forts can still be seen in many places. Numerous castles fringe the eastern part of Down, the best examples being the ruined Norman castle of Dundrum and Jordan's castle in the village of Ardglass, built in the late 14th century and virtually intact. Although English influence shrank in the later middle ages, it never lost its hold upon the peninsula of Lecale between Dundrum and Downpatrick. In later Tudor times parts of Down were colonized by English and Scottish adventurers; and, though the county did not form part of the scheme for the plantation of Ulster in the reign of James I, there was a big influx of colonial population at this time.

Population and Administration.—County Down had a population of 267,013 in 1961. Downpatrick (4,219) is the county town, but Bangor (23,865) is the largest town and one of the two municipal boroughs, the other being Newtownards (13,090). The city of Belfast overflows its boundaries into the northwestern part of the county. At Hillsborough is the official residence of the governor of Northern Ireland, and the parliament house is also within the county at Stormont. County Down returns eight members to the parliament of Northern Ireland and two to the United Kingdom parliament.

Agriculture and Industry.—Down is a predominantly agricultural county, the chief crops being oats, flax, potatoes and seed hay, with some vegetables for the Belfast market. Beef and dairy cattle, sheep and pigs are raised and there is extensive dairy and poultry farming. A large quantity of white fish is landed at Portavogie, Kilkeel and Annalong, and a considerable herring fleet operates from Ardglass.

By 1962 the forestry division of the ministry of agriculture had acquired 9,171 ac. of which about 7,000 ac. have been planted with trees. Because of the climate, these afforestation schemes were expected to reach maturity in 20% less time than in most parts of Great Britain. Tollymore park (*c.* 1,200 ac.), at the foot of the Mourne mountains, became the first forest park in Northern Ireland in 1955. Near Annalong and in other parts Mournes granite is extensively quarried.

There is industrial activity in many towns. In Newry there are spinning and weaving of both linen and cotton, the manufacture of waterproofs and other clothing, and the processing of food products such as dehydrated potatoes. At Banbridge there are spinning, weaving, bleaching and finishing of linen and the manufacture of footwear. Newtownards, much industrialized, carries on rayon weaving, fabric printing, and the manufacture of hosiery, aircraft components, draftsman's instruments and sheet metal work. Card and fibre boxes are made at Warrenpoint, electrical goods at Newcastle (*q.v.*), and leather is tanned at Killyleagh. At Castlereagh, which is within easy reach of Belfast, there is a modern industrial estate whose products include computers, industrial driers and welding equipment.

There is an active tourist industry in the county, particularly at coastal towns such as Bangor, Donaghadee, Newcastle, Kilkeel and Warrenpoint, and at the seaside resorts of the Ards peninsula. The only railways are from Belfast to Bangor and from Newry to Warrenpoint. There are about 1,150 mi. of trunk and classified roads in the county.

See A. Knox, *A History of County Down* (1875); J. Stevenson, *Two Centuries of Life in Down, 1600–1800* (1920). (HU. S.; J. H. HA.)

DOWNERS GROVE, a residential city in Du Page county, Ill., U.S., 21 mi. S.W. of Chicago. Pierce Downer settled there in 1832 and soon thereafter a tavern was erected at the site, in a hardwood grove surrounded by prairies, to facilitate stagecoach traffic along the modern U.S. highway 34 route. With the construction of the nearby Illinois-Michigan canal more settlers arrived, and after 1864, when the Chicago, Burlington and Quincy railway extended its road to Aurora, Downers Grove became a prosperous suburb of Chicago. Residents commute between Downers Grove and Chicago, the Argonne National laboratory for atomic-energy research near Lemont, Ill., and other areas. Industries within Downers Grove include the manufacture of plastics, roller bearings and power transmission equipment. For comparative population figures *see* table in ILLINOIS: *Population.*

(H. L. SM.)

DOWNING, SIR GEORGE (*c.* 1624–1684), English diplomat and public servant, made vigorous contributions to his country's prosperity as a financial and commercial administrator. He is also remembered as one of Harvard's first graduates and as "godfather" of Downing street. He was born in Dublin of Puritan stock, the son of Emmanuel Downing, barrister, and Lucy, sister of Gov. John Winthrop. In 1638 his family joined Winthrop in Massachusetts and George entered the newly founded Harvard college. By 1646, however, he was back in England serving in the parliamentarian army; he rose to be chief of intelligence to the forces in Scotland. He sat in the parliaments of 1654, 1656 and 1659. He was sent to France in 1655 to remonstrate on the massacre of the Protestant Vaudois and was appointed resident at The Hague in 1657 with instructions to effect a union of Protestant powers, to protect English commercial interests and to spy on the activities of exiled royalists.

By late 1659 Downing was ready to assist a restoration of the

monarchy. Charles II appraised his abilities, giving him a knighthood in 1660 and a baronetcy in 1663. In parliament Downing gave expression to his determination to build up English commercial prosperity at the expense of the Dutch in the Navigation act of 1660 and other protective economic legislation. Eventually his pugnacity as the king's envoy at The Hague fostered the outbreak of the first Dutch War. During the conflict he facilitated government borrowing by introducing a strictly regulated system of repayments based on the appropriation of parliamentary supplies. His appointment as secretary to the new treasury commission in May 1667 enabled him to realize his plans for the efficient management of public finances. In Sept. 1671 he left this post to become head of the customs commission, and was sent again to The Hague, avowedly to incite another war. His rapid success obliged him to flee prematurely in fear of his life; he was disgraced for disobeying orders and spent several weeks in the Tower of London. After his release he continued to serve the crown as a customs and exchequer official until his death in Cambridgeshire in July 1684.

Downing left a lasting mark on treasury methods of business and on English mercantile law, but his assiduity won him few friends. He was arrogant and mean and he has generally been stigmatized as treacherous for his zeal in seizing for execution in 1662 three fugitive regicides, one of whom had been his patron. Samuel Pepys, once his clerk, gave grudging admiration to a man not only as painstaking as himself but more successful in amassing a great fortune. Reputed one of the richest men in England, Downing acquired large estates in Cambridgeshire as well as the property in London which bears his name. In 1764 this wealth went toward the foundation of Downing college, Cambridge, according to the will of the 3rd and last baronet. Downing had married a sister of Charles Howard, afterward earl of Carlisle, in 1654, and William of Orange (later William III) was godfather to some of his children.

See J. Beresford, *The Godfather of Downing Street* (1925); C. Wilson, *Profit and Power: a Study of England and the Dutch Wars* (1957). (H. G. Ro.)

DOWNING, MAJOR JACK: *see* Smith, Seba.

DOWNPATRICK, an urban district, market and county town of County Down, N.Ire., lies 22 mi. S.S.E. of Belfast by road, where the Quoile river broadens into its estuary in Strangford lough. Pop. (1961) 4,219. The Dunum of Ptolemy and the Dun-de-lath-glas (fortress of the two broken fetters) of Irish chronicles, it takes its name from *dun* (fortress) and from its association with St. Patrick. Formerly a MacDunleavy stronghold, it was seized in 1177 by the Anglo-Norman adventurer John de Courci (*q.v.*) and served as his headquarters until 1203. The adjacent barony of Lecale, forming a peninsula between Strangford lough and Dundrum bay, has relics of many castles of this period and remained in English occupation during later centuries when English rule lapsed in most other parts of Ireland. At Saul, 2 mi. from Downpatrick, St. Patrick (*q.v.*) began his mission in Ireland in A.D. 432. De Courci used the cult of St. Patrick to the utmost to placate the native Irish; but his claim that he laid the remains of SS. Patrick, Bridget and Columba in one grave in Downpatrick is not taken seriously by any competent authority. This grave, which is in the grounds of the present Church of Ireland cathedral, is marked by a rough granite monolith. The cathedral was built in 1790 but incorporates the chancel of an older building. The 1500th anniversary of St. Patrick's landing was commemorated by the erection in 1932 of a small (Church of Ireland) church of Mourne granite at Saul and a large statue under Roman Catholic auspices on an adjacent hill. Downpatrick is a market town containing the county administrative offices, a hospital and some pleasant Georgian buildings. The remains of the Cistercian Inch abbey, founded by De Courci in 1180 are 2 mi. N. (Hu. S.)

DOWNS, the name given in the south of England to rounded and grass-covered hills. The most characteristic "downs" are built of chalk, but in the west (Somerset and Devon) the name is applied also to hills composed of other geological formations, although of similar appearance and history. In contrast, chalk hills of similar type are termed "wolds" in Lincolnshire and Yorkshire.

The main area of chalk downland lies in Berkshire, Wiltshire and northern Hampshire, centring around Salisbury plain. From this an offset runs southwest, turning abruptly and terminating in the Isle of Wight. Three main spurs run east. The South downs follow the seacoast through Sussex, reaching their highest point in Butser hill (889 ft.) and terminating in the cliffs of Beachy head. The North downs follow the southern boundary of the Thames valley, reach a maximum height of 868 ft. and bend southeast to finish in the "white cliffs of Dover." The largest and northernmost spur runs northeast as far as East Anglia. It is breached by the Thames at Goring, then becomes the dissected and wooded country of the Chilterns and only regains the character and name of downland east of Tring, in the vicinity of Dunstable. The region lying between the North and South downs is known as the Weald (*q.v.*).

Because of the porous nature of the chalk, the summits of the chalk downs are dry in summer. The only surface water available is usually in "dew ponds" where the winter rains are stored on a clay foundation. Under these dry conditions tree growth would normally be slow even if undisturbed. It has been prevented by sheep and rabbit grazing which destroys any isolated seedlings. Lower, on the flanks of the downs, there are often woodlands, sometimes in the form of beech "hangers," especially common (*e.g.*, in the Chilterns) where furniture making has remained a local industry. Other noticeable woodland features are the local abundance of yew, juniper and hox (*e.g.*, at Box hill). The yew wood at Kingley vale, a national nature reserve, has been described as the finest in Europe. There is reason to believe that the downs were formerly well wooded and that the chief trees were oak and ash, beech having spread after the original woods were cleared. Yew, a shade-tolerant tree, is believed to have established itself in the shade of the beeches.

The downs are also especially noteworthy for the numerous remains of ancient man they bear. The best known perhaps are the figures such as white horses cut out of the turf, the oldest of these being relics of pre-Conquest times when Anglian and Danish settlers worshiped Odin, whose white steed is thus represented. Other frequent prehistoric remains show that Neolithic men settled on the hilltops, which were then either open woodland or easily cleared, avoiding the denser woodlands in the swampy clayey valleys below. The pathways thus ran along the ridges and led to Salisbury plain, which became a natural centre of the early civilizations. The great megalithic monuments at Avebury and Stonehenge show that these early settlements were powerful and their populations numerous. Later monuments include Celtic linchets as well as the great ring encampments, many of which had been several times improved and strengthened so that, like Maiden Castle, the most famous, they were in use even at the time of the Roman invasions. The use of the downs for grazing and agriculture is thus probably very ancient.

After this the gradual and continued clearing of lowland forests led to the development of new routes running toward the north and south rather than east and west. Thus in medieval times, the gaps through the downs, mostly cut by rivers, became more important than the ancient ridgeways. They were marked by a series of medieval fortresses and towns, now usually nodal points in the railway system; *e.g.*, Winchester, Lewes, Rochester, Guildford, Arundel. But although the general use of the downs as ridgeways decreased, their pastoral use increased with the introduction of rabbits and the spread of sheep grazing after the 12th century. Much of the wealth of rural England came to be associated with the wool so nurtured.

The characteristic bare and rounded summits of the downs with their springy turf are thus very old and there has been time enough for them to develop an individual vegetation, including rare orchids, as well as a distinctive animal life, with many snails and insects which are almost restricted to this dry and lime-rich habitat. These features are rapidly disappearing. The coming of mechanized plows made it possible to cultivate all but the steepest slopes, and the original turf is everywhere being replaced by arable crops or by manured leas using improved grasses of high yield (*e.g.*, cocksfoot) and clover. Thus it is possible to maintain and fatten

cattle where formerly sheep or rabbits ruled. Further, the tractor meant the disappearance of the traditional downland flocks and their shepherds as well as the turf on which they grazed.

THE DOWNS is also the name of a roadstead in the English channel off Deal between the North and the South Foreland. It forms a favourite anchorage during heavy weather, protected, except during severe southerly gales, by the Goodwin sands. It has depths of 12 fathoms.

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DOWNSIDE, a modern Benedictine abbey with its associated independent Roman Catholic boarding school for boys, is situated near the village of Stratton-on-the-Fosse, Bath, Somerset, Eng.

The direct descendant of the English Roman Catholic foundation in 1605 at Douai, France, the community was transferred during the French Revolution first to Acton Burnell, near Shrewsbury, and finally in 1814 to Downside. The monastery, the abbey church and the school have been developed into striking examples of modern architecture. The school, whose housemasters are members of the community, is a public school. (T. J. HT.)

DOWRY is a term denoting the property, whether realty or personalty, that a wife brings to her husband on marriage. It it not a word that has all the technical connotations and implications of the French *dot* because of the different roots from which English and French law respectively have sprung. In English law, until the enactment of the Married Women's Property Act, 1870, the wife's property passed, in law, absolutely to the husband: the rigour of this rule was modified by the application of the rules of equity to the provisions of settlements, with the result that property was brought into the marriage settlement by the husband or by the wife, or by both, or by persons (such as the parents of either) interested in their welfare, and while the legal estate was vested in the trustees of the settlement, the beneficial interest in the property included in the settlement vested as provided by the terms of the deed. Thus, while in law a married woman could own no property, the position in equity was quite different. With the passage into law of the Married Women's Property Act marriage settlements were no longer necessary for preserving the wife's title to her own property, although the purpose of creating a fund for the benefit of the spouses and their children still remained.

In countries, such as France, where Roman law remained the basis of the law of the country and was received as such, the husband's rights in relation to the *dot* were never unlimited, and certain rights remained to the wife to take legal steps to protect the property which she had brought into the community of goods.

In many primitive societies husbands make a payment to their fathers-in-law, and the wife is often, in effect, bought from her father (*see* BRIDEWEALTH). The idea of the dowry is fundamentally different, namely that the bride or her father makes a payment to her husband to help him to discharge the responsibilities he assumes on marriage. But the institution of the dowry, performing these simple and elemental functions in relation to ordinary marriages, has played an important part in building the power and wealth of great families and even in determining the frontiers and the policies of states. The importance of the dowry in the framing of dynastic policies is epitomized by the epigram *Alli bella gerunt: tu, felix Austria, nube* ("Others wage wars: you, happy Austria, get married"); and the practice of preferring marriage to wars of conquest was not confined to Austria. *See* also HUSBAND AND WIFE, LAWS CONCERNING. (W. T. WS.)

DOWSING: *see* DIVINING ROD.

DOWSON, ERNEST CHRISTOPHER (1867–1900), a leading English poet of the 1890s, whose best-known poem is "Non sum qualis eram bonae sub regno Cynarae," with its refrain "I have been faithful to thee, Cynara, in my fashion."

He was born at Lee, Kent, on Aug. 2, 1867. He did not go to school, but traveled in France and Italy with his father, Alfred Dowson, who undertook his education. In 1886 he went to Queen's College, Oxford, to read classics, but stayed for only five terms. While there he met Arthur Moore (1866–1952), with whom he collaborated in two novels, *A Comedy of Masks* (1893) and *Adrian Rome* (1899). Another friend was Lionel Johnson (*q.v.*), whose example he followed in becoming a Roman Catholic (1891). A decline in Alfred Dowson's fortunes in 1888 obliged father and son to earn a living by managing a dry dock on the Thames.

Dowson's life was unhappy. His father died in August 1894, and his mother killed herself six months later. He himself was consumptive. He was in love for a long time with Adelaide Foltinowicz, the young daughter of a Polish restaurateur in Soho, but in 1895 she finally refused to marry him. Thereafter he lived mostly in France, supporting himself by ill-paid translations from Balzac, Voltaire, Laclos, and Richelieu. From 1896 his health declined, and he died of tuberculosis at the house of a friend, R. H. Sherard, at Catford, in Lewisham, on Feb. 23, 1900.

Dowson contributed to the *Yellow Book*, the *Savoy*, and other periodicals. His short stories, *Dilemmas*, appeared in 1895; a verse play, *The Pierrot of the Minute*, in 1897; and two volumes of poems, *Verses* and *Decorations*, in 1896 and 1899.

His poetry is largely personal lyric. Its main themes are regret at the passing of childhood and the transience of love. His style, which is influenced by the Latin lyric poets and by Swinburne and Verlaine, is marked by meticulous attention to melody and cadence, and by command of unusual forms and metres. W. B. Yeats acknowledged that much of his own technical development was due to Dowson, whose influence can also be traced in the early work of Rupert Brooke.

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DOXOLOGY, an ascription of praise to God. In Christian worship there are three common doxologies:

1. The Greater Doxology or *Gloria in excelsis*, used in the Roman Catholic Mass, the Orthodox liturgies and many Anglican, Lutheran and Protestant orders:

Glory be to God on high, and on earth peace to men of good will. We praise thee, we bless thee, we worship thee, we glorify thee, we give thanks to thee for thy great glory, O Lord God, heavenly King, God the Father Almighty. O Lord, the only-begotten Son, Jesus Christ; O Lord God, Lamb of God, Son of the Father, that takest away the sins of the world, have mercy upon us. Thou that takest away the sins of the world, receive our prayer. Thou that sittest at the right hand of God the Father, have mercy upon us. For thou only art holy; thou only art the Lord; thou only, O Christ, with the Holy Ghost, art most high in the glory of God the Father. Amen.

2. The Lesser Doxology or *Gloria Patri*, used in most Christian traditions at the close of the psalmody:

Glory be to the Father, and to the Son, and to the Holy Ghost, as it was in the beginning, is now, and ever shall be, world without end. Amen.

3. Metrical doxologies, usually variations upon the *Gloria Patri*. The most familiar in English is that of Thomas Ken:

Praise God, from whom all blessings flow;
Praise him, all creatures here below;
Praise him above, ye heavenly host;
Praise Father, Son, and Holy Ghost. Amen.

(J. J. PN.)

DOYLE, SIR ARTHUR CONAN (1859–1930), English novelist and historian best-known as the creator of the modern detective story and of the character of Sherlock Holmes, was born in Edinburgh, May 22, 1859. Educated at Edinburgh university, he practised medicine until 1891, when he published *The White Company*, a historical novel to which *Sir Nigel* (1906) was a worthy successor. His interest in the Napoleonic Wars inspired two short novels, a play and the sympathetic character of Brigadier Gerard, a creation on which rests his reputation as a humorist.

But it was through his cycle of Sherlock Holmes stories—the first of which appeared in 1887—that he attained universal recognition. His dexterous handling of the plots, and the crisp quality of the narrative, set a new tone in the technique of short-story writing, while the ingenious methods suggested for the detection of crime eventually furthered the advance of criminology.

Admired and respected by his fellow authors, Conan Doyle felt it a duty to give a lead in national affairs. In 1902 a knighthood acknowledged his work with the Langman field hospital in Bloemfontein, a history of the Boer War (1900) and a pamphlet vindicating the British army (1902). His interest in military matters, his activities with the Congo Reform association, his inquiries into two notable miscarriages of justice, the question of tariff reform and other public affairs took up much time. His *The British Campaigns in Europe* (definitive edition 1928) is a monument of scholarship. In 1917, Sir Arthur declared himself a spiritualist and the rest of his life was dedicated to the propagation of his faith. He died in Crowborough, Sussex, July 7, 1930.

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DOYLE, RICHARD (1824–1883), Anglo-Irish caricaturist, painter and illustrator who, together with his father, John Doyle, introduced into British caricature a moderate satiric tone, opposed to the savagery and unruliness of Gillray and Rowlandson. He was born in London in Sept. 1824, and studied with his father. From 1843 he regularly contributed decorations, theatre sketches and political caricatures to *Punch*, whose familiar cover he designed. But in 1850 he resigned because of *Punch's* anti-Catholic statements, and devoted himself to painting fanciful water colours which he often exhibited at the Royal Academy, and to book illustration (Thackeray, *The Newcomes*, 1854–55; Dickens' Christmas books; etc.). He died in London, Dec. 11, 1883.

JOHN DOYLE (1797–1868), who was also known by the pseudonym "HB" from cypher of his initials, $\frac{JD}{JD}$, was the father and teacher of Richard Doyle. He was born in 1797 in Dublin where he studied under G. Gabrielli and J. Comerford. He settled in London in 1821, and after an unsuccessful spell at portraiture he turned in 1829 to political caricatures. Immensely popular, they were praised by Macaulay and Wordsworth and collected in their entirety by Prince Metternich. Doyle made 917 plates, about 600 designs for which are in the British museum. He retired in 1851 and died in London, Jan. 2, 1868.

DÓZSA, GYÖRGY (1475–1514), leader of the Hungarian revolution of 1514, was a Szekler nobleman and soldier of fortune who had won such a reputation for valour in the Turkish wars that in 1514 he was appointed to organize and direct a new crusade against the Muslims. In a few weeks he recruited from among peasants thousands of volunteers, who, assembled in their counties, soon began to voice the grievances of their class. The situation worsened because no food or clothing had been provided for them, and when at harvest time the landlords ordered them to return to reap the fields, they refused. The landlords retaliated by maltreating the wives and families of the volunteers and setting armed retainers on the half-starved peasants. The movement was changed into a war of extermination against the landlords, and Dózsa lost control of the rabble. The rebels burned hundreds of manor houses and castles and killed thousands of the nobility. As the rising became a full-fledged revolution, the feudal levies of the kingdom were called out and mercenaries were hired from abroad. At first it seemed that the government was incapable of coping with Dózsa and his bands: the fortresses of Arad, Lippa and Világos fell, and Buda itself was threatened. At last, however, the rebels were destroyed. Dózsa was routed in Temesvár by the combined forces of János Zápolya and István Báthory (father of the future Stephen of Poland), taken prisoner and executed.

See D. G. Kosáry, *A History of Hungary* (1941), with bibliography; S. Markó, *Dózsa György* (1913), in Hungarian. (GE. GR.)

DOZY, REINHART PIETER ANNE (1820–1883), Dutch Arabic scholar of French (Huguenot) origin, is best remembered for his monumental *Histoire des musulmans d'Espagne, jusqu'à la conquête de l'Andalousie par les Almoravides, 711–1110* (1861). Dozy was born in Leiden in 1820 and died there in May 1883, having been professor of history at the university for 33 years. His history, a graphically written account of Moorish dominion in Spain which shed new light on many obscure points, long remained the standard work on the subject. His *Recherches sur l'histoire politique et littéraire de l'Espagne pendant le moyen âge* (2 vol., 1849; recast in 1860 and 1881) forms a trenchant addition to the *Histoire*. His *Supplément aux dictionnaires arabes* and the *Glossaire des mots espagnols et portugais* (ed. with W. H. Engelmann of Leipzig) are works full of research and learning and storehouses of Arabic lore. Dozy also edited many Arabic texts. *Het Islamisme* (1863), a popular exposition of Mohammedanism, is more controversial, and *De Israeliten te Mekka* raised criticism on religious grounds in Jewish circles.

See M. J. de Goeje, *Biographie de Reinhart Dozy* (1883); and biographical introduction to *Spanish Islam* (1913), F. G. Stokes's translation of Dozy's *Histoire des musulmans d'Espagne*.

DRACAENA, the common and generic name of certain shrubs or trees of the family Liliaceae (*q.v.*), containing about 50 species in the warmer parts of the old world. They have long, generally narrow leaves, panicles of small whitish flowers and berried fruit. The most remarkable species is *Dracaena draco*, the dragon tree of the Canary Isles, which reaches a great size and age. The famous specimen in Teneriffe, which was blown down

EDGAR AUBERT DE LA RÜE

DRAGON TREE (DRACAENA) OF FRENCH SOMALILAND

by a hurricane in 1868, was 70 ft. high with a circumference of 45 ft. several feet above the ground and was supposed to be 6,000 years old. A reddish resin exuding from the trunk is known as dragon's blood (*q.v.*). *D. fragrans* and *D. goldieana* are common greenhouse plants.

Some of the cultivated dracaenas of the florist belong to the closely allied genus *Cordyline*. They are grown for the beauty of form, colour and variegation of their foliage and are extremely useful as decorative house or greenhouse plants and for table decoration. A large number of the garden species of dracaena are varieties of *Cordyline terminalis* of eastern Asia.

DRACHMA, a silver coin of ancient Greece and the monetary unit of modern Greece. Its name was derived from the Greek verb "to grasp," and its original value was equivalent to that of a handful of arrows. The drachma had different weights in different regions. From the 5th century B.C., Athens gained commercial pre-eminence and the Athenian drachma became the foremost currency. The silver coin weighed 4.367 g. One drachma equaled 6 oboli, 100 drachmas 1 mine and 60 mine 1 Attic talent.

As a result of the conquests of Alexander the Great, the Athenian drachma came to be the monetary unit of the Hellenistic world. In time, silver coins of one drachma and its multiples were debased and progressively higher proportions of copper were admixed. The

drachma also became the prototype of an Islamic coin—the dirhem.

When Greece attained its independence from Turkey in 1828, the phoenix was introduced as the monetary unit, but it was replaced in 1831 by the drachma. In 1875 Greece joined the Latin Monetary union and the value of the drachma was set equal to that of the franc. Only paper money circulated in Greece, however, and before World War I the drachma was quoted at a discount to gold. During the war its value was maintained by virtue of the demand for Greek money by Allied forces stationed in Salonika. The outbreak of war with Turkey in 1919 caused serious inflation in Greece. By the end of 1920 the drachma had fallen from a par of 19.295 U.S. cents to 7.56 U.S. cents. Defeat by Turkey depressed the drachma still further. Even though exchange controls were introduced in 1931, the value of the drachma could not be maintained, and in 1936 there was a new effort at stabilization which linked the drachma to the pound sterling. The new exchange rate was fixed at between dr. 540 and dr. 550 to the pound.

BY COURTESY OF ROYAL GREEK EMBASSY

DRACHMA ISSUED DURING THE REIGN OF KING GEORGE I OF GREECE

From 1940 to 1944 Greece was under German occupation and its currency was subject to rigorous German regulation. Following the liberation of 1945, Greece entered a period of staggering inflation. With the assistance of the United States the economy gradually recovered and the inflationary forces were brought under control. In May 1954, a new official rate of dr. 30 per dollar or dr. 84 per pound was introduced; the official buying and selling rates for the U.S. dollar were set at dr. 29.85 and 30.15 respectively. (B. F. H.; Jo. M. L.)

DRACHMANN, HOLGER HENRIK HERHOLDT (1846–1908), Danish writer, most famous for his lyrical poetry, was born in Copenhagen, where his father was a physician, on Oct. 9, 1846. After leaving school he studied painting, exhibiting for the first time in 1869. At the same time he began to write, for which a journey in 1867 to Scotland, Spain and Italy supplied material. A visit to London in 1871 awakened an interest in social problems and after his return he joined the new radical movement of which Georg Brandes was the central figure. In 1872 he published his first work, *Digte*, a collection including both lyrics and poems expressing his theories.

During the following years he established his position as the greatest poet of the modern movement in Danish literature with collections such as *Dæmpede Melodier* ("Muted Melodies," 1875), *Sange ved Havet* ("Songs by the Sea") and *Venezia* (both 1877) and *Ranker og Roser* ("Weeds and Roses," 1879). The prose *Derovre fra Grænsen* ("From Over the Border," 1877), containing descriptions of the war against Austria and Prussia in 1864, and the verse fairy tale *Prinsessen og det halve Kongerige* ("The Princess and Half the Kingdom," 1878), showed a patriotic and romantic trend which brought him into conflict with the Brandes group, and about 1880 he took up a bourgeois-conservative standpoint opposed to naturalism. This phase was most clearly expressed in the travel book *Skyggebilleder* ("Shadows," 1883). Toward the end of the 1880s he returned to an individualist radicalism and a challenging, antibourgeois cult of freedom and beauty.

Drachmann was emotional by nature, and had much of the romantic bohemian in his make-up. Recurrent figures in his writings are the minstrel and the knight-errant. At the same time he was hard-working and very prolific. His output was of great variety, including verse, short stories, novels and plays. His lyric verse is the most important of the period. He forsook classical prosody for a freer metre and a lively rhythm, reflecting the cadences of natural speech. His imagery, which is often dreamlike and visionary, generally reflects his inner emotional world. Apart from his love poetry, his favourite subjects are the sea and life by and on it. The best later collections are *Gamle Guder og Nye* ("Old and New Gods," 1881), *Sangenes Bog* ("The Book of Songs," 1889) and *Den hellige Ild* ("The Holy Flame," 1899). Many of his stories describe fishermen and sailors, as in *Paa Sømands Tro og Love* ("Sailor's Honour," 1878) and *Lars Kruse* (1879), which reveal his sympathy with simple folk. His novels are often partly autobiographical, the characters being artists or writers, as in the most important, *Forskrevet* ("Pledged," 1890), in which his own personality is seen split into its bourgeois and bohemian components. Drachmann was not pre-eminently a novelist or a writer of epics, though he was a great stylist. Neither can his plays be counted among his best work, though the fantasy, *Der var engang* ("Once upon a Time," 1885) remains a favourite, chiefly because of Peter Lange-Müller's music. The melodramas *Volund Smed* ("Volund the Smith," 1894) and *Renæssance* (1894) also enjoyed success. Drachmann died at Hornbaek on Jan. 14, 1908.

BIBLIOGRAPHY.—Drachmann's poems were published in 12 volumes (1906–09). *See* also G. Brandes, in *Samlede Skrifter* (1899–1910), vol. 3; V. Vedel, *H. Drachmann* (1909); Paul V. Rubow, *H. Drachmann*, 3 vol. (1940–50). (S. M. K.)

DRACO (DRAKON), the name of an Athenian lawgiver of the 7th century B.C. His code is generally dated to 621; Aristotle says, in the archonship of Aristaechmus, which shows that unlike Solon, Draco was not himself made archon to perform his task.

The six junior archons (*thesmothetae*) are said by Aristotle to have been instituted, after 683, to record the laws. If this is correct, Draco's code was not the first reduction of Athenian law to writing, but it may have been the first comprehensive code, or a revision prompted by some particular crisis. The code was later regarded as intolerably harsh, punishing trivial crimes with death; it was probably unsatisfactory to contemporaries, since Solon not many years later repealed all but the laws dealing with murder and issued a new code. A decree of 409/408 B.C. orders the public inscription of this murder law, which is partly extant. Later authors refer to other laws of Draco, which may be genuine; but the constitution ascribed to Draco in ch. 4 of the *Constitution of Athens* (*q.v.*) by Aristotle is certainly a later fabrication.

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DRACO (the Dragon), in astronomy, a constellation of the northern hemisphere. The Greeks had many fables concerning this constellation; one is that when Hercules killed the dragon guarding the Hesperian fruit, Hera transferred the creature to heaven as a reward for its services. It stands between the bears, Ursa Major and Ursa Minor, keeping them apart. The star γ Draconis has acquired historic interest because, from his observations of it, James Bradley discovered the phenomenon of aberration of light (*see* ABERRATION [OF LIGHT]). It enjoyed this distinction because it is the brightest star that passes close to the zenith of Greenwich, so that errors of observation arising from refraction are minimized. *See* CONSTELLATION.

DRACONTIUS, BLOSSIUS AEMILIUS (5th century A.D.), the foremost Christian Latin poet of Africa, flourished at the time of the literary revival which took place under Vandal rule in the latter part of the 5th century. At Carthage Dracontius received the traditional rhetorical education under the grammarian Felicianus, and practised as a lawyer. Though his family was initially favoured by the Vandals, he eventually suffered imprisonment and confiscation of his property, on account of a poem in which he praised the emperor rather than the Vandal king Gunthamund (484–496). On his release it is suggested he migrated to Italy.

Dracontius' earlier verse is represented by the *Romulea*, a collection (prefaced by a trochaic dedication to Felicianus) of nine pieces in hexameters principally on mythological themes which form the basis for philosophical argument: one piece (v) is a versified *controversia*. The highly rhetorical flavour of these poems reappears in his elegiac *Satisfactio*, a plea for pardon addressed to Gunthamund during his imprisonment: a *controversia* is embodied in the *Orestis tragoedia* whose attribution to Dracon-

tius, though long in doubt, now seems certain; and even his most religious poem, *De laudibus dei,* shows the characteristic multiplication of *exempla.* This last poem, his most important work, comprises 2327 hexameters in three books: book i describes the Creation and Fall, and the evidence for immortality; book ii treats the benevolence of God as shown by the preservation and redemption of the world; and book iii is concerned with the dealings of God with man. The account of the Creation (= book i, except the first 117 lines) was separately circulated in the middle ages under the title *Hexaemeron,* and was revised and augmented in the 7th century by Eugenius III, bishop of Toledo. Dracontius shows wide familiarity with pagan Latin literature and with the Bible. His syntax and prosody reflect contemporary usage, and there is some harshness and obscurity of language.

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DRAFTED MASONRY, in architecture, masonry formed of large stones dressed or cut round the edge to a single plane, with the face between left as it came from the quarry. Many notable Roman examples exist, such as that of the Porta Maggiore at Rome (period of the emperor Claudius, *c.* A.D. 50). It was also particularly common in the near east, being found from the time of Cyrus, in the platform at Pasargadae (*c.* 530 B.C.), up to the time of the castles built by the crusaders. In the Renaissance drafted masonry was used occasionally for decorative purposes, as in the Riccardi palace at Florence by Michelozzi (*c.* 1430). When so used it is sometimes loosely termed "rustication."

DRAGO, LUIS MARÍA (1859–1921), Argentine statesman and author of the Drago doctrine (*q.v.*) opposing the forcible collection of debts through military intervention, was born May 6, 1859, at Buenos Aires. A member of a distinguished Argentine family, at an early age he became chief editor of *El Diario* in Buenos Aires. He later served as financial officer of the government, then minister of foreign affairs (1902) during the period of the intervention of the three European powers in Venezuela seeking the forcible collection of the public debt of that country. It was on this occasion that he wrote a historical letter to the Argentine minister in Washington setting forth the so-called Drago doctrine. Drago represented his country at the Hague peace conference of 1907. Two years later he served as a member of the tribunal of arbitration created by the United States and Great Britain to decide the North Atlantic fisheries controversy. He died on June 9, 1921, shortly after he had been invited by the council of the League of Nations to draft the statute of the Permanent Court of International Justice. *See* DRAGO DOCTRINE. (C. G. FE.)

DRAGO DOCTRINE. The government of every state, declared Lord Palmerston in 1848, is entitled by diplomatic methods to take up the complaint of any of its subjects against the government of another state and, if well founded, to demand redress. Palmerston added that in certain circumstances the government might be prepared to go to the length of using force. To this statement Lord Salisbury subsequently gave his assent in 1880. In 1902 Venezuela, having failed to comply with the demands made by Great Britain, Germany and Italy to make good its default in respect of its external loans, was called upon by these powers to honour its obligations. Failing to obtain satisfaction, a blockade of certain Venezuelan ports was instituted. This led to dispatch of a note from Luis M. Drago (*q.v.*), foreign minister of the Argentine republic, to the Argentine minister at Washington declaring that the principle should be accepted that for the common safety of the South American republics, just as the Monroe Doctrine is a principle enforced by the United States for the preservation of the territorial *status quo* throughout the American continent against European aggression, the collection of pecuniary claims of citizens of any country against the government of any South American republic should not be effected by armed force. This proposal, however, did not find general acceptance, but by the Hague convention (1907) the contracting powers agreed not to have recourse to armed force for the recovery of contract debts claimed from the government of one state by the government of another state as due to its nationals. This agreement, however, did not apply if the debtor state refused or neglected to accept an offer of arbitration, or after accepting the offer prevented any compromise being reached, or after an award failed to carry it out.

See Sir T. Barclay, *Problems of International Law and Diplomacy* (1907); Robert J. Phillimore, *International Law,* vol. ii (1854–61). (H. H. L. B.; X.)

DRAGOMAN is a comprehensive term applied to anyone serving as an intermediary between Europeans and orientals, whether as a hotel tout or travelers' guide, or as the chief dragoman of a foreign embassy, whose functions at one time included the conduct of important political negotiations (Arabic *tarjuman,* "interpreter"; *cf.* Hebrew *targum*). In the latter sense the dragoman has, essentially, ceased to exist, especially since the passing of the Ottoman empire from the stage of history (*c.* 1919–23) in the near and middle east, although in the second half of the 20th century many embassies in the Arab world still employed a *k'vass,* largely for ceremonial purposes, and there were still oriental secretaries.

The original employment of dragomans in the Ottoman government arose from religious scruples against the use of the language of a non-Moslem people. Ottoman political relations compelled the sultan's ministers to use interpreters, who rapidly acquired a very considerable political influence. The first chief dragoman of the Sublime Porte was Panayotis Nikousia (1665–73). Alexander Mavrokordatos (*q.v.*), later *exaporritos* ("secretary of state"), who succeeded Nikousia, negotiated the treaty of Karlowitz (1699) for the Ottoman empire, and became very prominent in the development of Ottoman policy. From the end of the 17th century until the Greek national revolt in 1821–29, Greeks (Phanariotes; *q.v.*) practically monopolized the conduct of Ottoman foreign relations, and soon established the system under which the chief dragoman, as a matter of course, was elevated to the dignity of hospodar (*q.v.*) of one of the Danubian principalities (Rumania).

Similarly, foreign emissaries accredited to the Sublime Porte, in the absence of duly qualified linguists, found it necessary to employ Greeks, Armenians or Levantines with the appropriate knowledge of language, laws, customs and administration of the country. They became the confidential intermediaries between the missions and the Sublime Porte. But the disadvantages of this system were soon patent, and as early as 1699 the French government decided to establish a school for French dragomans at Constantinople, for which the École des Langues Orientales in Paris was substituted in later years. In 1877 Great Britain inaugurated a system for the selection and training of British-born dragomans, and most of the European great powers eventually took similar steps. The United States, a latecomer to the scene, did not.

The functions of the first dragoman were essentially political in character. The subordinate dragomans transacted less important business, including, generally, all matters in which the interests of foreign citizens were involved. The high esteem in which the dragomans were held by most foreign powers was demonstrated by the fact that they were often elevated to the most important diplomatic posts.

In the Russian, Austrian and German foreign services a number began careers as a junior dragoman, and the French chief dragoman usually attained the rank of minister plenipotentiary. The more important consulates in the Ottoman provinces were also provided with dragomans, whose duties were of a similar if less important nature. Banks, railway companies and financial institutions employed dragomans to facilitate their business relations with Ottoman officials. (H. N. H.)

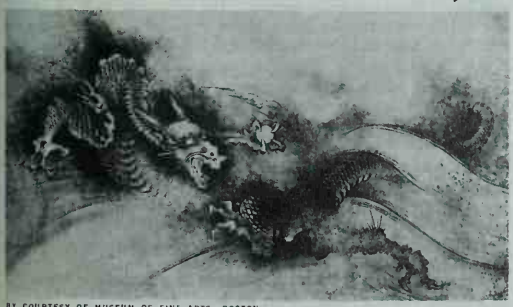
DRAGOMIROV, MIKHAIL IVANOVICH (1830–1905), Russian general, known principally for his writings on military tactics, was born on Nov. 8 (new style; Oct. 27, old style), 1830. He entered the guards in 1849 and in the following decade began his study of military education. He helped to reorganize the Russian army's educational system and taught members of the

imperial family. He took part in suppressing the Polish insurrection of 1863 and was attached to the Prussian army during the Austro-Prussian War of 1866. In the Russo-Turkish War of 1877–78 he commanded the 14th infantry division, which led in the crossing of the Danube. After the defeat at Plevna, he strenuously opposed suggestions that the Russian army retreat back to Rumania. Wounded at Shipka pass, he had to leave active service and for the next 11 years was director of the Nicholas Military academy. Collating Europe's best military literature, he introduced it into the Russian army training schools. He improved the morale and technical efficiency of the officer corps, especially on the staff. In 1889 he became commander of the Kiev military district and governor general of the three southwestern Ukrainian provinces, retaining this post until 1903. General Dragomirov's larger military works—among others, his *Uchebnik taktiki* ("Course of Tactics," 1879)—have been translated into French and German. In formal tactics he was the head of the "orthodox school," advocating the offensive at all costs, and the combination of crushing short-range fire with the bayonet charge. He followed Suvorov's ideas to the limit, and many felt that he pressed them beyond the attainable. He died at Konotop, Chernigov province, on Oct. 28 (N.S.; Oct. 15, O.S.), 1905. (B. J.)

DRAGON, a fabulous monster, usually conceived as a huge, bat-winged, fire-breathing, scaly lizard or snake, with a barbed tail. The belief in dragons seems to have arisen without the slightest knowledge on the part of the ancients of the gigantic and astonishingly dragonlike extinct reptiles of past ages. The word is derived through the French and Latin from the Greek *drakon,* connected with *derkomai,* "see," and interpreted as "sharp-sighted." The equivalent English word "drake" or "fire-drake" is derived from Anglo-Saxon *draca.* In Greece the word *drakon* was used originally of any large serpent, and the dragon of mythology, whatever shape it may have assumed, remains essentially a snake.

In general, in the near eastern world, where snakes are large and deadly (Chaldaea, Assyria, Phoenicia, and to a lesser degree in Egypt), the serpent or dragon was symbolic of the principle of evil. Thus Apophis, in the Egyptian religion, was the great serpent of the world of darkness vanquished by Ra, while in Chaldaea the goddess Tiamat, the female principle of primeval Chaos, took the form of a dragon. Thus, too, in the Hebrew sacred books the serpent or dragon is the source of death and sin, a conception which was adopted in the New Testament and so passed into Christian mythology. In Greece and Rome, on the other hand, while the oriental idea of the serpent as an evil power found an entrance and gave birth to a plentiful brood of terrors (the serpents of the Gorgons, Hydra, Chimaera and the like), the *dracontes* were also at times conceived as beneficent powers—sharp-eyed dwellers in the inner parts of the earth, wise to discover its secrets and utter them in oracles, or powerful to invoke as guardian genii.

In general, however, the evil reputation of dragons was the stronger, and in Europe it outlived the other. Christianity, of course, confused the benevolent and malevolent serpent deities of the ancient cults in a common condemnation. The very "wisdom of the serpent" made him suspect; "the devil," said St. Augustine, "is a lion and a dragon; a lion because of his rage and a dragon because of his wiles." In Christian art, the dragon came to be symbolic of sin and paganism, and as such was depicted prostrate beneath the heels of saints and martyrs. The dragon myths of the pagan east took new shapes in the legends of the victories of St. Michael and St. George; and the kindly snakes of the "good goddess" (*see* BONA DEA) lived on in the *immanissimus draco* whose baneful activity in a cave of the Capitol was cut short by the intervention of the saintly pope Silvester I. In this respect indeed Christian mythology agreed with that of the pagan north. The similarity of the northern and oriental snake myths seems to point to a common origin in remote antiquity. Whatever the origin of the northern dragon, the myths, when they first appear, show him to be in all essentials the same as that of the south and east. He is a power of evil, guardian of hoards, the greedy withholder of good things from men; and the slaying of a dragon is the crowning achievement of heroes—of Siegmund, of Beowulf, of Sigurd, of Arthur, of Tristram—even of Lancelot, the beau ideal of medieval chivalry.



BY COURTESY OF MUSEUM OF FINE ARTS, BOSTON

CHINESE DRAGON FROM "NINE DRAGON SCROLL" BY CH'EN JUNG, MID-13TH CENTURY, SUNG DYNASTY. IN THE MUSEUM OF FINE ARTS, BOSTON

As to the dragons' form, this varied from the beginning. The Chaldaean dragon Tiamat had four legs, a scaly body and wings. The Egyptian Apophis was a monstrous snake, as were also, originally at least, the Greek *dracontes.* The Persian dragon was noteworthy for its cloven hoofs. The dragon of the Apocalypse (Rev. xii, 3), "the old serpent," is many-headed, like the Greek Hydra. The dragon slain by Beowulf is a snake (worm), for it "buckles like a bow"; but the dragon done to death by Sigurd, though its motions are heavy and snakelike, has legs, for Sigurd wounds it "behind the shoulder." On the other hand, the dragon seen by King Arthur in his dreams is, according to Malory, winged and active, for it "swoughs" down from the sky.

The qualities of dragons being protective and terror-inspiring, and their effigies decorative, they were early used as warlike emblems. Thus, in the *Iliad,* Agamemnon has on his shield, besides the Gorgon's head, a blue three-headed snake, just as ages afterward the Norse warriors painted dragons on their shields and carved dragons' heads on the prows of their ships. From the conquered Dacians, the Romans in Trajan's time borrowed the dragon ensign which became the standard of the cohort as the eagle was that of the legion. Under the later eastern Roman emperors the purple dragon ensign became the ceremonial standard of the emperors, under the name of the *drakonteion.*

In England before the Conquest the dragon was chief among the royal ensigns in war. Its origin, according to the legend preserved in the *Flores historiarum,* was as follows: Uther Pendragon, father of King Arthur, had a vision of a flaming dragon in the sky, which his seers interpreted as meaning that he should come to the kingdom. When this happened, after the death of his brother Aurelius, "he ordered two golden dragons to be fashioned, like to those he had seen in the circle of the star, one of which he dedicated in the cathedral of Winchester, the other he kept by him to be carried into battle."

From Uther Dragonhead, as the English called him, the Anglo-Saxon kings borrowed the ensign, their custom being, according to the *Flores,* to stand in battle "between the dragon and the standard." The dragon ensign which was borne before Richard I in 1191, when on crusade, "to the terror of the heathen beyond the sea," was that of the dukes of Normandy; but even after the loss of Normandy the dragon was the battle standard of English kings, and was displayed, for example, by Henry III in 1245 when he went to war against the Welsh. Not till the 20th century was the dragon officially restored as proper only to the British race of Uther Pendragon, by its incorporation in the armorial bearings of the prince of Wales. Thus the dragon and wivern (*i.e.,* a two-legged snake; M.E. *wivere,* "viper") took their place as heraldic symbols (*see* HERALDRY).

In the far east the dragon has managed to retain its prestige and is known as a beneficent creature. In China, it appears as the national symbol and was the badge of the royal family. In Chinese art, the imperial dragon can be identified by its five claws; the ordinary Chinese dragon has only four. The Japanese dragon,

known as *tatsu*, is identifiable by its three claws, and is capable of changing size at will, even to the point of becoming invisible. Both Chinese and Japanese dragons, though regarded as powers of the air, are wingless. They are among the deified forces of nature of the Taoist religion, and the shrines of the dragon-kings, who dwell partly in water and partly on land, are set along the banks of rivers. (W. A. P.; T. A. Sb.; X.)

Zoology.—The term "dragon" has no zoological meaning, but it has been applied in the Latin generic name *Draco* to a number of species of small lizards found in the Indo-Malayan region and characterized by the possession of winglike folds of skin projecting from the sides of the body and supported by the greatly elongated ribs. These structures do not involve the legs and cannot be used as actual wings for flight; they serve merely as gliding planes which extend the distance over which the animal can leap from one to another of the trees in which it lives. The largest form is only about ten inches long.

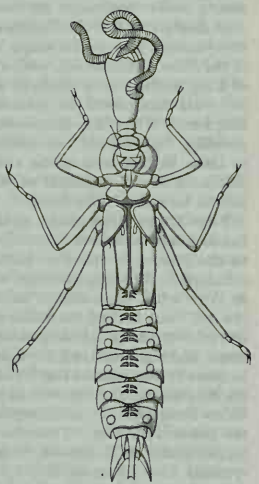
Another lizard to which the name is popularly applied is the giant monitor, *Varanus komodoensis*, discovered in Komodo, an island of the Lesser Sundas, in Indonesia. It is a heavily built lizard that reaches a length of at least ten feet, thus greatly exceeding all other living lizards, although the extinct *Varanus priscus* of Australia attained perhaps twice the length. *V. komodoensis*, which is almost at the point of extinction because of the interest of collectors, is now protected.

Military.—In military use the name dragon was applied to the musket—ornamented with the head of a dragon—from which the dragoons (*q.v.*) derive their name; later it was applied to a tractor for drawing guns, propelled by an internal-combustion engine and running on caterpillar tracks. *See* also Draco.

DRAGONET, a name applied to perchlike, often brightly coloured fishes of the family Callionymidae. The common dragonet, *Callionymus lyra*, which inhabits the coasts of Europe, has a slender naked body and large eyes close together on top of the flattish, triangular head. The male is larger and more ornamental than the female. After active courtship, the male and female swim side by side toward the surface, at which time the floating eggs are extruded and fertilized. (C. Hu.)

DRAGONFLY, the common name applied to insects of the order Odonata. Dragonflies are swift-flying, graceful insects which patrol the edges of ponds and streams. In the hand they are harmless and can be recognized by the great jeweled eyes; the two pairs of similar, narrow, transparent wings; the long, usually slender abdomen or "tail"; and the forward position of the six similar legs. Many are conspicuously marked with bright colours on a dark background; others are dark with a metallic iridescence.

Habits and Structure.—Dragonflies are more perfectly attuned to life on the wing than any other group of insects. Some species seldom alight from dawn to dusk during warm, sunny weather, but others are so sensitive to changes in light that they immediately seek shelter when the sun is overcast. A few species sleep around the clock except for short flights at dawn and dusk. Dragonflies hunt only during flight; the six feet, placed far forward below the mouth, form a spiny basket in which flying insects are caught.

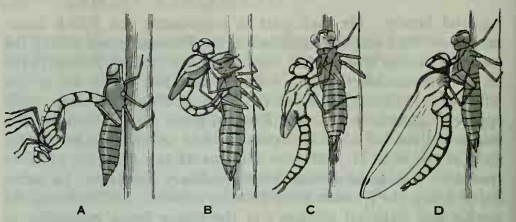


BY COURTESY OF W. J. LUCAS

FIG. 1.—DRAGONFLY LARVA, WITH LABIUM EXTENDED, SEIZING ITS PREY

The larvae live in water until the last stage of development is reached

The dragonfly's life is encompassed and guided by vision. It is, however, a mosaic vision: the sum of images received by 1,000 or more individual "cameras" that make up the two compound eyes. These eyes, occupying over half the head surface, are acutely sensitive to moving objects. The antennae, the main organs of smell in insects, are reduced in dragonflies to little more than bristles with probably little use. The two pairs of jaws are well armed with crushing and piercing teeth.



A B C D

FIG. 2.—METAMORPHOSIS FROM LARVA TO DRAGONFLY

On leaving the water, the final change takes place. The front part of the dragonfly (A) is liberated through the larval cuticle followed by the tail (B) and the whole body (C). Metamorphosis is nearly complete (D) when the wings have acquired their full dimensions and the abdomen is not yet fully extended

The wings are thin, tough membranes stretched on an elaborate frame of veins, the arrangement of which reveals a basic plan throughout the order; variations occurring in the families are associated with particular flight habits. These differences in venation, being well preserved in fossil dragonflies, have furnished the most useful characters for a natural classification of the dragonfly order.

Of the three thoracic segments, the first, bearing the forelegs, is free and necklike, whereas the other two segments are united into one large fixed region, the pterothorax, bearing the wings as well as the middle and hind legs. This stoutest part of the body, owing to the skewness of its development, displaces the legs forward and the wings backward. The forward position of the legs gives the dragonfly great freedom in perching or hanging from branches or other supports.

The last segment of the ten-segmented abdomen of the male is equipped with three or four terminal holding devices or claspers. On the second and third segments is a complex copulatory organ to which he transfers sperm from the genital opening near the end of the abdomen. The act of mating is peculiar. The male grasps the head or thorax of the female from above with his claspers and, while thus joined in tandem, either during flight or at rest, the female loops her body forward and places its tip next to the male organ. The male may release the female after insemination or he may hold her in tandem while she lays her eggs. No other insects have a similarly complex mating, this one being adapted to fast flight. The females of those species with an ovipositor place their eggs in plant tissues, whereas species without an ovipositor scatter eggs over the water's surface during flight.

Development.—The larva, unlike the aerial adult dragonfly, is aquatic throughout its period of growth. Most species develop in fresh water, some tolerate brackish water and a few are mud dwellers. None are truly marine. The larva can walk or climb, and swims efficiently by a sort of jet propulsion: water is drawn into the rectum and then forcibly ejected. Descended from air-breathing land insects, the larva has a complete tracheal or air-tube system, which carries oxygen to all parts. In the water the tracheal openings (spiracles) are closed and oxygen is absorbed into the tracheal system directly from the water; osmosis takes place through the walls of the gills and of the rectum, which areas are supplied with microscopic branches (tracheoles). In the Anisoptera, the tracheolar gills are in the rectum and are folds of the rectal walls. They are aerated by water drawn through the anus into the rectum. When the insect emerges from the water the spiracles of both nymph and adult admit oxygen directly from the atmosphere.

The larva captures its prey by means of a prehensile lower lip or labium, which is folded under the head when not in use, but can be suddenly extended to seize prey by a pair of terminal hooks (fig. 1). Larvae of most species wait until the prey comes within reach

of the hooks, but the more aggressive species stalk the prey until it is within striking distance.

The period of development varies from one to four years or longer, and there are about 10 to 15 larval stages. The insect hatches as a transient stage, the pronymph, followed by the first true larval stage, a minute creature similar to the later stages, but without traces of wings until after the third or fourth molt. The first food taken consists of microscopic organisms, such as large protozoans. Later small Crustacea (*Cyclops, Daphnia*) or small worms (Oligochaeta) are eaten, and finally larger Crustacea and insect larvae, including midges, mosquitoes and May flies, form the diet for this carnivorous insect.

During the larval period the wings continue to develop until the last stage is reached. Then for a week or so the larva lies sluggishly and ceases to feed, while the internal larval organs are replaced by those of the adult. Wings are now closely folded within the larval wing sheaths. Eventually the urge toward light and air becomes prominent and the insect crawls up an emergent plant stem, stump or rock. When the cuticle is dry enough it splits along the back, and the pale, soft creature slowly withdraws its head, legs, wings and lastly its abdomen (fig. 2). After emergence the teneral (newly exposed adult) dragonfly must wait another half hour or so until its wings and appendages have acquired their final form. Even more time is required before the colour pattern has reached its full depth and brilliance (fig. 3). This is a critical period, since swallows and other birds rear their young largely on soft, emerging dragonflies. Many species, however, avoid this danger by emerging at night, and are already on the wing when the birds first awake.

Geographic Distribution.—The Odonata are a small order of insects (about 4,870 species) as compared with the larger orders Coleoptera, Diptera and Hymenoptera (over 85,000 species each). Because they are adapted to sunshine they are most abundant in the tropics, with 500 species in India, 450 in North America and 100 in Europe. One species, *Pantala flavescens,* is circumtropical, being found in all the continents except Europe. Many genera with few species are circumpolar.

Geological History.—Dragonflylike fossils appear in the Paleozoic (about 260,000,000 years ago), occurring in the Carboniferous strata at Commentry, France, and later in the Permian of Kansas. These were of the order Protodonata; many were large, some two feet across the wings. In the Mesozoic great size is lost and early modern forms appear, *i.e.,* the suborders Anisozygoptera, Zygoptera and Anisoptera in the Bavarian slates (Jurassic). Cenozoic dragonflies, early modern, occur in the U.S. Green River beds of the Eocene, and in Miocene beds in Colorado and at Oensingen, Switz. In the latter appear libellulid larvae, the most modern type.

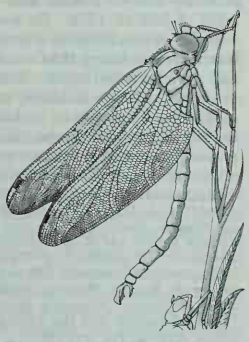


FIG. 3.—THE PERFECT DRAGONFLY, METAMORPHOSIS HAVING BEEN COMPLETED, RESTING TO DRY ITSELF BEFORE EXTENDING ITS WINGS HORIZONTALLY

Economic Importance.—Since dragonflies feed on small insects captured during flight, many species are useful in the natural control of mosquitoes and black flies.

The larvae of some genera, such as *Lestes* and *Sympetrum,* feed extensively on mosquito larvae and pupae. The larvae of other dragonflies inhabiting lakes and streams provide food for fish. On the other hand young fish with the yolk sac still attached are often preyed upon by dragonfly larvae.

CLASSIFICATION

Dragonflies chiefly fall into two suborders, the Anisoptera and the Zygoptera; only two species remain of the suborder Anisozygoptera.

Anisoptera.—The Anisoptera are generally larger and more robust, with hind wings broader at the base than are the fore wings. When at rest the wings are laterally extended. The eyes may be separated or may meet for a short distance along the middle line of the head. These dragonflies are swift and agile in flight and are skilful dodgers. Many practise that most difficult maneuver of hovering, a flight skill possessed by few insects. About eight families are recognized in this suborder. Widespread northern genera are *Aeshna, Gomphus, Cordulegaster, Libellula* and *Sympetrum.*

Zygoptera.—The Zygoptera, often called damsel-flies, are typically smaller and more fragile. Their wings are paddle-shaped and their flight is relatively feeble. When at rest the wings are generally folded over the back. The head is hammer-shaped and the eyes are widely separated though prominent. There are 11 or 12 families. Common northern genera are *Calopteryx, Enallagma, Ischnura, Agrion* and *Lestes.*

Anisozygoptera.—In Japan and India live two species of *Epiophlebia,* of an otherwise extinct suborder, the Anisozygoptera.

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(C. H. KY.; E. M. W.)

DRAGONHEAD, the common name, from the appearance of the flower, for plants of the genus *Dracocephalum,* comprising about 40 species of annual and perennial herbs of the mint family (Labiatae). They have blue, purple or white flowers crowded in dense heads in the leaf axils or in terminal spikes. Although a few species are grown in the garden, they are of secondary importance. False dragonhead or obedient plant (*q.v.*) is the name given to species of the genus *Physostegia* of the same family.

(J. M. BL.)

DRAGON'S BLOOD, a red-coloured resin obtained from several species of plants. *Daemonorops draco,* one of the rattan palms, which produces much of the dragon's blood of commerce, is a native of the Indonesian area. The fruit is round, pointed, scaly and the size of a large cherry; when ripe it is coated with the resinous exudation known as dragon's blood. The substance in commerce is dark red-brown, nearly opaque and brittle; it contains small shell-like flakes and gives, when ground, a fine red powder which is soluble in alcohol, ether, and fixed and volatile oils. If heated it gives off benzoic acid. In Europe it was once valued as a medicine because of its astringent properties and is now used for colouring varnishes and lacquers and in photo-engraving; in China, where it is mostly consumed, it is employed to give a red facing to writing paper.

The drop dragon's blood of commerce is still one of the products of Socotra island (off the coast of Somaliland), and is obtained from *Dracaena cinnabari.* The dragon's blood of the Canary Islands is a resin procured from the surface of the leaves and from cracks in the trunk of *Dracaena draco.* The hardened juice of a euphorbiaceous tree, *Croton draco,* is the dragon's blood of the Mexicans, used by them to heal wounds and as an astringent. *See* DRACAENA.

DRAGOON, originally a mounted soldier trained to fight on foot only. (*See* CAVALRY and INFANTRY.) This mounted infantryman of the late 16th and early 17th centuries, like his comrades of the infantry who were styled "pike" and "shot," took his name from his weapon, a species of carbine or short musket called the dragon. Dragoons were organized not in squadrons but in companies, like the foot, and their officers and noncommissioned officers bore infantry titles. The invariable tendency of the old-fashioned dragoon, who was always at a disadvantage when engaged against true cavalry, was to improve his horsemanship and armament to the cavalry standard. Thus dragoon came to mean medium cavalry, and this significance the word has normally retained since the early wars of Frederick the Great. The light cavalry of the British army in the 18th and

early 19th centuries was for the most part called light dragoons. The phrases "to dragoon" and "dragonnade" bear witness to the mounted infantry period, this arm being the most efficient and economical form of cavalry for police work and guerrilla warfare. The "Dragonnades," properly so called, were the operations of the troops (chiefly mounted) engaged in enforcing Louis XIV's decrees against Protestants after the revocation of the Edict of Nantes.

DRAGUIGNAN, a town of southeast France, capital of the *département* of Var, is situated on the left bank of the Nartuby river, 50 mi. (80 km.) N.E. of Toulon by road. Pop. (1962) 11,526. The town is 679 ft. above sea level at the southern foot of the wooded heights of Malmont. Two gateways remain of the 13th-century walls and in the Rue de la Juiverie is a synagogue with a 13th-century façade. The museum is housed in the 18th-century summer palace of the bishops of Fréjus. There is a bust of Georges Clemenceau by Auguste Rodin and, outside the town, a large United States military cemetery. There are manufactures of leather, soap and spirits and trade in olive oil and grapes. The town was in German hands during World War II from Nov. 1942 to Aug. 1944.

DRAINAGE BASIN, an area of land from which the natural drainage flows into a single stream. *See* WATERSHED.

DRAINAGE OF LAND: *see* LAND RECLAMATION.

DRAKE, SIR FRANCIS (*c.* 1543–1596), English admiral, the greatest and most famous of Elizabethan seamen, was born near Tavistock of Devon yeoman stock. The date of his birth is uncertain, and nothing definite is known about his early years beyond the fact that his father became a preacher at Chatham dockyard and that Francis was apprenticed to the coasting trade. From his father Drake inherited an ardent Protestantism. He sailed with John Lovell on a slaving voyage from Guinea to South America in 1566 and commanded the "Judith" (50 tons) on the third slaving voyage of his kinsman Sir John Hawkins of Plymouth in 1567–68. From this voyage only Drake's own ship and that of Hawkins escaped from a disastrous encounter with the Spaniards at San Juan de Ulua. For the next few years he was the most successful of the many corsairs raiding the Spanish main, his most daring exploit being an attack on Nombre de Dios in 1572, on which expedition he first saw the Pacific and vowed "to sail an English ship in those seas."

Between 1577 and 1580 Drake performed the first circumnavigation of the world undertaken by an Englishman. The objects of the voyage are obscure because there were at least two plans: a public plan promoted by Sir Francis Walsingham and other notables for the discovery of trading bases in the legendary Terra Australis and the Moluccas; and a secret plan supported by the queen for a raid on the west coast of South America, to which was added the suggestion that Drake should search for the western exit of the northwest passage. The discrepancy between the two plans may explain his quarrel with Thomas Doughty (whom he executed at San Julián on the excuse that he was a "conjurer") and the return of William Winter (Wynter) with one of the ships. Drake sailed on Dec. 13, 1577, in command of the "Pelican" (renamed "Golden Hind," 100 tons) and four smaller ships with about 160 men. Off Cape Verde he captured a Portuguese vessel from which he took the pilot, Nuno da Silva, whom he later put ashore at Guatulco. He then sailed down the east coast of South America to San Julián and through the Strait of Magellan, from which he emerged on Sept. 6, 1578. A storm separated him from Winter's ship and drove him south to about 57°. It is doubtful if he thereby discovered Cape Horn, but he certainly proved that Tierra del Fuego was an island by realizing the existence of the strait which now bears his name. Sailing alone up the coasts of Chile and Peru, he sacked towns and plundered shipping, notably the "Cacafuego" treasure ship. It is not known how far north he went (some accounts say 48°), but bad weather forced him south again to land at an unidentified spot in latitude 38° which he named New Albion. The authenticity of a brass plate discovered near San Francisco, Calif., in 1936 has been questioned. He crossed the Pacific to the Moluccas, where he loaded six tons of cloves, most of which were jettisoned when the ship ran on a reef. It was there that he "excommunicated" his chaplain, Francis Fletcher, who wrote an account of the voyage. He returned to Plymouth on Sept. 26, 1580, the profits of the voyage amounting to about £500,000. With his share he purchased Buckland abbey, South Devon, which became the home of his descendants and which contains a Drake museum. The queen knighted him at Deptford on board his ship, of whose timbers there remain a chair at Oxford and a table in the Middle Temple hall.

Drake married a second time in 1585, his first wife having died in 1583. He then embarked on the first act of open war with Spain as commander of a fleet of 29 ships to attack Spanish possessions in the Caribbean. He sacked San Domingo, Cartegena and St. Augustine in Florida and took off the first Virginian colonists before his return in 1586. Since the Spanish Armada (*q.v.*) was now preparing, he sailed in 1587 to attack it in Cádiz harbour, a brilliant exploit popularly known as "singeing the king of Spain's beard." He also captured the "San Felipe" carrack valued at more than £100,000 in English currency. In 1588 he was appointed vice-admiral under Lord Charles Howard of Effingham at Plymouth. His offensive plans to attack the Armada before it left Spain were not approved until it was too late. News reached Plymouth that the Armada was in the channel on Friday, July 19 (old style; July 29, new style); according to a story first printed in 1624, the commanders were playing bowls on the Hoe, but Drake's remark "there's time for that and to beat the Spaniards after" only appears in 1736. The night after the British fleet put to sea in chase of the Armada Drake, in his flagship, "Revenge," captured the "Rosario" galleon. He may have suggested the fireship attack on the Spanish fleet at Calais and he certainly played the leading part in the attack off Gravelines on July 29 (O.S.; Aug. 8, N.S.) which finally shattered the Armada.

Drake commanded the naval force when Sir John Norreys commanded the land force in an attack on Lisbon in 1589. Delays, bad victualing and disagreements between the commanders led to the failure of the expedition, after which Drake was not employed again for five years. In 1595 he and Hawkins sailed in command of an expedition of 27 ships in which it was hoped to repeat the success of 1585, but the Spanish defenses proved too strong. Hawkins died off Puerto Rico and Drake off Porto Bello, in the night of Jan. 27, 1596. He was buried at sea.

Drake is described by a Spaniard as being "of medium stature, blonde, rather heavy than slender, merry, careful. He commands and governs imperiously. Sharp, ruthless, well-spoken, inclined to liberality and to ambition, boastful, not very cruel." His tactical genius and powers of leadership were of the highest order. As the embodiment of Elizabethan maritime enterprise, he may be said to have founded the British naval tradition. *See* also references under "Drake, Sir Francis" in the Index volume.

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(C. C. L.)

DRAKENSBERG MOUNTAINS (Afrikaans DRAKENSBERGE; Sesuto QUATHLAMBA) is the name given to two distinct parts of the South African Great Escarpment, or plateau edge (*see* SOUTH AFRICA, REPUBLIC OF). Originally the name appears to have derived from the peak known as the Drakens (*i.e.*, Dragon's) Mountain, or Dragon's rock (8,944 ft.) to the west of Matatiele. The name has become general for the whole "High Berg," forming for the greater part of its course the eastern border of Basutoland, and the "Low Berg" which forms the boundary between the Orange Free state and Natal.

The highest part of the escarpment is formed by a thick covering of Karroo (Stormberg) lava overlying Stormberg sandstones, extending from Xalanga peak in the south (about 25 mi. E. of Dordrecht) to the Sentinel peak at the Mont-aux-Sources (10,822 ft.) in the north (where it forms the highest part of the main watershed of the Republic of South Africa), a distance of about 280

mi. In this stretch are many outstanding peaks, the highest being Thabana-Ntlenyana (Thadentsonyane), 11,425 ft. From the Mont-aux-Sources to Laing's Nek, south of Charlestown, the Low Berg has no covering of lava, its highest points being formed by Stormberg ("Cave") sandstone, such as the Binghamsberg (6,859 ft.) and Rensburgskop (7,500 ft.). South of Laing's Nek, Majuba and Mount Prospect there are peaks which are now detached from the escarpment by headstream erosion. In the Transvaal the plateau edge between Carolina in the south and Haenertsburg in the north is an extremely bold, cliff-like feature formed mainly by the resistant Black Reef quartzite of the Transvaal system. This feature is known generally as the Transvaal Drakensberg, its highest point on the quartzite being Marieps mountain (6,382 ft.) and, a little to the west of the quartzite, the andesite peak Mt. Anderson (7,498 ft.). (J. H. WN.)

DRAM (DRACHM), a weight approximately equal to that of the ancient Greek coin, the drachma; in apothecaries' weight one-eighth of an ounce, or 60 gr. (3.888 g.); in avoirdupois weight one-sixteenth of an ounce, or 27.34375 gr. (1.772 g.). For short the term is used for a fluid dram (drachm), a measure of capacity equal to one-eighth of a fluid ounce. The U.S: *Pharmacopoeia* differs in usage from the British. The former uses apothecaries' weights, the latter the avoirdupois.

DRAMA, a town and *nomos* (prefecture) in the region of Macedonia, northern Greece. The town (pop. [1961] 32,195) lies at a height of 344 ft. at the northern edge of the broad, artificially drained plain of Drama, which was formerly a lake basin, and at the foot of the Falakron mountains, where the limestone yields copious springs. An irregular mountain torrent, the Drama, flows through the market place. The town replaced Philippi as the chief centre of the plain in the 18th century, but it remained a small, congested town of Turkish style until after World War I. With the departure of its Turkish inhabitants and the influx of Greek refugees in 1922 and subsequent years, its population was almost doubled and new suburbs on the grid plan were added. The town is a military and administrative centre and a tobacco market. It has rail links with Salonika and Istanbul, and is connected by road to the port of Kavalla. The *nomos* of Drama has a population (1961) of 120,006 and contains some of the finest tobacco-growing land in Europe. (WM. C. B.)

DRAMA (ARTICLES ON): *see* THEATRE (ARTICLES ON).

DRAMA. After an introductory discussion on the nature of drama, this article deals with its development, primarily as a literary form, in the western world: its origins in ancient Greece; its development there and in Rome into the classical drama which became at the Renaissance the model for modern drama; its revival, after the decline of the dark ages, out of the liturgy of the medieval church and its survival as folk drama during its second decline at the end of the middle ages; and, finally, its revival again at the Renaissance, when classical drama was rediscovered, and its history in Europe and, later, the United States, from then until the mid-20th century. For other aspects of drama, and for drama in the east, the reader should consult the articles THEATRE; THEATRES (STRUCTURES); and the articles on the literature and music of particular countries—*e.g.*, CHINESE MUSIC; CHINESE LITERATURE; JAPANESE MUSIC; ORIENTAL MUSIC; NŌ DRAMA; INDIAN LITERATURE; SANSKRIT LITERATURE; HINDI LITERATURE; BENGALI LITERATURE; AUSTRALIAN LITERATURE, CANADIAN LITERATURE; etc. For further information on drama in ancient and modern Greece, Rome, Great Britain, the United States, France, Germany, Italy, Spain, Portugal, etc., *see* also the articles on the literature of the countries concerned and the biographies of dramatists and writers on drama, *e.g.*, ARISTOTLE. *See* also COMEDY; VAUDEVILLE; MUSICAL COMEDY; MUSIC HALL AND VARIETY; PANTOMIME; etc.; for further information on dramatic forms, *see* CRITICISM and DRAMATIC CRITICISM.

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I. THE NATURE OF DRAMA

Drama is a form of art in which the artist imagines a story concerning persons and incidents, without himself describing, narrating or explaining what is happening. In practice a story can be presented in this way entirely in dumb show with no speaking, and it must be recognized that this, too, is drama. But as it has normally been understood and practised by dramatists the art is one in which words are used to express the thoughts, emotions and desires of personages imagined as having these when interacting in a relationship with one another. More than speech is implied by what the characters say; nevertheless, it is by using words alone that the dramatist creates his imagined characters, the incidents in which they are involved in a shaped and purposeful plot and the background of place and time in which everything is imagined as occurring. Dramatic speech not only expresses what is going on within the characters, it also makes clear what action they are taking outwardly in a nexus of relationship to one another and the situations in which they are involved in the imagined world of the drama. Basically the dramatic relationship is one of conflict, not only between individuals and one another but also between individuals and spiritual or supernatural forces.

Drama is certainly literature from one point of view, inasmuch as it is composed in words; but as it is written for theatrical performance the literary art is subject to influences exerted by the kind of theatrical presentation in terms of which it is created. From another point of view, therefore, it is possible to see the art as existing fully only in performance; in this view the medium of the art is no longer one of words alone, but of words to which are added the material conditions of performance. The literary text is regarded by those who hold this view as a kind of blueprint, the potential of which cannot become actual until the characters are created in the imitative art of the actor, with the incidents

enacted and the location presented physically on a stage with the required scenery, properties, lighting and sound effects.

Theoretically it must be conceded that a person whose understanding of humanity was adequate and whose imagination was powerful and creative enough would be able to experience a play as completely when reading it as when responding to a performance. Nevertheless, in practice it is an undisputed fact that customarily a dramatist assumes that his audience will respond to his writing and imagine his play in the most complete and pleasurable experience as the result of watching a performance rather than by reading it. As with radio drama, the performance may be one which can only be heard and not seen; but even then the actors create the characters and enact the incidents by expressing vocally the full significance of the words. And in radio drama as in that of the theatre or of television, the way in which the artist writes—the length of his work and its shaping—is influenced by the needs of performance. This is the great difference between drama of the theatre, radio and television on the one hand, and what is called closet drama on the other. Closet drama, as the name suggests, is written for private reading and not in relation to performance of any sort. Such are the plays of Sir Henry Taylor (1800–86), Charles Whitehead (1804–62) and Robert W. Buchanan (1841–1901) and Tennyson's *Harold. A Drama* (1876). Closet drama usually lacks a true dramatic structure and can be longer than plays for performance: it tends to resemble a narrative written in dialogue, is written in verse which allows the author to poeticize and generalize pseudo-philosophically and is a symptom of a culture whose theatre is dominated by prose drama. It is possible to deny this form the title of drama proper; but theoretically it can be classed as a dramatic form, if a poor one, on the ground that the artist expresses himself by imagining characters involved in incidents without describing, narrating or explaining in his own person.

Strictly speaking then, drama proper is restricted to what is written designedly for performance in a theatre or in front of an audience. It may be noted in this connection, that a drama can be performable without being performed. This was the case, for example, with Milton's *Samson Agonistes;* his rejection of contemporary performance was an attack on the stage of his day and its patrons, and his play has been performed successfully in the 20th century.

1. Text and Performance.—The relationship between a dramatic text and its performance before an audience has given rise to a great deal of comment and theorizing. Some critics and dramatists have asserted that the full effect of a play comes from performance only and have then gone on to insist that the rapport between the performers and their audience constitutes an essential element of the drama itself, without which no play can be completely experienced. There is no doubt that in fact the response of the audience has a reaction upon the quality of the performance; and to that extent it is true that a sufficiently large and responsive audience will result in a performance which enables them to imagine the play more completely; or in other words, the attitude of the audience can help or obstruct the performers in their task of representing the characters in action and all that they have meant for the author in his work of art. But there is no certainty that the audience is essential, and perhaps the only statement that can be justified is that the audience's presence makes the task of the performers less difficult; for in the case of radio drama the absence of an audience means that no such rapport is possible as in a theatre, and yet performances create the work of art in the listeners' minds.

2. Drama as a Literary Kind.—For the ancient world and in more recent times up to the beginnings of naturalistic theory in the 16th century, it was normal to regard drama as a kind of literature written in one of the three possible modes or manners. The first of these, the mode or manner of narration, is that in which the poet speaks to his reader or public in his own person, in narration, description, explanation or comment. In the second mode, that of drama, the poet does not speak in his own person in the narrative manner, but through his imagined persons and their actions: this mode is also called the mode of dramatic presentation, of dialogue and of conversation. The third mode is a mixture of the first two, with the poet speaking sometimes in his own person in the manner of narration and sometimes through his imagined persons in the manner of dramatic presentation. According to this classification, poems that would now be called narrative—such as epic—would be regarded as in the mixed manner, as would Milton's sonnet on his blindness. For people thinking in terms of these three modes, the mere fact that a piece of writing was in dialogue meant that it should be classified as in the manner of drama; and to speak of nondramatic dialogue was a contradiction in terms. The difference between a philosophic dialogue and a tragedy written for performance was as clearly understood, however, as if the former were not included in the category of the dramatic. And in this respect it is worth noting that even though a philosophic dialogue is not dramatic in the modern sense of the word, it is an exposition of a conflict of ideas without the writer's speaking in his own person.

3. The Origins of Drama.—That drama as an art has arisen to a large extent out of the natural human instinct for imitation is a point—made first apparently by Aristotle—on which there is general agreement. There is also general agreement that in all likelihood the art gradually developed out of mimetic song and dance associated with ritual. There is not really enough detailed evidence available to prove that in fact this is what has happened; nevertheless, none of the existing evidence suggests any other kind of origin. Two types of theory have been elaborated as to the kind and purpose of the ritual in which were involved song and dance and the wearing of masks, the elements out of which drama has developed; and each type of theory seems to be supported by what is known of the part played by imitation and disguise in such ritual in primitive societies still existing in the modern world. One type of theory finds the beginnings of drama in ritual celebrating the victory of the force of life over that of death as seen in the alternation of the seasons; in the mimetic act of worship the New Year triumphs over the Old Year, as life fights out its battle with death in the folklore of many peoples all over the world. Such rites are traced in the dialogue and impersonations of European folk festivals and in the sword dances and mummers' plays of England and northwest Europe and in the mid-20th century still existed in practice among American Indians and in Africa, Australia, the South Seas and New Guinea. The other type of theory sees drama as originating in a tomb ritual, by means of which the dead were honoured, so that in attaining immortality they might continue to guide and protect the living, otherwise deprived of their strength and wisdom. And here again support is found in the practices of primitive tribes who in the 20th century in Africa practised a type of dramatic ritual in which the exploits of dead kings were re-enacted. It seems possible that each kind of theory is valid, that drama in fact owes its origin to more than one kind of rite, to that celebrating life's victory over death, to fertility ritual and to the rites of the tomb.

A survey of the early phases in the development of drama in different parts of the world shows it associated with liturgy in fact. There is not complete agreement that liturgical drama existed in Egypt as early as between 3,000 and 4,000 years B.C., a suggestion which has been made on the evidence of what are known as the Pyramid texts. These have been interpreted by some authorities as showing that priests, in animal masks to represent the deities, gave performances in tombs and buildings attached to pyramids. There is more agreement that in the 2nd or 3rd millennium B.C. the Abydos passion play really was performed; though this also may be regarded as expanded ritual rather than drama. The subject was the death and dismemberment of Osiris, with the reassembling of his limbs by Isis and Horus. No text survives, but there is an account given by Ikhernofret, who treated older material, of the presentation for which he was responsible between 1887 and 1849 B.C. In other parts of the world religion is similarly associated with the comparatively early stages of dramatic development. In Arabia, Turkey and Persia soon after the deaths of Mohammed and his children a tradition of passion plays arose dealing with the sufferings of Hassan and Fatima. In China at an early date mimetic song and dance were part of harvest celebrations. Drama proper has been shown to have developed there independently much later, but a very early ritual drama associated with ancestor

worship involved the singing and dancing of priests. Tibet, Korea, the East Indies and Japan—the last-named in its *Nō*-plays—show ritual and drama similarly intermingled. In India, too, there are very strong grounds for relating the development of drama at some stage with the festivals of the Krishna cult. That the drama of western Europe also developed from ritual, first in Greece and then in its revival in the middle ages, will be seen below.

4. Drama as an Imitation of Life.—In all these forms of drama, although human behaviour is imitated, the dramatist and the performance are not aiming at evoking a response from the audience by creating a deceptive illusion that art is not art. Human emotions have to be true to life, but the way in which they are expressed does not have to be a realistic imitation of what would be seen and heard in life outside art. As a result technique is sometimes realistic and sometimes not, as the evocation of an imaginative response and not deception is the object. Nevertheless, for an understanding of the art of drama as it exists today, consideration must be given to the concept of it which occurs in what is known as consistent naturalism. This was first put forward with what seems superficially like logical consistency in Lodovico Castelvetro's commentary on Aristotle's *Poetics* in 1570, *La Poetica di Aristotile volgarizzata*. All poetry, it is claimed, being an imitation of life, that is best which is most verisimilar or true to life. It follows that poets who use only words cannot give a verisimilar imitation of both words and things; but the dramatic poet can deceive his audience into accepting his poem as not an imitation, a work of art, at all. To do this he uses words and things to imitate words and things, respectively, with consistent verisimilitude to obtain illusion. It follows from this fundamental conception that dramatic speech must be, or seem to be, exactly what the speaker would use if he were to come to life miraculously outside the theatre in the given situation. It should be noted that despite the fact that naturalism assumes that the audience can be deceived, what happens in fact is that the dramatist restricts himself to imagining only what might happen, occurring in the way in which it really would happen; and as a result members of the audience respond to a performance by which they are induced also to imagine only what might happen occurring as it would happen, for that is all that they see and hear. Naturalistic and unnaturalistic drama differ only in theory; what actually takes place in each art is fundamentally the same. In each, words are used to create characters thinking, feeling and wanting or willing as real human beings would in the imagined situations. In drama written according to naturalistic theory, however, the dramatist must make them express what they have within them in words which will be accepted by the audience as those which they really would use. In drama not written according to naturalistic theory, on the other hand, the actual words themselves do not have to be, or to seem to be, those which really would be used if the character were to come to life: instead the artist can use literary techniques to create the inner life of the imagined character, and it is the inner life that must be truthfully imagined in terms of human nature as it exists.

5. Drama as Entertainment.—A distinction is sometimes made between drama for sheer entertainment and drama which expresses insights into life and its problems at the same time: the drama of entertainment is related to the art of the mime in earlier times devoted only to entertainment, but drama with a serious purpose is envisaged as having developed not from such miming but from the tradition in which mime and song were a part of ritual. There is also a suggestion sometimes that this latter is to be considered as more representative of real drama. It seems, however, that although serious drama is more impressive to an adult civilized mind, the drama of entertainment is no less properly dramatic. It is not safe, moreover, to assume that the drama of entertainment derives from one kind of mime only, while more serious drama has developed from religious practices; it is more likely that all have been influenced by one another throughout history. Certainly Aristophanic comedy involves the mime of burlesque which is essentially entertainment. As for the element of entertainment, it exists in even the most serious drama, which is well described as both teaching and delighting, with the delight arising in part from the quality of what is being said as well as the way in which it is said. *See* also BURLESQUE; MIME. (B. L. J.)

II. GREEK DRAMA

A. ORIGINS

In many parts of the world at many periods there have existed rituals out of which drama could have developed. The widespread use of masks in religious ceremonies implies the idea of impersonation, whether of a worshiper merging himself with his god or of a magician possessing himself of powers not naturally his. In fact few cultures have independently produced a drama, and it is not possible to give a clear account of the impulse which has led to the transformation or of the process by which it has been effected. In the first flush of anthropological discovery numerous attempts were made to uncover the ritual forms latent in Greek tragedy and comedy, and so to account for their origins. None of them has won wide acceptance, and the all but unique transformation of Greek ritual into Greek drama remains unexplained. But that Greek drama emerged from ritual, and ritual of a primitive character, is not to be doubted.

Dionysus was the deity with whom, for the most part, was connected the ritual from which drama arose. Dionysus was among other things an embodiment of the forces of nature manifest in the growth of vegetation, especially the vine, and in the animal world, where he was associated especially with the bull and the goat. Unlike the Olympian deities, who were often remote and unapproachable, he entered into possession of his worshipers, whose frenzied excitement, leading sometimes to a bloody climax, is unforgettably described in Euripides' *Bacchae*. Dionysus had also divine counterparts to his ecstatic human worshipers, mischievous and licentious spirits of forest and mountain, satyrs, silenuses and nymphs, whose wild revelry is frequently represented on Attic vases. As will be seen, these satyrs gave their name to a peculiar form of drama.

Dionysus is scarcely mentioned in the Homeric poems, which means not that he was unknown in Greece (the name occurs on a tablet from Pylos) but that his cult had no place in the society which is there represented. Dionysus was largely the god of the poor and oppressed, to whom he gave relief in temporary forgetfulness from the harshness of life. His turbulent worship was for long excluded from the public cults of Greek cities, and it is significant that both in Athens and in Sicyon it was tyrants, anxious to secure popular support against the aristocrats they had deprived of power, who instituted public festivals of Dionysus.

At the Great Dionysia at Athens, where tragedy, if not comedy, first achieved maturity, Dionysus was honoured with four separate types of performance, dithyramb, tragedy, satyr-play and comedy. The dithyramb was a hymn to Dionysus sung and danced by a choir of 50; each of the ten tribes into which the citizen body was divided competed with a choir; this form alone of the four was not dramatic. In the tragic competition each of the three tragic poets chosen to compete produced three tragedies followed by a satyr-play; this last treated some heroic legend in a burlesque spirit, and its chorus consisted of satyrs, beings represented in human form with animal attributes, usually a horse's tail. In comedy five poets competed for the prize, each with one play. It is noteworthy that the satyr-play was always the work of a tragic poet and that the same poet never wrote both tragedies and comedies. Tragedy was introduced when Peisistratus founded, or rather refounded, the festival between 534 and 531 B.C., comedy not till 486. Plays were later introduced into the minor festival of Dionysus, the Lenaea, comedy about 440 and tragedy ten years later.

1. Comedy.—Although the establishment of comedy was subsequent to that of tragedy, and although the oldest surviving comedy, Aristophanes' *Acharnians* (425 B.C.), is some half a century later than the oldest extant tragedy, comedy preserves more obvious traces of its origin from ritual. Most of the earlier plays of Aristophanes can be roughly divided into four parts: an introduction, mainly in iambics, in which the basic fantasy is explained and developed; the parabasis, in which the chorus (sometimes represented as animals) interrupt the action in order to come forward and address the audience on topics of the day; the contest or agon,

a set debate, the most famous example of which is the one between the Just and the Unjust Argument in the *Clouds;* and finally a series of scenes, again in iambics, in which the hero, his project now achieved, gives short shrift to a number of characters who seek favours from him. The play ends with a banquet or a wedding. Aristotle states in the *Poetics* that Crates, about 450, was the first comic poet to give his play a plot, and that he did this under the influence of the Dorian comedy which had developed at Syracuse; previously Attic comedy had been satirical and abusive, having arisen from the improvisations, spoken or shouted rather than sung, of the leaders (*exarchontes*) of the phallic songs such as were still customary in his day at certain cities. Leaving for the moment the question of the iambic parts of comedy on which the plot mainly depends, it is easy to see a possible connection between the parabasis, with its attacks on individuals, and the more primitive ribaldry of the Dionysiac *komos* ("revel") from which comedy gets its name, "the song of the *komos*"; an alternative derivation from *kome* ("village") is mentioned by Aristotle but not approved by him. It is not quite clear from what kind of *komos* he supposed comedy to have been derived, but celebrations of the sort were common in Greece, loosely organized processions in which the phallus, the emblem of male fertility, was conspicuous, and in which those who took part were exhilarated by holy drunkenness, sang traditional songs with occasional inspired improvisations, and exchanged highly obscene badinage with the passers-by. The original function of the obscenity, though this was doubtless forgotten in historic times, was by spoken reference to the organs and actions of procreation to increase the fertility, both vegetable and animal, of the community; in addition, perhaps, by attributing to each other afflictions and infirmities which they had not got, they hoped to deceive the evil spirits who distribute such things and cause them to go elsewhere. A comic version of a *komos* is represented in the *Acharnians* 238–279.

It is easy to believe that the outspoken comments of the comic chorus developed from those of the *komos*. The connection between *komos* and the debate or agon is less obvious though not intrinsically unlikely; further, the agon shares with the parabasis the so-called epirrhematic structure, a roughly symmetrical arrangement of lyric stanzas and passages in "long" metres from which the iambic trimeter, the characteristic metre of dramatic dialogue, is virtually excluded. Without the agon there would be little need for actors at all, and comedy would not have reached the dramatic stage. But it is a plausible hypothesis that in the first 30 years after the introduction of comedy at the Dionysia it consisted mainly of an entry by the chorus leading up to parabasis and agon, and that the iambic prologue and the short iambic scenes at the end were added as the use of plot developed after about 450.

The precise form of *komos* from which Attic comedy arose is not known, but it may be significant, in view of the frequent occurrence in comedy of animal choruses, that men masquerading as animals and accompanied by a flute player are found on a number of Attic vases dating from about the end of the 6th century. Aristotle mentions also the existence of comedy at Megara at the time of the democracy in the 6th century, with which the shadowy figure of Susarion is sometimes associated, and "Megarian jokes" are mentioned with some contempt by Athenian comic poets. Athenaeus tells of a *komos* of potentially comic character at other places in Dorian Greece, notably the *phallophoroi* ("phallus bearers") at Sicyon. Figures, some with phallus, wearing heavily padded stomachs and buttocks similar to representations of Athenian comic actors are found on Corinthian vases of the late 7th century B.C. Incidentally, these are supposed by some to be satyrs of an original Peloponnesian type. They are certainly connected with Dionysus.

Whatever may be the truth about the influence of Dorian ritual on the choric parts of Attic comedy, there is some evidence of a Dorian origin for the more dramatic element. Athenaeus also mentions certain *deikelistai* who at an unspecified date performed at Sparta realistic scenes from low life with a number of stock characters like the quack doctor and the thief. In 1906 excavations in the sanctuary of Artemis Orthia at Sparta revealed a quantity of clay models of masks dating from the 6th century and resembling those used later in Attic comedy. Further, the *kordax*, the obscene dance of Attic comedy, is known to have been associated with Artemis. A possible channel for the transmission of this dramatic form to Athens is through Megara and the poet Epicharmus, who had a connection with the Megarian colony of Megara Hyblaea in Sicily. Epicharmus produced his comedies at Syracuse, probably at the festival of Artemis, during the first half of the 5th century. His plays had normally no chorus, and it is possible that his actors wore no phallus. His plots were sometimes realistic, and led eventually to the mime as found in the urban mimes of Theocritus, sometimes burlesque heroic; his characters were carefully differentiated studies in conventional types more like those of the Attic New Comedy than of the Old.

On the subject of the origins of comedy there is little that can be stated with confidence, but the theory of Attic comedy as a union between a native choric element connected with the cult of Dionysus and a Dorian drama which reached its full development in Sicily at least does not conflict with the evidence, internal or external.

2. Tragedy.—The only extant Greek tragedies are the 35 plays of Aeschylus, Sophocles and Euripides, written probably between 472 and 405. They contain no survivals comparable to those of comedy, though if ordinary Greek ritual forms were extant no doubt much in the hymns and dirges of tragedy would be found to resemble them. The point that emerges clearly when the plays are arranged as far as is possible in chronological order is that the chorus is increasingly predominant in the older plays, though there is now reason to think that the play with the greatest proportion of choral ode, the *Supplices* of Aeschylus, is not in fact the oldest. The conclusion that tragedy arose from a type of performance which was purely choral, though not necessarily correct, is supported by the celebrated fourth chapter of Aristotle's *Poetics*, which is the natural starting point for further inquiry.

The salient points in Aristotle's account are the following: tragedy began from the improvisations, presumably spoken, of the leaders (*exarchontes*) of the dithyramb; in the early stages the plays, if they can be so called, were short, the diction ludicrous, and the general character akin to that of the satyr-play; only at a late stage did the plays acquire size and dignity, and the metre of dialogue changed from the gay trochaic tetrameter to the iambic trimeter; Aeschylus added the second actor and made dialogue dominant over choral lyric; Sophocles added the third actor. This may be supplemented from the 26th oration of Themistius, who quotes Aristotle to the effect that Thespis introduced prologue and speech, which is to say that he was the first actor. It seems to have been the general belief that Thespis made this innovation and that tragedy became an accepted form when, probably toward the end of Thespis' life, Peisistratus made it part of the Dionysia about 534.

This tantalizingly brief account can be explained and expanded a little from other sources. "I know how to lead off (*exarchein*) the dithyramb, the song of the lord Dionysus, when my wits are thunderstruck with wine"; so wrote Archilochus, incidentally in trochaic tetrameters, in the 7th century B.C. The basic idea seems to be of the poet performer who improvises to a chorus which sings a traditional song in reply. Possibly this led the chorus to dramatize the subject of which they were singing instead of using lyric narrative. Otherwise this does not provide any obvious entry into drama, any more than the responses of two semichoruses, in which some scholars have supposed the origin of drama to lie. According to Herodotus the dithyramb itself was developed into a regular poetic form by Arion in Dorian Corinth about 600, but the statement in the Suda lexicon that Arion introduced speaking satyrs cannot be true if prologue and speeches were invented by Thespis, who was still alive *c.* 534. The statement in the same source that Arion invented the tragic method (*tropos*) means only that he used the musical "mode" afterward associated with tragedy.

The next step was the introduction of the actor, hardly before about 560; in other words, the *exarchon* became an actor who spoke a prologue and made speeches between choral songs; presumably his speech announcing events which had taken place off stage gave the motive for the next song. The form into which the

actor was introduced can scarcely have been the dithyramb, which continued as narrative lyric down to a late period. Presumably it was a kind of choral lyric in honour of Dionysus which had split off at an earlier date and was already called tragedy. Further, it is said to have been of satyric character, and nothing in the dithyramb suggests a connection with satyrs (except for dubious evidence from vases which may show a chorus of satyrs). Aristotle does not say that tragedy developed from the satyr-play; perhaps he accepted the tradition recorded in the Suda lexicon that the satyr-play proper was introduced by Pratinas from Phlius in the Peloponnese between 500 and 490; but he must mean that it was a largely humorous performance with a chorus of beings partly animal in form. Finally this changed to the more dignified tragic form using iambic metre. As Aeschylus was regarded in the late 5th century as the second founder of tragedy, Aristotle may have thought of the change as taking place soon after 499, when Aeschylus began to produce, though the time between Thespis and Aeschylus is short for such a change. Certainly the *Capture of Miletus* by Phrynichus, which in 494 reduced the theatre to tears, was no humorous work. The use of a second actor increased dramatic possibilities enormously, since dialogue was no longer restricted to one actor and the half-impersonal leader of the chorus.

So long as it was believed that satyrs were goat-men and that, just as comedy was the song of the *komos*, tragedy was the song of goats, this account seemed to have some measure of confirmation. But it has long been clear that at Athens in the 5th century no distinction was made between satyr and silenus and that both were a mixture of man and horse, although the shaggy skins worn by dancers in earlier representations may be meant to suggest goats. But to Plato, for instance, satyr-play and silenus-play were alternative expressions. Attempts to show that the chorus of satyrs was sometimes addressed as goats have failed, though both in the *Ichneutae* of Sophocles and in the *Cyclops* of Euripides they are called "beasts" (Gr. *theres*). And the word tragedy can be explained alternatively as song for a goat as prize, or song connected with the sacrifice of a goat. Doubts of the reliability of Aristotle's account are increased by the difficulty of combining with it the only other solid piece of early evidence. Herodotus relates that about 590 B.C. Cleisthenes, the anti-Dorian tyrant of Sicyon, in an effort to get rid of the Dorian hero Adrastus, disestablished his cult, taking away from him the "tragic choruses" which had celebrated his sufferings and giving them to Dionysus. The importance of this is that it suggests that the subject matter of tragedy is essentially the sufferings of heroes, not the story of Dionysus, so much so that in antiquity there was a saying "nothing to do with Dionysus," which may have arisen from the paradoxical absence of his story from the forms intended to do him honour. This passage was the main support for Sir William Ridgeway's theory in *The Origin of Tragedy* (1910) that tragedy was derived from lamentations at the tombs of heroes. Incidentally, it is unlikely that the chorus which lamented Adrastus was composed of satyrs. In regard to the reliability of Aristotle's account, therefore, two alternatives suggest themselves:

1. Aristotle, though writing nearly 200 years after the time when records began to be kept, none the less possessed reliable information which showed the progression dithyramb—satyr-type play—serious tragedy. He does indeed claim in the *Poetics* to have fuller knowledge of the history of tragedy than of comedy, though on the most natural reading of the words he refers not to origins but to later developments. It is a striking fact that from at least the early years of the 5th century tragedy and satyr-play were closely associated, written by the same poets and performed by the same chorus; it is hard to see why this should have happened unless there were strong historical reasons for it. Further, if Aristotle wrote from conjecture rather than knowledge, it is unlikely that he would have produced a theory so strikingly at variance with his own scheme of literary development, according to which the serious-minded on the one hand advanced from hymn and encomium through epic to tragedy, and on the other the frivolous passed from invective through lampoon to comedy. Presumably he would not have intruded the ludicrous satyr-play into the sequence of serious developments unless he had had good grounds for thinking that it belonged there.

2. On the other hand, it is quite possible that Aristotle possessed no reliable information about the period before Thespis or even Aeschylus. Observing the four literary forms, all connected with Dionysus, and the peculiarly close connection between tragedy and satyr-play, he may have suggested *a priori* that both of them were derived from the dithyramb, thus reducing the four to dithyramb and comedy as the basic pair, even though the difficulty of fitting the satyr-type play into the development of tragedy between Thespis and Aeschylus was considerable. The notices in later writings which seem to support the theory may be derived in the last resort from Aristotle and his school and so lack independent authority.

On the question of whether Aristotle had access to reliable information about the early history of tragedy modern opinion is very evenly divided. It is possible that tragedy, like comedy, arose out of a combination of Peloponnesian with local Attic ritual. There is evidence not to be dismissed lightly for tragic choruses connected with hero-worship at Sicyon and a tragic style of music, perhaps arising out of the dithyramb, at Corinth. A kind of Doric was used for the lyrics of Attic tragedy. It would be idle to pretend that there was positive evidence for rustic drama in Attica which might lie behind Thespis' innovation, but there seems to have been some primitive mumming at Eleutherae whence Dionysus came to Athens, and there was a Dionysiac legend attached to Icaria, the birthplace of Thespis. (D. W. Ls.)

B. History

1. Tragedy.—The history of tragedy between the institution of the contest (534/531 B.C.; *see* above) and the time of Aeschylus (first competed 499, first victory 484) is wholly obscure. Since even the mature drama of Aeschylus consists to a surprising extent of scenes between the chorus and a single actor, most conspicuously in the *Supplices* which many scholars now date to 463, it is likely that the earliest tragedy was very largely lyric. Aeschylus appears 11th on the list of those who won tragic victories, a small number for the 50 years down to 484 if the records are complete. Of his predecessors apart from Thespis only Choerilus, Pratinas and Phrynichus are known by name.

Phrynichus (first victory 511 B.C.; another 476, with Themistocles as choregus) claimed to have invented as many dance movements "as waves on a stormy sea" and wrote lyrics beloved by Aristophanes long afterward. Many of his plays started a tradition in tragedy; *e.g.*, *Alcestis* (*cf.* Euripides), *Danaides* together with *Aegyptii* (*cf.* Aeschylus) and *Phoenissae* (celebrating the victory of Salamis, like Aeschylus' *Persae*). His *Capture of Miletus*, however, celebrating a disaster with political bearings, incurred a fine and was never imitated.

In early times each tragic dance probably concentrated on one situation, so that the three made up a loosely connected story, like some of the recorded trilogies of Aeschylus. His *Oresteia*, however, the only surviving trilogy, was written toward the end of his life and is a magnificent unity. The element of epic story as opposed to Bacchic dance steadily increased. Aeschylus drew "slices from the great banquet of Homer" (not the *Iliad* and *Odyssey*, which belonged to the Panathenaea, but the rest of the epic tradition); and Sophocles was named "most Homeric." Sophocles particularly developed the "plot"; *i.e.*, the art of telling a story not by narrative but by action. Only one trilogy is credited to him, and he made each play an independent whole. The third actor, introduced by him (*see* above), led the way to complex dramatic effects: as when a messenger brings the news of Orestes' death at the same time to Clytemnestra and Electra, throwing one into exultation, the other into despair, while the news itself is a lie. No such effect could be produced with the two actors of Aeschylus, whose genius liked to concentrate on one great situation, like the age-long martyrdom of Prometheus, or one problem, like the crime that can only be avenged by more crime (*Oresteia*). Sophocles made his diction more natural, his character drawing more subtle and varied and his verse more fluent, often ending a line with no pause, and sometimes even with an elision. One may

say he created the "well-made play" admired by Aristotle.

Greek opinion, however, demanded, as may be seen from the *Frogs* and from Plato, that a poet should be *sophos* ("wise" or "enlightened") and Euripides particularly responded to the demand. In some ways he returned to Aeschylus in his grand choral effects, his religious problems, even his revival of the obsolete long-trochaic metre; but in thought he belongs to the Sophistic age, being a friend of Anaxagoras and Protagoras and particularly admired by Socrates. He subjected to criticism both the traditions about the gods and the Socratic theory that virtue is knowledge. He was also an adept in *rhetorike,* not "rhetoric" in its English sense but the new "art of speech," aiming at order and lucidity. His plays generally start with a prologue, often spoken by a supernatural being, explaining the subject, and end with a divine judgment or prophecy. This produces both a ritual form and an artistic pattern: calm—passion and crisis—calm. The variety of his themes is remarkable; he has dramas of love (*Hippolytus, Medea*), of mystery (*Bacchae*) and realism (*Electra*), of adventure (*Helena*), of epic fullness (*Phoenissae*) and of static Aeschylean tragedy (*Troades*).

Tragedies continued to be written and performed in large numbers during the 4th century B.C., and there was for a time in the 3rd century a school of tragic poets at Alexandria. At Athens the tragic festivals seem to have continued as late as the 2nd century A.D., but from all this activity only a number of names and a few fragments survive. The works of the three great poets and of several others were preserved practically complete in the great library at Alexandria, but later they ceased to be widely read or acted, and a small selection was made primarily for reading in schools about A.D. 200; these are the plays still extant, together with nine others of Euripides which chance has preserved.

2. Old Comedy.—This is known only by 11 plays of Aristophanes, though other writers, such as Cratinus, Eupolis, Crates, Pherecrates and Magnes, are known by name and by numerous fragments. A substantial portion of the *Demes* of Eupolis was recovered early in the 20th century. The subjects discussed are public and topical, whether political (*Acharnians, Knights, Lysistrata*), philosophical (*Clouds*) or literary (*Frogs, Thesmophoriazusae*), and seem to be addressed to a very well-read audience. As remains of the popular fertility revel the following may be noted: the frequently indecent language; the constant suggestion in the background of a better world to be attained in some new age; and the personal abuse of politicians, as in the cartoons in modern newspapers. These attacks were often violent, especially against the ultrademocratic war party, and were forbidden by law (414 B.C. and later) when that party was chiefly in power.

In the later plays of Aristophanes the choral lyric is sometimes omitted, its place being taken by the stage direction "chorus," as in Menander. Indeed his last plays, except for some burlesques of tragedy, form a transition to Middle Comedy, of which no fully developed play survives. The most important writers of Middle Comedy were Alexis and Antiphanes.

3. New Comedy.—This was a comedy of manners with no coarseness of dress or language and no mixture of the supernatural or heroic. "O Menander and life, which of you imitated the other?" asks one ancient critic. The characteristic plot is an inheritance from the adventure plays of Euripides, such as the *Ion,* in which a baby who has been exposed at birth is "recognized" and restored to the appropriate station in life; a frequent consequence in New Comedy is that it makes possible a desired marriage. The chief writers of New Comedy were Menander, Philemon and Diphilus. Only fragments of the two last-named survive. Menander also was known only by numerous quotations (including St. Paul's "evil communications corrupt good manners," I Cor. xv, 33) and Terence's Latin imitations until the discovery in 1905 of a papyrus containing a great part of three plays. In 1958 a complete play, the *Dyskolus,* was published, a somewhat surprising work by reason of the simplicity of its plot. The remains confirm the ancient praises of Menander's quietly witty style and delicate character drawing, but it is a little strange that his rather slight work should have enjoyed so extraordinary a reputation in the last centuries of the ancient world.

4. Production.—The typical Greek play of the late 5th century B.C. was performed in a large open-air theatre by three actors, who might take some ten parts between them, and a chorus of 15 (24 in comedy). In the absence of most theatrical devices the spectacle depended mainly on the richness of the actors' dress, which was often in striking contrast to the normal simplicity of Greek clothing. Masks were worn by all and tragic actors had leather boots (*cothurni*), which might have thick soles to increase the wearer's stature, though this was probably not customary until later than the 5th century. The crane (*mechane*) could be used to introduce deities traveling through the air (hence the expression *deus ex machina,* "god from the machine"), and a movable platform (*enkyklema*) to suggest an indoor setting. On the stage actors did little but talk. Violent action was described, often very vividly, in set speeches by messengers.

The plays, which were about half the length of an Elizabethan drama, were lightly divided into scenes by songs, accompanied by dancing, from the chorus; there were often four such songs in a play. During these songs a longer time might be supposed to elapse than the actual time taken by the performance, but, since an actor often remained present while the chorus sang, the break was less violent than when the curtain falls on the modern stage. At moments of high emotion spoken dialogue could be replaced by song, and Euripides often gave his characters long solos. The whole structure was remarkably varied and flexible.

Although a tradition of acting Latin comedies grew up in the Renaissance, Greek drama was not attempted on the stage until the late 19th century. Since then there have been numerous and successful performances both in the original Greek and in translation. The regular productions which take place in Greece itself are particularly celebrated. The two great difficulties to be surmounted are the absence of a familiar convention which might mitigate the strangeness of the chorus, and the general ignorance of the myths and legends of the Greeks from which the ancient dramatists took their themes, developing them in accordance with their own ideas in the assurance that the audience would see the significance of every variation from the tradition. It is striking that, whereas at the time when the universal use of the classics for education made these myths well known they were little used in the theatre apart from opera, dramatists of the 20th century have frequently sought to exploit the meaning and the emotion latent in such stories as those of Oedipus and Agamemnon.

(G. G. A. M.; D. W. Ls.)

III. ROMAN DRAMA

1. Early Dramatists.—The Romans claimed small originality for their drama, which derived mainly from Greece, but a native germ may have existed in the "Fescennine verses," rude exchanges of ribaldry in improvised rhythm at harvest homes and other occasions of merriment. Livy, in his summary of Roman dramatic origins, says that in 364 B.C., at a time of pestilence, Etruscan *ludiones* were summoned to Rome to avert by their dancing the wrath of the gods. This tradition of early Etruscan influence is supported by Livy's statement that the Etruscan word for "player" was *ister* (Lat. *histrio*) and by the probable connection of *persona,* "player's mask," with *phersu,* the name of the masked gladiator seen in some Etruscan tomb paintings.

From an early period Rome had been in contact with the Italian Greeks, and must have been aware of their dramatic exhibitions (illustrated, presumably, in the so-called phlyax vase paintings). Further, the Oscan inhabitants of Campania had long possessed a rude masked performance, afterward developed at Rome into a distinctive form under the title *fabula Atellana* (Atella was a town in Campania). From the combination of the Etruscan dance to music and the Fescennine verse there grew what Livy calls a "medley" (*satura*), which apparently had no plot, but consisted of jest, horseplay and songs composed for accompaniment by the pipes. However artificial and at times absurd Livy's account may be, it seems to contain elements of truth.

In 240 B.C., the year after the close of the First Punic War, Livius Andronicus, a Greek (probably from Tarentum) who made a living as a teacher and literary man at Rome, translated

a Greek play for production at the Roman games. The titles of eight (?) tragedies and three comedies of his survive. Their literary merit was probably slight; his achievement is to have been a pioneer (though the degree of skill with which Greek metres are handled in the extant dramatic fragments may suggest some doubt as to whether he really was a pioneer in adapting Greek verse to the Latin language). The native Italian genius of Gnaeus Naevius (first production in 235 B.C.) shone most brightly in comedy; titles of 34 of his comedies (translated, of course, from the Greek) are known, as against 7 tragedies. The fragments of the comedies are infused with a flavour of common and indeed low life, Italian in spite of the Greek framework. One of his most famous plays was the *Tarentilla*, which vividly portrayed one of those Greek courtesans with whom Roman soldiers must have become familiar in the war. The plot turned upon the adventures of two young men detected by their fathers living with two girls in Tarentum and haled back to respectability. Naevius' creation of the Roman historical play (*fabula praetextata*), dealing with heroes of Roman legend or contemporary history, is still more striking evidence of his originality. His outspoken attacks (presumably from the stage) on the nobility are said to have been punished with imprisonment or exile.

In tragedy Naevius was followed by the great poet Quintus Ennius, who was born in Calabria in 239 and died in 169 B.C. In comedy he seems to have been a failure (two comedies only are known by name), but there are titles and fragments of about 20 tragedies and perhaps 2 *praetextatae*. He is said to have been especially attracted by Euripides; his translation of the *Medea* was famous, and his *Andromacha* was well known as late as the time of Cicero, who loved to read and quote him.

2. Plautus and Terence.—After Ennius no one attempted both tragedy and comedy. Indeed Titus Maccius Plautus (*c.* 250–184 B.C.), a native of Sarsina in Umbria, had already confined himself to comedy. He is the great representative of the *fabula palliata*, translated from Greek New (some would add Middle) Comedy; 20 of his plays are extant. He introduced quite freely allusions to Roman legal procedure, manners and customs, Italian place names and Latin puns. Of large-scale alteration the only specific evidence is Terence's statement that he omitted a scene through "carelessness," but his boisterous humour turns his "translations" into original Italian comedies. One of the greatest masters of the Latin language, Plautus riots and gambols in dialogue in which everything is sacrificed to the desire to raise a laugh, but the nimbleness and suppleness of his diction are extraordinary. His high spirits and his mastery of dialogue and metre were never again equaled in Roman comedy.

Statius Caecilius (d. 168 B.C.) was regarded by some later critics as the chief of Roman writers of comedy. He was famed for his *argumenta* ("plots," or perhaps "exposition of the plot"), moral force and emotional power. His chief model was Menander, to whom he owed 16 of his 42 named comedies; the fragments, while free from allusions to Italian topics, show that he could on occasion alter and coarsen the style of his original.

Terence (*c.* 185?–*c.* 159 B.C.) traditionally came from Carthage to Rome as a slave, and became a literary friend of "noblemen" (later identified with Scipio and his circle). His literary methods incurred the jealous hostility of a rival dramatist, Luscius Lanuvinus. Of Terence's six plays it is generally held that the first was the *Andria*, produced in 166, and the last the *Adelphi*, produced in 160 B.C. His prologues deal sharply with the attacks of his critics and the fickleness of the public. Terence lacks the boisterous mirth, rich vocabulary and metrical mastery of Plautus; his style is graceful and correct without formality; he is free from the discrepancies of Plautus; his main interest is in the portrayal of character; his deliberate departures (attested by Donatus) from his models were criticized by his enemies as *contaminatio*, "spoiling," but the only alterations which he admits are occasional borrowings from a second Greek source.

The only other writer of *palliatae* who is more than a name is Sextus Turpilius (d. 103 B.C.). He seems to have kept close to his Greek originals; his *Leucadia* (from Menander) had an unusually interesting plot; his *Demiurgus* was revived in Cicero's day. Turpilius is the last known writer of comedy, but old *palliatae* continued to be produced until the end of the republic and perhaps later.

3. Later Developments.—Roman tragedy after Ennius was continued by his nephew, Marcus Pacuvius (*c.* 220–*c.* 130 B.C.), born at Brundisium, a painter as well as a poet. Titles and fragments of 12 tragedies and one *praetextata* still remain. He was regarded by later critics as the chief Roman writer of tragedy, or second only to Accius; his plays contained famous pathetic scenes; he was celebrated for his "learning," and seems to have paid particular attention to sound effects. Many of his plays continued to be performed down to the end of the republic; a canticum from his *Armorum Iudicium* was declaimed at the funeral of Julius Caesar. Later generations seem to have wearied of his harsh, strained style, his weird compounds and his pedantry.

In strong contrast was the spirited and lofty genius of L. Accius (170–*c.* 85 B.C.), a man of immense energy, who has left the titles of over 40 tragedies and of two *praetextatae*. He liked violent plots, flamboyant character drawing and forceful rhetoric; his *Atreus* contained the famous retort *oderint dum metuant!* ("let them hate provided that they fear"). In him republican tragedy is at its climax and already approaching the excessively rhetorical style of Seneca. Perhaps Accius was the last writer of tragedies intended for the stage.

The native Latin comedy, *fabula togata*, may have come into being about the end of the 2nd century B.C. It seems to have avoided dangerously political topics by keeping to the life of obscure folk and of the country towns. Its chief writers were Titinius (of unknown date), T. Quinctius Atta (d. 77 B.C.) and Lucius Afranius, who lived later than Terence (whom he praises) and who seems to have brought the *togata* to its highest point; his *Simulans* was performed in Cicero's day, his *Incendium* during Nero's principate. Nothing is known of the plots of the *togatae*, or of the rustic *Atellanae* which had a vogue in the last century B.C. These farces had originally dealt with stock characters (Maccus, the clown; Pappus, the old fellow; Manducus, "Champjaws," the ogre; Dossennus, usually explained as the "hunchback," from *dorsum*). Pomponius and Novius gave the *Atellana* literary form.

About this time, too, the maskless mime came into fashion; Cicero seems to say that by his day mimes had ousted the *Atellanae* from public favour. The principal writers of these often immoral playlets were Decimus Laberius (*c.* 105–43 B.C.) and Publilius Syrus, a former slave from Syria, who successfully challenged the sexagenarian Laberius to a dramatic contest at the *ludi Caesaris* in 46 or 45. There is a large collection of *sententiae* or pithy sayings attributed to Syrus.

During the last century of the republic the tragedies of the earlier masters were frequently produced. The Augustan age gave birth to two new plays (now lost), Varius' *Thyestes* and Ovid's *Medea*. The writing of tragedies for "recitation" (reading aloud to an invited audience) now became a fashion; this is perhaps the origin of the nine tragedies attributed to the younger Seneca. In these plot and character are subordinated to extravagantly rhetorical effects and display of ingenuity and erudition; artificial as they appear today, they exercised great influence at the time of the Renaissance. The only extant *praetextata*, the *Octavia*, must have been written after the death of Nero.

4. Production of Plays.—Performances of plays were part of the free public entertainment offered at the great festivals (*ludi Romani, Megalesia*, etc.) or at funerals, triumphs and the dedication of temples. The earliest scene buildings were no doubt simple structures of wood, put up for the occasion. Seats for spectators are mentioned in the plays and prologues of Plautus; in 194 B.C., according to Livy, special seats were assigned to the senators. An attempt in 155 B.C. to build a stone theatre was prevented by the consul Publius Cornelius Scipio Nasica; Pompey's stone theatre was built in 55 B.C.

The scene building formed the permanent background to the performance; changeable scenery was unknown. The actors declaimed to music provided by the piper (*tibicen*). At first authors acted in their own plays; but later a manager (such as Ambivius Turpio, who produced for Caecilius and Terence) with a troupe

of actors (*grex*) brought out the play, engaging their services to the magistrate who had charge of the festival. The actors may have been slaves (though the Atellan farces, according to Livy, were produced by freeborn citizens down to his own day); in the course of time, however, great actors such as Clodius Aesopus in tragedy and Quintus Roscius in comedy are said to have achieved not only fame and fortune but a certain position in society. At the bottom of the social scale came the mime.

5. Downfall of the Classical Drama.—The great theatres of the empire seem to have been intended chiefly for trivial or degrading performances. There were dramatic *cantica;* thus Nero "sang" such parts as Orestes the matricide. Far more important was the *pantomimus,* the masked dancer, who performed scenes in dumb show, supported by a chorus. This "Italian dance" was introduced in 22 B.C. by Pylades and Bathyllus. The themes were mostly taken from mythology; the librettos sung by the chorus for these ballets (*fabulae salticae*) were sometimes written by such eminent poets as Lucan and Statius. Purely literary plays of every type continued to be written, but not, apparently, for the stage. A *comoedus* was now a slave who read extracts from comedy at a banquet; on the stage comedy gave place to farce, chiefly the mime, which survived all other kinds of comic performances, perhaps because of its more audacious immorality and open obscenity. Women as well as men took part in these performances; in the 6th century the mime actress Theodora captivated Justinian himself and became his empress. Long before this the mime had come into open and bitter conflict with the Christian church, which, without usually caring to distinguish between the nobler and the looser elements in the drama, involved all its manifestations in a consistent condemnation (as in Tertullian's *De spectaculis*).

At Rome the last mention of *spectacula* as still in existence seems to date from the earlier half of the 6th century. In the capital and provinces of the eastern empire the decline and fall of the stage cannot be similarly traced. Perhaps the mimes, as they lost all footing in the centres of civic life, became a wandering fraternity, who appeared at festivals when their presence was required, and vanished again into the depths of the obscurity which has ever covered the strolling player's life. These strange intermediaries carried into succeeding ages such traditions as survived of the acting drama of pagan antiquity. (WM. BE.)

IV. MEDIEVAL DRAMA

1. Forms and Content.—The traditional concept of medieval drama is so inclusive that it takes in many spectacular activities that are not in the true sense drama at all. May games, sword dances, processions and dumb shows in honour of royal and noble persons entering or passing through cities, and pageants in general, lack one or more of the three essentials of true drama—impersonation, dialogue and action. This is not true of the three principal kinds of medieval drama, mystery plays, miracle plays and morality plays, all of which make use of all three elements of drama. It can also be seen that the middle ages invented, somewhat sporadically, the farce and the *pastourelle.*

The first and most important of these forms is the mystery play, derived, like the French *mystère,* from the Latin *ministerium* ("service"), for the mystery play grew out of the liturgy and was controlled by it from beginning to end. The word "mystery" here carries no suggestion of the unknown and the unknowable. The mystery play originated in the *Quem quaeritis* trope, a musical addition to the liturgy of the 9th century, and grew gradually greater for about six centuries by the addition of scenes and themes into perhaps the most extensive dramatic series that has ever appeared in the world.

In the presence of this wide inclusiveness and this manifestation of such deep human interest it is necessary to ask where the events originated and how they were used in drama. The source is obviously the Bible, but not by free choice of subject; during the earlier centuries of the Christian church a process of selection of biblical topics manifested itself for purposes of instruction and commemoration, the main points being man's creation, fall and redemption.

The word "liturgy" in its stricter sense refers to the manner of the celebration of the Eucharist or Lord's Supper, a daily service of prayer whose guide is the missal or prayer book. This does not normally include historical or instructional features except in matters of daily conduct. In a more general sense, "liturgy" means all the services of the church, thus including the service of the divine office. The latter is concerned with the vast number of special services observed throughout the year, with which the development of religious houses, or monasteries, was closely related. Houses of monks and nuns, by their specialization, could carry through day by day and hour by hour the full commemorative and instructional requirements of the church; cathedrals, priories, collegiate churches and perhaps some amplified parish churches could also meet the full requirement. They did this according to a division of the day into set periods, called hours (*see* HOURS, CANONICAL). Of these so-called hours, matins, the night office, is of particular interest to the student of drama. It was a long period of relative leisure devoted mainly to worship and to readings from the Scriptures and the Church Fathers, and it seems to have been the time when religious plays were written and revised.

Instruction took the form of lections, selections from the Bible, not chosen according to individual motive but prescribed (*see* LECTIONARY). The year itself was divided into seasons, each with its special significance in the telling of the great story. The year began with Advent, starting the Sunday nearest to Nov. 30, which was a time for the contemplation of ultimate things. From Advent came the plays of the Last Judgment and of Antichrist. Christmastide and Epiphany, a period of 13 days, told the stories of the nativity, the shepherds and the magi. The days after Epiphany were devoted to the creation and the lives and deeds of the patriarchs. Lent and Eastertide dealt with the passion and the resurrection (*see* CHURCH YEAR).

By the 11th century the number of service books necessary to perform the service of the hours (or divine office) had become great, and a condensation known as the breviary was made. It was divided into two parts: the Temporale, devoted to events recorded in the Bible, and the Sanctorale, containing services in commemoration of saints and martyrs (*see* BREVIARY: *Contents*). It may be said that mystery plays belong with the Temporale and miracle plays with the Sanctorale.

Miracle plays originated in the liturgy as did the mystery plays and like them increased greatly in size and number until miracle plays became of almost equal importance with mystery plays. Most saints' plays in English were destroyed during the Reformation, but great numbers have been preserved in France.

The third great kind of medieval drama is the morality play. It was the last invented (by about 1400) and possibly reached its finest form in English. It is discussed at some length below, and in these introductory remarks it is necessary only to insist on a clear understanding as to what a morality play is. It is basically a dramatized allegory. The mere appearance of allegory in plays does not make them morality plays, since in the middle ages allegory was apt to appear anywhere and everywhere.

In the mid-20th century there have been many revivals of mystery plays. The Chester cycle has been successfully performed in a simple manner. The York plays have been produced triennially. This was a more difficult undertaking and the cycle was more modernized. There has also been on the stage a popular condensation and modernization of the Wakefield cycle. Various single mystery plays have also been put on the stage, mainly by amateurs. Possibly the most detailed and accurate of the revivals is that of the Beauvais *Daniel* from ms. Egerton 2615 in the British museum, London, with full choral and liturgical accompaniment. There are also many places in France, Germany, the Netherlands and Austria where mystery plays have continued to be performed by the people or have been revived for particular reasons. The most famous is Oberammergau (*q.v.*).

2. The Revival of Drama: The Mystery Play.—During the Carolingian renaissance of the 9th century there was a new impulse in the field of church music, and simple attempts were made to beautify the Gregorian chant (*see* PLAINSONG: *The Gregorian*

Music), mainly by variation of final syllables in such words as *hallelujah*. These additions were recorded in an imperfect system of musical notation (*q.v.*) known as *neumae*. There was no staff, and it has been suggested that, since tunes are best remembered when coupled with words, these variations were associated with appropriate language and that these words came to be tropes. They were chosen from passages associated with the context and became, as time went on, very abundant, and indeed occupied whole volumes called *Troperia*. One of these was widely accepted and began to operate as a living drama. In the course of a century or so this trope took on the form of a fully developed play of the resurrection.

The earliest example appears in a 10th-century manuscript from the monastery of St. Gall in Switzerland. It was sung in connection with the Mass of Easter as an addition to the service and is known as the *Quem quaeritis:*

Item de Resurrectione Domini

Interrogatio:

Quem quaeritis in sepulchro Christicolae? ("Whom seek ye in the sepulchre, Christian women?")

Responsio:

Iesum Nazarenum crucifixum, o caelicolae. ("Jesus of Nazareth the crucified one, O dwellers in heaven.")

Non est hic, surrexit sicut praedixerat; ite, nunciate quia surrexit de sepulchro. ("He is not here, he has arisen as it has been prophesied; go ye and announce that he has arisen from the tomb.")

Resurrexi.

The last word—"I have arisen"—belongs to the next feature of the service of the Mass. The scene is at the tomb of Jesus, and the first interrogation is that of the angel of the tomb. The first response is that of the three Marys whose mission is to anoint the body of the Lord (Luke xxiii, 55–56). The phraseology is not, however, from the Gospel of St. Luke but is repeated from various parts of the service of the Easter Mass. The words "Go and announce that he has arisen from the tomb" are themselves an invitation to further development and the trope grew by incremental additions.

An idea of the early stages of growth can be derived from the service as described in the *Regularis Concordia* of St. Ethelwold, a document for the direction of Benedictine monasteries prepared at Winchester between A.D. 965 and 975. This stage of development is shown also in the *Winchester Troper*, a Bodleian manuscript (No. 775) dating from A.D. 979. Indeed, there are many manuscripts from continental countries, published or described by Karl Young (see *Bibliography*), which show the *Quem quaeritis* in an early stage such as that of *Regularis Concordia* or in various more advanced conditions. The next earliest version from England, however, is a 14th-century version considerably extended. It belonged to the Sarum service and is preserved in ms. 15,540 in the Bodleian library at Oxford, but was formerly in possession of the Church of St. John the Evangelist in Dublin. It begins with a series of laments of the three Marys on their way to the tomb, always a lyrical feature of the play; then comes the *Quem quaeritis* trope; then the episode of the visit of the disciples Peter and John in response to the report of the Marys; then a lyrical sequence, *Victimae paschali laudes*, of importance in the further development of the play; then a dialogue between the Marys and the disciples (apparently represented by the choir), who sing a song of glorification. After that the service of matins is ended with the singing of *Te Deum*. All this is still within the limits of the original scene, but another closely related event appears in many early manuscripts. It is, as recorded in St. John's Gospel, Christ's appearance to Mary Magdalen in the garden.

The next important addition, in the 12th century, is the *Peregrini*, a play based on the story of the walk to Emmaus, as recorded in Luke xxiv, 13–35, which later had added to it the appearance of Christ to the disciples in the upper chamber. This almost completes the story of the development of the resurrection plays proper. The Harrowing of Hell, based on the apocryphal Gospel of Nicodemus, which seems to have had an independent origin, was intruded into the resurrection play, and, with the same desire for completeness, there was prefixed a scene showing the Setting of the Watch to prevent the friends of Jesus from removing the body from the sepulchre. In it appears Pilate, the first hostile character to appear in the plays.

Passion Plays.—Plays of the resurrection group, although important theologically, proved after the performance of mystery plays came into secular hands (*see* below) to be less popular than plays of the passion, and the question is whether or not passion plays originated within the church. The evidence is scanty but it is clear that such plays did belong to the Latin and not the vernacular drama. Only two dramatic texts have been preserved. Both are in the 13th-century German Benediktbeueren manuscript. The first, the *Ludus breviter de Passione*, is clearly marked as a prologue or first part of a resurrection play; indeed, it gives at the end the first line of such a play. This is the way in which one might expect that scenes of the passion would be developed within the drama of the church. The other text, longer and fuller, suggests a different origin. It begins with the calling of Peter and Andrew (Matt. iv, 18–20) and proceeds through the plays of the ministry of Jesus, the betrayal, capture, trials, crucifixion, death and burial, which seem to be taken with little modification from New Testament readings. But these parts seem to be an amplification of an independent play on the worldly life of St. Mary Magdalen and the raising of Lazarus, like those that appear in independent liturgical *ordines* on these subjects. At any rate, it can definitely be stated that the play of the passion in Latin was late in developing.

Pastores and Magi.—The second great unit of the medieval mystery play is made up of plays that arose contemporaneously with the Easter plays at Christmas and the Epiphany. Development follows the same route in these plays as that followed in the Easter group. For the play of the shepherds (*pastores*) there is actually a trope imitative of the Easter *Quem quaeritis*. It is of the 11th century from Limoges, and we have *Quem quaeritis in praesepe, pastores, dicite?* ("Whom seek ye in the crib, shepherds, speak?") The question is asked by the midwives, and the shepherds say they have been led to the crib of Jesus by the prophecy of Isaiah (Isa. vii, 14). To this was soon added an episode of the announcement of the birth of the Saviour to the shepherds as they were tending their flocks in the field (Luke ii, 10–11). With slight additions the popular play of the shepherds was complete. Meantime, there arose at the Epiphany (Jan. 6) a tiny play of the magi or wise men of the east (Matt. ii, 1–16), and the *pastores* and the magi were united and amplified by the activities of the great villain Herod, who attempts to destroy the magi and in his rage at their escape, orders the killing of the children, or the slaughter of the innocents. This in turn brings into existence the play of the flight into Egypt, and to that in some plays were added the traditional episodes of the fruit-laden cherry tree and the falling of the Egyptian idols.

The Christmas cycle is not complete, however, without the play of the prophets (*prophetae*), a most interesting development. A sermon wrongly attributed to St. Augustine, and read as a lesson at matins on the night before Christmas, developed as a sort of processional play that was used as prologue to the Christmas group. The sermon, which is highly rhetorical, was designed to convert Jews, pagans and Arians. It was the part directed at the Jews that grew into a play. It is a principle of Jewish Law, the preacher says, that the testimony of two witnesses is adequate for the establishment of truth. He will bring forward many witnesses, and he proceeds to recite messianic prophecies from Isaiah, Jeremiah, Daniel, Moses, David and Habakkuk. He goes further and quotes Simeon, Zacharias, Elizabeth and John the Baptist; even cities three witnesses from the pagans themselves: Virgil, Nebuchadrezzar and the Erythrean Sybil (who prophesied the Trojan War). In a very simple play from Limoges (11th century) the prophets in costume recite their prophesies, St. Augustine being the precentor. Another *prophetae* from Laon goes further in development, as does a play from Rouen, with many more prophets and greater scenic growth. With the addition of the annunciation and the visit to Elizabeth the structure of the Christmas cycle, a play that in one form or another lasted for centuries, and still survives in the modern nativity play, was complete.

Old Testament Plays and Others.—On the three Sundays and ferial days of the weeks preceding Lent the readings at the serv-

ices of the hours were from Genesis and Exodus, with some other small parts from the Pentateuch, and thus provided the materials for Old Testament plays. There exist a fragmentary play of Joseph from Laon (13th century) and one from Vorau of Isaac and Rebecca and their sons, dated by Karl Young at the end of the 12th century (see *Bibliography*). It is clear that both of these were performed inside the church as part of the service. Also, some testimony comes from the famous 12th-century play of the temptation and fall of man, the *Ordo Adae*. It is in Anglo-Norman, and, although carefully scriptural, is highly developed. Stage directions and quotations from the liturgy are still in Latin, and there can be little doubt that it originated in the church service. This is only part of the well-known list of popular Old Testament plays in the vernacular. A play of the fall of Lucifer is known to be of later origin than are the main body of Old Testament plays: the creation, the fall, Cain and Abel, Noah, Abraham and Isaac, Jacob, Joseph and Moses and the exodus, with other occasional plays—the death of Cain, Seth in Paradise—and at least two plays that seem to have originated from the *prophetae*—Balaam, and Moses and the tables of the Law.

The other important group of plays necessary to present the whole story of mankind in relation to God are plays of the last judgment, the *Judicium*. They are normally only two and these may have originated together as parts of one theme—Antichrist and doomsday. *Antichristus* was a traditional devil mentioned in II Thess. ii, 3–11 and elsewhere in the New Testament, and was well known. A drama on the subject appears in a highly advanced stage with political bearings in the Tegernsee manuscript of the 12th century, and it has been thought that that play is the original rather than an amplification, but this is now seen to be a mistake. The play appears in a much simpler form, as if from the liturgy, in an Italian version, along with the *Judicium*. This other Advent theme of the last judgment, which became a necessary part of full-scope mystery plays, rests on Matt. xxv, 31–46 and was a regular feature of the liturgy of Advent. Another play of considerable interest is the *Sponsus* or play of the wise and the foolish virgins (Matt. xxv, 1–13). This led an independent existence of some scope.

Period of Transition.—By the early 14th century the religious drama had in most places passed from the hands of the clergy into the hands of the laity. The process was a long one, no doubt varied from place to place, and was never complete. It is thought that trade guilds, which were also religious guilds, were the principal avenue of transition. At least it may be said that, after the transfer was complete, trade guilds were in many places in charge. Also, mainly in France, guilds of minstrels or musicians called *puys* were in charge of religious plays. The move was also in most places made from indoors to outdoors. It is clear that the *Ordo Adae* was acted at the church door, partly inside and partly outside a church, and there is an interesting record from Beverley, Yorkshire, from *c.* 1220, of a play of the resurrection that was then being performed between the buttresses on the north side of the Church of St. John of Beverley.

The transition from Latin to the vernacular was a still more gradual process. In any purely liturgical plays short phrases in the vernacular appeared either by way of paraphrase or as lyrical forms. The development was always toward making the plays intelligible to the uneducated audience. This concession to those who did not understand Latin appears first in dialogue, and in many instances the vernacular took possession of the dialogue while Latin remained in stage directions, quotations from the service and in those parts of a play that were to be spoken or sung by groups of characters.

Corpus Christi Plays and Passion Plays.—A turning point came, particularly in England, with the feast of Corpus Christi, which was established by the Council of Vienna in 1311. The feast is in honour of the Eucharist and is observed on the Thursday after Trinity Sunday. Its observance spread rapidly over Europe and it was celebrated at Canterbury in 1318 and at London in 1347. Some remarkable changes took place in the religious drama in some places in England, Germany, Spain and possibly France as the new feast became a centre of dramatic activity. The region affected in England was mainly the northern and midland counties.

It is possible that the pattern of the Corpus Christi play came from Chester, where a full-scope play, from the creation to the last judgment, seems to have been borrowed from France and translated into English. The traditional date, which has been questioned, however, is 1328. This French play has been identified with the famous *Le Mystère du Viel Testament*, but it cannot of course have been that play in the form in which it now exists in a printed version of 1501. In the 175 years between the early 14th and the beginning of the 16th century the French religious drama underwent enormous changes and amplifications, and the original form of the play is unknown.

There are unmistakable records of Corpus Christi plays in about 20 places in England, and there may have been more. Texts of such plays have been preserved from Chester, York, Wakefield (usually called the Towneley plays from the owner of the manuscript) and another cycle known erroneously as *Ludus Coventriae* or Hegge plays, which may possibly be the lost Lincoln plays. The conjecture that this cycle represents the lost Lincoln plays rests on various circumstantial considerations: similarity in dialect, since it may at least be said that there are no dialectal obstacles in the way; evidence of theological culture in the cycle, since Lincoln was outstanding in the middle ages as a seat of learning; but mainly a set of agreements between Lincoln records as to the special features of the Lincoln cycle and the obvious contents and forms of *Ludus Coventriae*. One of these is the union of a St. Anne's day play with a Corpus Christi play appearing in both the manuscript and the Lincoln records. The idea is presented only as an attractive probability and for further detail the reader is referred to Hardin Craig's *English Religious Drama of the Middle Ages* (1955).

Besides these full cycles, there are preserved two single plays or pageants from Coventry, one from Norwich and one from Newcastle upon Tyne. There are also two plays of Abraham and Isaac whose cyclic connection is not known although their form indicates that they are part of a Corpus Christi play. Besides these, the Digby manuscript (in the Bodleian library, Oxford; a collection of plays from different sources and dates) contains three plays that seem to be independent. There is the conversion of St. Paul, always an independent play and acted in some unknown small town; a play of St. Mary Magdalen with the raising of Lazarus and a play of the slaughter of the innocents, which is one annual part of a play performed on St. Anne's day (July 26). Another Bodleian manuscript contains a burial and resurrection, which seems to be a play on those subjects never joined with a cycle.

While the plays were still performed in the church, certain places called *loca* or *sedes* were fixed upon, and much of the action took place in the space between these stations. This is the basis of the multiple stage of the medieval drama, for when the plays were taken out of doors the same system was followed. Stations were grouped together, and spectators occupied the area around the group of *loca* or *sedes*, which had now become decorated platforms called "mansions," each one representing a particular locality. The action was largely in the *platea*, the space between and in front of the platforms. Many of these areas must have been circular. When, however, the plays again went indoors, into a hall, the various stations were arranged side by side on a platform, distance still being imaginary. The feast of Corpus Christi had a procession about the city, and in some places the procession was made up of individual scenes. The stations necessary for such processional plays were loaded on wagons called pageants and drawn to selected, open places, where the plays, in chronological order, pageant after pageant, were enacted. Some of these pageants showed more than one locality, so that distance was still disregarded. The classical idea of unity of place was not introduced into the drama until the Renaissance.

The English Corpus Christi plays happen to be better preserved, both as regards texts and records, than any other, so that there is a general impression that all medieval religious drama took their form, although, in point of fact, Corpus Christi plays were

not even dominant in England, being confined to a relatively few northern and midland cities. The Corpus Christi plays were also exceptional on the continent of Europe, and even in London and the southern counties, from which no texts and few records have been preserved, the large-scale mystery plays were passion plays. The main difference between these and the Corpus Christi cycles is that the passion plays had no plays of the nativity. There is a great stock of such passion plays in French and German, and a few in Low German and Spanish. No doubt they were once plentiful in Italy, although none has been preserved.

There are simple passion plays in the vernacular, not far removed from the strictly liturgical plays of the church, from Trier and Wolfenbüttel in Germany, and a fragmentary early play from Kloster Muri in Switzerland. Later and fuller plays in German come from Redentin, Vienna and Erlau. St. Gall in Switzerland supplied two most interesting early plays, one of the passion, the other of the nativity. In fact, most stages of development are represented in the plays in German, culminating in a host of long later passion plays—those from Alsfeld, Frankfurt, Heidelberg in Germany and the Tirol in Austria. In France the drama has not been studied from the point of view of development, and what we have are great passion plays from Semur, Arras and Angers, and the vastly expanded works attributed to Arnoul Greban and Jean Michel. Little is known about these two great 15th-century figures in the history of *les mystères* in France. Greban, poet and musician, was born at Le Mans and died there about the year 1471. Michel, who was younger than Greban and made use of his work, is known only as a dramatist and man of culture. They are thought of by some scholars as independent dramatists, but they are merely the last of a long series of redactors. Both wrote long plays on the passion, which when combined and acted in 1507 ran to 65,000 lines and occupied six days in the performance.

Cyclic Plays in England.—Much remains of the English cyclic plays, however much the losses may be regretted. Each of the four extant cycles—York, Wakefield, Towneley and the so-called *Ludus Coventriae*—has its own greatness as a picture of the spiritual life of the middle ages. Each is a version of the great story of the fall and redemption of man which reveals the goodness and wisdom of God. If the fitting of symbols to events, ideas and emotions may be rightly taken as the basis of the growth of the mind, how could a long period of slow human development have had a better subject for contemplation? The Chester plays, which are rich in content, underwent the least change in spirit and style. They tell the great story in adequate yet simple form. The local and municipal pride of the prosperous city of Chester is the most probable reason for this truly medieval adequacy of the Chester plays.

York was also a long-established centre of medieval culture, and the York plays show careful preservation of early style in a different yet characteristic way. York was for centuries powerful politically and religiously and was industrially prosperous. Trade guilds in York were numerous and anxious to participate in the fashionable Corpus Christi play. It was managed by the municipality itself and in consequence the number of plays was greatly increased both by the division of existing plays and the creation of new ones. In this amplification use was made of a narrative poem originating from Northumbria, *The Northern Passion*, and later of the vernacular *Gospel of Nicodemus;* still later, with further use of the New Testament Apocrypha, there was a great redaction of the plays into alliterative verse. It affects about 14 plays and this last great redactor or reviser of the York plays was a dramatic genius of excellent quality.

The Wakefield plays, preserved in the slightly imperfect Towneley manuscript, now in the Huntington library in California, were originally identical with the York plays. At some time, probably in the later 14th century, the York plays were transferred bodily to Wakefield and established there as a Corpus Christi cycle. After the transfer each cycle went its own way. Six plays within the cycles remain practically unchanged and there are identical speeches here and there in other plays. Twelve plays have been revised in York and not in Wakefield; five in Wakefield and not in York. There are also 12 plays that seem to have undergone independent revisions in both cycles. Finally, there are some plays in one cycle that do not appear in the other. This is in large part due to defects or omissions in one manuscript and not in the other, although, at least in the York cycle, there may be plays composed after the separation. The best-known feature of the Towneley cycle is the work of a talented redactor, described by C. M. as "the Wakefield Master" in his article on him (*International Quarterly,* 1905). Brilliant in metre, language and rhyme, particularly in the management of stanza forms, witty and satirical, his work is easily recognizable.

The fourth of the great cycles is sometimes called the Hegge (pronounced "hedge") plays, again from an early owner of the manuscript. Its old name is *Ludus Coventriae* because it was thought to come from Coventry. Early in the 19th century, however, it was seen that these plays could not be the Coventry cycle, because some parts of the true Coventry were known, and they were very different plays. The Hegge plays as a whole are distinguished for dignity and theological learning.

A Cornish mystery play, which appears in three great groups—creation, passion and resurrection—is in early and simple form, with, however, a different basis from the English plays. They are evidently like the plays acted in Brittany and are distinguished by the introduction of a wide variety of subjects. Little is known about the mystery plays of London except that they were of enormous extent. They were of early origin, and a great play at Skinners Well, near Clerkenwell, in 1409, lasted for five days. It included the creation and apparently the passion and must have been acted on a stationary stage like the passion plays of the continent. It may be inferred that the lost plays of southern England were also of the continental type. Nativity plays were probably acted separately, and this may also have been true at Aberdeen. The Creed play, dating from the early 15th century and performed at York every tenth year instead of the Corpus Christi cycle, not on Corpus Christi but on Aug. 1, the feast of St. Peter ad Vincula, seems to have been on the popular French theme of the Apostles' Creed—to which, it was thought, each of the apostles had contributed a clause—illustrated by incidents from their lives.

Mystery plays, which were as a whole simple and devotional and not theological or controversial, were partly suppressed during the Reformation and partly merely neglected in the revival of classical learning at the Renaissance. There is evidence that their loss was lamented by simple citizens.

3. The Miracle Play.—Miracle plays, or plays presenting the lives and martyrdoms of the saints, originated in the liturgy in the same way as the mystery plays. This is clear from a single example. There exist four liturgical plays in Latin drawn from the legend of St. Nicholas, mainly, perhaps all, derived from the service of St. Nicholas' day (Dec. 6). There may have been other saints' plays in Latin, but none has been discovered. There are early records of a play of St. Catherine at Dunstable, *c.* 1100, and an early play of St. Dorothea located by W. Creizenach (see *Bibliography*) in Upper Saxony. Plays of St. Agnes and St. George are probably of early origin. Miracle plays of the Virgin Mary as well as of the saints were numerous in Germany, indeed all over Europe, and grew to great proportions in France, as witnessed by the 14th-century collection, *Les Miracles de Nostre Dame.* They were also numerous in England and Scotland, but the zeal of the reformers has destroyed the texts. There were plays of St. Catherine, St. George, St. John the Baptist, St. Nicholas and many others, but all that are left in English are the *Croxton Play of the Sacrament* in east midland dialect, probably dating from the 15th century, which describes a miracle said to have taken place in 1461; and the possibility that the manuscript called *Dux Moraud,* which appears to have been written down in the 14th century and was found on the margin of an assize roll, is a single player's part of a miracle play. There is also a miracle play in ancient Cornish on the life of St. Meriasek from Cambourne in Cornwall.

The lost Paternoster plays of York, Beverley and Lincoln seem to have been made up of a group of saints' legends. This is

a matter of some interest, since it has long been believed that the Paternoster play was the first recorded morality. But there are serious objections to this conclusion. It is known from an allusion by Wyclyf in 1378 that the play had to do with the Lord's Prayer and from records at York and Beverley that it had seven parts, each called by the name of one of the seven deadly sins. There is no immediate knowledge of the contents of the plays themselves, but there is a traditional belief that each of the seven petitions of the Paternoster was regarded as a defense against one of the sins. Moreover, certain saints were distinguished by their successful resistance to some one of them. At Lincoln, particularly, and at other places where there were Paternoster plays, there are mentions of at least five of these sin-resisting saints, and it becomes a plausible conjecture that the Paternoster play presented the lives of these saints. If so, it follows that the Paternoster play was not a morality but was a series of miracle plays.

4. The Morality Play.—A morality play is a dramatized allegory, and its characters are abstractions. The hero is Mankind or *Humanum Genus,* and the theme is man's response to the temptations and moral forces of life and his possible salvation through the mercy of God at the moment of inevitable death. These forces for good or evil including Death itself are personified abstractions. The morality was a late arrival on the medieval stage, for no examples seem to be earlier than the beginning of the 15th century. Possibly the earliest is a fragmentary play, *The Pride of Life.* The prologue is complete and it is possible to see what the story was. The King of Life, accompanied by Fortitude and Sanitas, challenges all comers including Death. He fights with Death and is overcome. The theme in general is the same as that of *Everyman,* which, however, although possibly much older, did not appear in England until it was printed by Richard Pynson early in the 16th century.

Three plays of general significance appear in one manuscript, the *Macro Morals,* now in the Folger Shakespeare library, Washington, D.C. The manuscript was so called after Cox Macro, a former owner, and the three morality plays it contains are on different paper and in different handwritings. The plays, which have been bound up into one volume, seem to have no connection with one another. All seem to belong to the 15th century, and W. K. Smart makes a fair case for dating *The Castle of Perseverance c.* 1405. The other two have been thought to have been written later in the century. *The Castle of Perseverance* introduces most of the customary themes: the Good and the Bad Angel, the World, the Flesh and the Devil, the Seven Deadly Sins, the siege of a castle and the Dance of Death. Confession, Shrift and Penitence appear and salvation is determined after a debate of the so-called Four Daughters of God (Ps. lxxxv, 10). *Mankynd,* in the same manuscript, a play badly degenerated by use by traveling players, is also on the theme of salvation. The third, *Mind, Will and Understanding,* is more psychological, more satirical and more learned. Anima and Universal Wisdom appear in the play.

Other moralities that may be considered as belonging in some sense to the simple medieval and general group are *Magnificence* (printed 1529) by John Skelton; the *Satire of the Three Estates* (1540) by Sir David Lyndsay; and *Mundus et Infans* (1522). In Tudor times the morality play became much more elaborate and had a great effect on later dramatists. It lasted and exercised an influence on the Elizabethan drama in such plays as Marlowe's *Doctor Faustus* (1592) and Thomas Dekker's *Old Fortunatus* (1599). (*See* below and also ENGLISH LITERATURE: *Elizabethan and Jacobean Drama.*)

5. Folk Drama.—There is little that is actual drama in the extensive medieval activities spoken of as folk drama, which is what is now thought of as vaudeville, not, however, as pseudo-dramatic entertainment in theatres, but largely in folk festivals and customs. The subject is interesting and has had much attention paid to it by scholars. In festivals such semidramatic entertainment mainly belongs to folklore, but there was also a miscellaneous element made up of clownage, jugglery, song, dance, mimicry (of animals as well as human beings), burlesque, monologue and the merely peculiar or grotesque. Now and then in its varied activity impersonation, dialogue and action came together, and actual drama resulted. The noted example is that *c.* 1470 in France there appeared *Pierre Pathelin,* the first farce, probably the dramatization of a *fabliau* (*q.v.*).

Another very clear case of a drama developed from a folk festival is connected with the annual May game. It is thought that toward the end of the 13th century a minstrel, Adam de le Hale of Arras, wrote an actual drama for such a festival in the form of a *pastourelle, Le Jeu de Robin et Marion.* In it Marion, a village maid, is tempted to forsake her local sweetheart in favour of a charmer from the city, but she remains steadfast in her affections. It was introduced, it is not known how, into England and became associated with the peasant hero Robin Hood (*q.v.*). In some ballads and ballads in the form of dialogue Robin becomes Robin Hood and Marion becomes Maid Marian. The little play remains in primitive form.

The whole group of so-called mummers' plays (*see* MUMMERS) common in England, Scandinavian countries and other parts of Europe, lived on until the 20th century. At their basis, it is thought, there lay long-forgotten heathen rites carried out to secure the favour of spirits in the revival of spring and the growing of crops. In the mummers' plays are a group of oddly named characters who make traditional speeches, which, like the speakers themselves, are merely vague echoes from the past—the Fool, Pickle Herring, Blue Breeches, Pepper Breeches, Ginger Breeches, the Doctor, Mr. Allspice and Cicely. These are mainly from the Revesby Sword Play, written down in the 18th century. This and the Shetland Sword-Dance are apparently fullest of ancient superstition and indeed are thought to suggest human sacrifice (*see* also FOLKLORE).

6. Medieval Knowledge of Classical Drama.—In the long period of the middle ages before 1400 almost nothing was known about classical drama, not even that it had been acted by actors on a stage. Terence was a school author much admired and very influential, but chiefly revered as a philosopher, and this did not lead to the writing of plays imitating his comedies. There is a fragment 65 lines long of a dialogue called *Terentius et Delusor* that may have been the prologue of a comedy. Of immediate imitations the one case was that of Hrosvitha, a nun of Gandesheim, living in the later part of the 10th century, who wrote six obvious imitations of Terence. They were discovered and printed by Conrad Celtes in 1501. This pious lady, shocked no doubt at the pagan realism of Terence, wrote comedies in which she substituted for Terence's courtesans, tricky slaves, bawds and greedy old men, chaste Christian women, honest men and the sufferings and constancy of martyrs. She does not altogether lose the wit and skill of her model and is interesting for herself, but she had no influence.

There is also a group of survivals known as elegiac comedy, which are at least semidramatic. They have been organized into groups by scholars but can hardly be said to have been connected and can have had little influence and currency. There is *Querolus,* a sort of sequel to the *Aulularia* of Plautus, and *Geta,* an imitation of his *Amphitruo.* There are a score or more of these imitations of Latin comedy. They seem to be the work of individual scholars or small groups of scholars or of schools, and their interest lies in their anticipation of the Renaissance; but they are not in the main current of medieval drama. (H. Cc.)

V. MODERN DRAMA

Drama developed in modern Europe as the result of the new kind of interest being taken in the classical world by Italians as early as the beginning of the 14th century. Nicholas Trevet (*c.* 1258–*c.* 1328), the Englishman, who was an acquaintance of Dante's, wrote a commentary on Seneca (*c.* 1306?), pronouncing him a truly tragic writer because not only were his themes tragic but his manner was that of drama as opposed to narration. As the various countries of western Europe responded to an increasing experience of classical drama, however imperfect or distorted, the same sorts of reactions took place in general, although they did not necessarily occur in the same sequence in every country and the process started later in some countries than in others.

Everywhere there already existed some type of liturgical drama and some native form such as farce which could react to, if it was not utterly suppressed by, the new enthusiasm for the classics. Everywhere modern drama emerged as the result of a study of the Latin and later of the Greek dramatists, which involved experiment in performing them, in translating them and in imitating them, both in Latin and in the vernacular. In theory and in practice an influence was exerted by Aristotle's *Poetics,* which was almost unknown in medieval Europe, after its rediscovery some time in the 15th century, with the subsequent outburst of commentary, interpretation and misinterpretation. As drama was performed and analyzed with varying thoroughness in the schools the pronouncements and dogmas of the major critics gradually filtered down to the schoolboy and so contributed to the creation both of new playwrights and their audiences.

1. The Influence of Humanism.—The results of studying the Romans as living drama showed themselves early in the 14th century in Italy with the Senecan inspiration of Albertino Mussato's Latin tragedy, *Ecerinis* (1315). Terence was studied and acted at Vittorino da Feltre's school set up in Mantua in 1428; and Plautus was the model for a number of Latin plays written at Ferrara by Tito Livio dei Fruvelosi (1432–34). Another early Latin play, *Philogenia,* was written by Ugolino Pisani at Parma in 1430. The study, writing and performing of drama increased with the growth of the academies, particularly those of Rome and Ferrara. Roman comedy, especially Plautus, was performed at Rome with farces in the Atellan fashion; and by the end of the century Plautus and Terence were being acted in many places in accordance with the notions of humanist scholars who were misreading Horace and Vitruvius and who completely despised the native farce of their own land. One new form, the pastoral, developed out of the blending of classicism with a genuinely Italian spirit. At first even some element of the existing *sacra rappresentazione* was involved in the *Favola di Cefalo* (1487) written by Niccolò da Correggio, treating material from book vii of Ovid's *Metamorphoses.* In another direction the pastoral, in the form of eclogues recited by actors in masks as *intermezzi* between the acts of regular tragedy, led to the development of the masque (*q.v.*). But a pastoral form developed separately as a mingling of comic and tragic elements in an idyllic and idealized pastoral setting: such are *Egle* (1545) by G. B. Grimaldi and *Sacrifizio* (1554) by Agostino Beccari. The outstanding example of the pastoral proper is *Aminta* (1573) by Torquato Tasso; as well known, but not so exquisitely written, is *Il Pastor fido* (1590) by Giovanni Battista Guarini. Italian influence showed itself in Spain in the pastoral dialogues, called *representaciones,* in which Juan del Encina celebrated the history of the Alba family and of the royal house. Pastoral in England is seen in masques and in Italian-inspired works such as Abraham Fraunce's translation of Tasso's *Amintas* (1587), Samuel Daniel's *The Queenes Arcadia* (1606) and John Fletcher's adaptation of *Pastor fido* as *The Faithful Shepherdess* (?1609). (*See* also PASTORAL.)

The first important comedy written in Italian was *Calandria,* a free adaptation of Plautus' *Menaechmi* by Bernardo Dovizi (1470–1520; known as "Il Bibbiena"), performed in 1513. After translating Latin comedies for performance Ludovico Ariosto wrote his own well-constructed comedies, with conventionally paired characters, both male and female; *I Suppositi* (1509) and *Negromante* (1520), on which he worked for ten years, are his best plays. Ariosto tended to satire, an element which was even more pronounced in *La Mandragola* (*c.* 1513–20), the most important of the comedies of Niccolò Machiavelli, author of *Il Principe.* The conventions of Latin comedy laid down by the scholars were opposed by Pietro Aretino in his vivid, fast-moving if rather shallow comedies which include *La Cortigiana, Il Marescalco, Talanta, L'Ipocrito* and *Il Filosofo.* In Portugal Bibbiena and Ariosto served as models for Francisco de Sá de Miranda. Luis Vaz de Camões preferred to go directly to Plautus for his *Auto dos Enfatriões* (1587).

In France as in Italy the humanists despised the existing vernacular comedy, in this case the form of farce which had developed with such vigour throughout the 15th century. There was a careful study of Plautus and Terence and by 1500 Plautus' *Amphitruo* had been translated. In 1534 Terence's *Andria* was translated and in 1539 a collection of translations by different hands appeared as *Le Grant Térence tant en rime qu'en prose.* In the middle of the century the group of writers known as the Pléiade (*q.v.*) turned to the reform of comedy. Pierre Ronsard translated Aristophanes' *Plutus* (1548) and *Eugène* (1552) by Étienne Jodelle forced the subject of a satirical medieval farce into the regularity of the *commedia erudita.* In 1554 Bibbiena's *La Calandria* was played at Lyons before Henry II. Jacques Grévin wrote *Maubertine, ou la tresorière* (1558) and *Les Esbahis* (1560) in an effort to reform comedy; Jean de la Taille actually wrote *Les Corrivaux* (1562) in prose, and in 1567 Jean Antoine le Baïf published *Le Brave,* modeled mainly on Plautus' *Miles gloriosus.* Pierre Larivey, of Italian birth, translated 12 Italian comedies into lively French. These, in his versions, were more genuinely comically dramatic than anything earlier and established a foundation on which Molière was able to work later. Italian comedy is even more gallicized in *Les Contens* (?1580) by Odet de Turnèbe (1553–81).

In Italy humanist influence was so strong that native comedy was quite displaced apart from the *commedia dell' arte* (*q.v.*). In France there was a wide rift between educated comedy and what was enjoyed by the populace; but in England native forms of farce and interlude did not suffer. Before Erasmus and his English admirers virtually founded the grammar school system there existed a vigorous drama which was by no means unsophisticated, represented by plays such as *Fulgens and Lucrece* (*c.* 1497; only discovered in 1919). This was written by Henry Medwall, chaplain to John Cardinal Morton, and has for its theme the conflict between the patrician's love of pleasure and the high principle of the commoner. He shows the same skill in *Nature* (?1530), which is more of a morality play. John Rastell, the printer of *Fulgens and Lucrece,* himself wrote two didactic plays, which are not theatrical, *A New Interlude and a Mery of the Nature of the Four Elements* (1519) and *Of Gentylnes and Nobylyte* (*c.* 1527). Rastell's son-in-law, John Heywood, wrote the interludes *Wytty and Wytless, A Play of Love* (1533), the *Play of the Wether* (1533) and *The Four PP.* (1543–47). Two others have been conjecturally ascribed to him, *Johan Johan* (1533) and *The Pardoner and the Frere* (1533). These are all unaffected structurally by humanist theory.

As humanist education was established in England stress was laid not only on the reading and analysis but on the performance of Plautus and Terence and of neo-Latin drama. This was the work of the continental playwrights, John Ravisius Textor (1478–1524), Georgius Macropedius (Georg van Langveldt, 1475–1558) and others. The Latin plays of the Dutch writer Gulielmus Fullonius or Gnaphaeus (Willem van Volder, 1493–1568), on the theme of the prodigal son, were popular, especially *Acolastus* (1539), translated with a commentary by John Palsgrave (1540). Such theoretical and practical work, probably strengthened by the sound critical principles of Erasmus, led to plays such as *Ralph Roister Doister* (?1553) by Nicholas Udall, headmaster of Eton and then of Westminster; this is the first English play in acts on the classical model and blends neoclassical with English elements, its characters being types from Plautus' *Miles gloriosus* anglicized. It is thought that Udall's biblical play *Ezechias* (played before Queen Elizabeth I in Cambridge, 1564) was an early work and that he may be the author of *Thersytes* (*c.* 1537), a skilful adaptation of the dialogue by Textor; *Jacob and Esau* (1568) is also conjecturally ascribed to Udall. A Textor dialogue was the basis of Thomas Ingelend's *The Disobedient Child* (1570?). The two latter, with the anonymous *Misogonus* (written 1577) and George Gascoigne's *The Glasse of Government* (1575), are of the prodigal son type. Nine years earlier Gascoigne had translated Ariosto's *I Suppositi* into prose as *Supposes* for performance at Gray's Inn. There were numerous other translations from Italian, now lost, as well as the anonymous *The Bugbears* and John Phillip's *Pacient Grissill* (1565); so far as is known, all, like these two, were in rhyming verse. One group of plays on English themes from this period includes *Tom Tyler and*

His Wife and the Cambridge farcical comedy *Gammer Gurton's Needle* (1575). Romantic subjects, occasionally with allegorical elements, were treated in plays such as *Common Conditions* (printed 1576), *The Rare Triumphs of Love and Fortune* (printed 1589) and *Sir Clyomon and Sir Clamydes* (printed 1599).

In Germany, Latin drama was similarly cultivated by humanists of whom the most famous were Jakob Wimpheling (1450–1528) and Johann Reuchlin (1455–1522). But the secular German drama supported by the civic guilds did not suffer from humanism and flourished, particularly as written in the 16th century by Hans Sachs, not only in the form of *Fastnachtspiele* (Shrovetide plays) but also in the form of tragedies and comedies. In the Low Countries, moralities continued, thanks to the support of the civic guilds, organized as *Rederijkers Kamers* or chambers of rhetoric (*see* DUTCH LITERATURE); the famous *Elckerlijc* (printed 1495; in English *Everyman*) won first prize in a civic contest at Antwerp (1485). The *Rederijkers* developed colourful *tableaux vivants*, which could be used allegorically.

2. Jesuit School-Drama.—*Tableaux vivants* were adapted to the purposes of the Counter-Reformation in due course by the Society of Jesus (first organized in 1534), whose first college for outside pupils was established in 1548, the year after the banning of the performance of religious drama in France. Jesuit education was hardly less important an element in the development of European drama than that provided by the grammar schools of England. The first mention of a Jesuit play occurs in 1551 and by 1600 there were 250 schools and 90 seminaries throughout Europe where drama was performed according to the regulations in *Ratio atque institutio studiorum* (1577, revised several times by 1599). Plays were to be in Latin, performances—only at the beginning or end of the school year—were not to be staged elaborately, and there were to be no interludes between the acts. The subjects were religious, usually involved martyrdom, and were designed to evoke pity and terror and to inspire a reverence for, and even a capability to endure, a noble death. No feminine character or costume was permitted. Eventually the vernacular was allowed to some extent for lay audiences. Although there was opposition to worldliness in the staging of Jesuit plays, the tendency was to become more elaborate in the 17th century, absorbing elements from the *tableaux vivants* of the Low Countries, from ballet and opera in other parts of Europe and from the secular drama of Spain; even fireworks and special theatrical effects were introduced.

Thousands of plays were written by teachers and pupils and performances involved great scholarship as well as theatrical values. The Jesuits were acknowledged masters of the art of "Pronunciation" or rhetorical delivery, which is fundamentally akin to acting, making many of the same technical and imaginative demands. Their authority was recognized in this field even in England. Jakob Bidermann (1578–1639) and Nicolaus von Avincini (1612–86) were two of the prominent personages in Germany, where in the 17th century in Jesuit schools alone was there a living dramatic tradition preserved in the Catholic provinces; and Protestant schools elsewhere responded by developing their own drama. In Poland, Jesuit theatrical activity likewise stimulated rivalry from the Orthodox Church, whose members adapted their adversaries' plays into Russian. Simeon Polotski (1629–80), tutor to the sons of Tsar Alexis, was involved in this school drama, the only drama in Russia of that time.

There are obvious links between Jesuit drama and the religious drama of the middle ages; but the later form was much more varied and colourful in its theatrical techniques and the borrowing from the Dutch *tableaux vivants* of a series of curtained archways within a façade had repercussions on the structure of baroque theatre in Europe. The influence of the genre can only be estimated accurately by remembering that in his youth Voltaire took part in plays at the Collège Louis-le-Grand.

3. Neoclassic Imitation.—Tragedy as well as comedy started in Italy with Latin imitations, at first of Seneca. As Italian neoclassic criticism began to develop the notion of a "regular" drama, Italian Senecan plays displaced those in Latin. Giorgio Valla's Latin edition of Aristotle's *Poetics* (1498) preceded by ten years the famous edition of the Aldine press. Giovanni Rucellai's *Rosamunda* (1515) is a typical expression of the conception of tragedy which emerged from the blending of what was derived from Horace, postclassical Roman theory, Seneca and the study of Aristotle. Critical study continued: Lodovico Dolce translated Horace into Italian (1535); Alessandro de' Pazzi produced a Greek text of Aristotle with a parallel Latin translation (1536); and Bernardino Daniello's *Poetica* (1536) shows in its references to tragedy and comedy a debt to both Horace and Aristotle. In 1548 came the first complete commentary on the *Poetics*, Francesco Robertello's *In librum Aristotelis de arte poetica explicationes*. The effect of such theorizing in other countries as well was felt in imitations of Seneca and the Greeks, in attempts to develop regular neoclassical drama and in the influences exerted by such attempts on the development of the dominant forms in Spain, France and England.

In Italy the first notable imitation of Greek tragedy was Gian Giorgio Trissino's *Sofonisba* (written in 1515 but performed in 1556); typical imitations of Seneca are Sperone Speroni's *Canace* (1543) and G. B. Giraldi Cinzio's *Orbecche* (1541). A similar sequence occurred in France: Seneca, printed in 1485, was followed in 1506 by Erasmus' Latin translations of two Euripidean plays, *Hecuba* and *Iphigenia*, with French translations appearing later. The Senecan model for regular tragedy was established by Jodelle with *Cléopâtre captive* (1552). There followed equally dull plays expressing the Senecan spirit as then understood: *Médée* (1555) by Jean Bastier de la Péruse, Jacques Grévin's *Julius César* (1561), *La Soltane* (printed 1561) by Gabriel Bounin and André de Rivaudeau's *Aman* (1561). Contemporaries regarded Robert Garnier as the genius who outstripped the rest; among his plays are *Porcie*, *Hippolite*, *Cornelie*, *Bradamanthe* and *Les Juifves*. In its day the attraction of this sort of drama seems to have been partly in the gravity of spirit and partly in what it offered to minds educated in the tradition of rhetorical delivery which could enliven in performance, or imagined performance, what is now so dead in the text. Passionate and intricately or formally constructed speeches could be enjoyed in their own right. Similar circumstances had produced the second vernacular tragedy in Europe, *Castro* (*c.* 1558), by the Portuguese poet Antonio Ferreira.

England had some attempts at regular "Senecan" tragedy, for the most part the work of the circle associated with Mary Sidney (1561–1621), who became countess of Pembroke and who translated Garnier's *Marc-Antoine* (1578) as *Antonie* (1592). Samuel Brandon's *The Vertuous Octavia* (1598), Thomas Kyd's *Cornelia* (1594, from Garnier, 1574), and Daniel's *Cleopatra* (1594, from *Marc-Antoine*) and *Philotas* (1605) complete this group of plays, which had little practical influence. Neoclassicism made its effect felt on English drama in another way; translation of Seneca played its part, however, in developing the spirit rather than the form of popular English drama. In 1558 a number of university men started individual translations which were collected and published by one of their number, Thomas Newton, as *Ten Tragedies of Seneca* (1581; ed. by T. S. Eliot, 2 vol., 1927).

The first tragedy on a Senecan model in English, *Gorboduc* (or *Ferrex and Porrex*) by Thomas Norton and Thomas Sackville was acted by members of the Inner Temple before Queen Elizabeth on Jan. 18, 1562. It is a blend of English and classical elements, ignoring the unities of time and place, employing classic formalities such as chorus and messenger, but adding unclassical dumb shows before each act; it is the first English play in blank verse. Four years later (1566) Gray's Inn performed *Jocasta* by George Gascoigne, Francis Kinwelmersh and Sir Christopher Yelverton, little more than a translation of Dolce's *Giocasta*. Classical plays in Latin and English were being written in the universities, including Nicholas Grimald's *Christus Redivivus* (1543) and *Archipropheta* (printed 1548) and plays in Latin by William Gager (fl. 1580–1609) at Oxford. At Cambridge, where Thomas Watson (1513–84) and John Christopherson (d. 1558) treated biblical and national history, the best known is Thomas Legge's tragedy, *Ricardus III* (1579). Neoclassical influence did not freeze inspiration in such English tragedies as John Pickering's *Horestes*

(1567), R. Bower's *Apius and Virginia* (printed 1575) and Thomas Preston's *Cambises* (*c.* 1569). Among plays of this sort written about this time are *Gismond of Salerne* (1568) and two tragicomedies, *Damon and Pithias* (1564–65) by Richard Edwards and *Promos and Cassandra* (printed 1578) by George Whetstone.

Although neoclassicism and humanist education produced academic and untheatrical drama in Italy and France in the 16th century, in England the same influence led to an articulate and theatrical body of plays. Humanism in England in this period seems to have provided the audience as well as the writers; popular demand was satisfied by dramatists who had learned to construct, to write speeches, even to command verse and prose in grammar school and university. It is usual to trace the progress of Elizabethan drama as rising from these beginnings to a culmination in Shakespeare, after whose time there is a gradual deterioration into a decadence in which sensation arises from skilful but superficial contriving of plots, halfheartedly pretending to deal with themes which are not really of importance to the writers. It is true that the later writers have a more obvious and more sophisticated technical virtuosity; but it may be questioned whether at any time there was much Elizabethan drama that survives careful scrutiny, except for the plays of Shakespeare and Ben Jonson.

4. England: Elizabethan and Jacobean Drama.—An early arrival was the chronicle play, foreshadowed by *Gorboduc*, Thomas Hughes's *The Misfortunes of Arthur* (1587) and the experiments usually ascribed to John Bale in *Kynge Johan* (1548). The chronicle play differs from these in that it is a dramatization of an existing historical chronicle. *The Famous Victories of Henry the Fifth* (acted before 1588) belongs to this genre; so do the two parts of *The Troublesome Raigne of John King of England* (1591) and *The True Chronicle History of King Leir* (first acted *c.* 1593–94), which was used by Shakespeare for his tragedy. Out of the school drama developed the plays of John Lyly with their fairy lore, mythology, classical and romantic legend, and their allegory. He started for English prose dialogue a development like that which began for blank verse with Christopher Marlowe, assuming that Marlowe preceded Kyd. The pre-Shakespearean scene has much life and variety in the work of George Peele, Robert Greene, Thomas Kyd and Christopher Marlowe, to name a few. Peele's *David and Bethsabe* (printed 1599) and Greene's *James IV* (printed 1598) and *Frier Bacon and Frier Bongay* (printed 1594) have fresh vigour and signs of a command of language which are associated traditionally with pre-Shakespearean drama. Other important writers of this period are Thomas Lodge, Thomas Nashe, Henry Chettle and Anthony Munday.

In all these may be seen the fruits of a classical education that strengthened rather than suppressed what the writer derived from his native culture. Marlowe in particular drew vigour from the elements of classicism that cramped French and Italian writers. His blank verse is classical in its fundamental structure, and had he paid more attention to what could be learned from academic theory in the matter of integrating plot, character and theme, his weaknesses might have been fewer. Kyd, too, shows the besetting failure of popular Elizabethan dramatists, both before and after Shakespeare, to make character and incident elucidate theme, to relate linguistic virtuosity to dramatic imagining, to shape plot out of a consistent chain of cause and effect. Only Ben Jonson shows an imaginative intelligence and a discipline which can be compared with Shakespeare's, and then primarily in comedy. Although George Chapman was ostensibly engaged with a theme—the nature of heroic man and of his conflict with fate—too much of his work is sensational, superficial and contrived. With John Marston, Francis Beaumont and John Fletcher, John Webster, Cyril Tourneur, Thomas Middleton, John Ford and Philip Massinger tragedy and tragicomedy alike do not derive from an organically developing and fully imagined action of character and incident: opportunities are contrived for special effects, and irrelevant satire and inconsistencies of plot and character detract from the work of all. Domestic tragedy of the nature of *Arden of Feversham* (printed 1592), *A Yorkshire Tragedy* (printed 1608) and Thomas Heywood's *A Woman Killed With Kindness* (printed 1607) share the virtues and defects of the other kinds. Comedy tends to support criticism more satisfactorily, possibly because it admitted to less pretentiousness in the matter of heroics, poeticizing and sententious comment. Jonson was followed in this kind by Thomas Dekker, John Marston and George Chapman and by Richard Brome, who wrote in Jonson's shadow. Other writers of comedy were Fletcher, Middleton and Nathan Field, and in the time of Charles I, aristocratic manners and interests were treated by James Shirley in a way that anticipates some of the qualities of the Restoration drama.

It is quite possible that criticism of these dramatists has been misled by the quality which exists in Shakespeare to ascribe merit unjustifiably to his fellow playwrights. When we measure him against them we become aware of the possibilities of Elizabethan drama as a genre: he developed his blank verse, his rhyme and his prose from the same common stock, but he commands his medium where they too often are the prisoners of theirs. He constructs and shapes his plots more competently, and tends to be turned aside by far fewer irrelevancies. His choice of word is more precise; his use of figure, whether of words, such as climax and antithesis, or of thought, such as metaphor, is at once more varied, richer and less complicated than theirs; and his imagery not only develops coherently in relation to his themes but expresses the psychological needs of his characters. Plot, character and theme all go together. And basically the equipment with which he did all this was derived from the kind of learning taught in the grammar school, which he shared with them and which allowed him to develop in a native way while using a fundamentally classical tradition. It is certain, however, that his gift of imagining character was his own, even though it was put into practice in words the mastery of which he owed to the opportunities given him by humanist teachers.

Popular as the art of the Elizabethan dramatists undoubtedly was, it did not differ from neoclassicism in the way in which German romanticism differs from the classicism of Corneille or Racine. The Elizabethan ignored the unities, the chorus, the purity of style of the neoclassicist; but he made use of neoclassic teachings on plot structure, on writing itself, on the use of rhyme, on the need to relate the particular incident to what was felt to be true about life in general.

5. Spain: Drama Before and During the Golden Age.—Spain, like England, was not dominated by neoclassicism; its religious drama survived and profoundly influenced the writers of the Golden Age, who were even less inclined than the English to conform to Italian views on decorum and the unities. Lucas Fernández ignored the academic humanist teaching enough to write an Easter play, the *Auto de la Pasión* (printed 1514), performed by the clergy in Salamanca cathedral. But Bartolomé de Torres Naharro, influenced by Italy, wrote a sort of comedy of manners and romantic plays, in the latter anticipating the conflict of love and honour in Lope de Vega. Gil Vicente, a Portuguese who wrote in Portuguese and Spanish, has comic scenes and combines satire, secular accounts of Spanish history and allegorical treatment of religious issues in his *Trilogis das Barcas* (discovered and printed 1784); most of his pieces are *autos* (short dramas originally in a biblical setting). Lope de Rueda (1510–65) was the first professional actor-manager in Spain and developed a form, the *paso*, a short comic sketch; he also wrote *autos*. Gradually a national drama was developing, especially after the opening of the public theatres, the *corrales*. Heroic subjects from Spanish history were treated by Juan de la Cueva. A popular Spanish legend was treated by Micer Andrés Rey de Artieda (1549–1613), as *Los Amantes de Teruel* (1581). *Autos* and *entremeses*, these latter much like medieval farces, were written by Cervantes, whose *Numancia* (printed 1616) has much of the morality in it. Cervantes borders on the Golden Age, which really begins with Lope de Vega, who not only wrote a tremendous number of popular works but established traditions in the Spanish theatre so far as concerned the *comedia de capa y espada* (cloak-and-sword comedy); he wrote a heroic drama in which historical persons of noble and royal rank are involved, notwithstanding which there is a humorous underplot, and left models for domes-

tic drama in which the principals are characters low in the social scale. His styles, subjects and kinds of drama are too varied and mixed to be classified. His *Fuente-Ovejuna* (?1613) has often been regarded as an anticipation of "proletarian theatre."

This was the great age of Spanish drama, with a number of very competent writers, even apart from Lope and Calderón. Gabriel Téllez ("Tirso de Molina," *q.v.*), a Mercenary friar, is best known for his female characters and for characterization in general, especially in *El Burlador de Sevilla* (on Don Juan, printed 1630), *El Condenado por desconfiado* (1635) and *La Prudencia en la mujer* (1634). Francisco de Rojas Zorrilla wrote comedies of intrigue and of character, and in *Del Rey abajo, ninguno* (printed 1650) has a power treatment of conflict between the yeoman class and the aristocracy. Juan Ruiz de Alarcón y Mendoza wrote more systematically worked-out intrigues; in both his early and late work there is a more disciplined structure than in that of his fellows. His *La Verdad sospechosa* (printed 1634) was the model for Pierre Corneille's *Le Menteur* (1643). Another member of the group, Guillén de Castro y Bellvís (1569–1631), wrote *Mocedades del Cid* (1618), which served Corneille for his *Cid* (1637).

The outstanding figure of the second phase of the Golden Age —the baroque period—is Pedro Calderón de la Barca, whose huge output not unnaturally shows some superficiality but is based on fine craftsmanship and inventiveness and expresses a fundamentally philosophic and mature attitude. He treats honour rather than love in cloak-and-sword plays which tend unfortunately to be limited in their range by his acceptance of the rigid code of Spanish social life. Calderón's essential profundity and rich splendour are best seen in the religious and philosophic *autos* such as *El gran teatro del mundo, La Vida es sueño, El Principe constante, La Devoción de la Cruz;* his treatment of sainthood is most impressive in *El Mágico prodigioso*. The only dramatist whose quality approaches Calderon's is Agustín Moreto y Cabaña, who treats farcical situations with freshness of wit and charm: *El Lindo Don Diego* (printed 1662) and *El Desdén con el desdén* (printed 1654) show the liveliness of his comedies of manners. No writer of consequence survived Calderón.

6. France: The 17th Century.—In France the public had not been interested in the academic regular plays already discussed, but still valued their farces above such grave tragedies as Antoine de Monchrestien's *L'Écossaise* (1601) on Mary, Queen of Scots. Much more popular was the body of tragedy and tragicomedy provided by Alexandre Hardy for the actors at the Hôtel de Bourgogne. Hardy kept the five-act division but moved from scene to scene with the freedom of the Spanish and English. In 40 years he wrote between 600 and 700 plays, the best known being *Mariamne* (1610). Hardy had the action, subjects and themes of popular drama; had he been a greater writer he might have fostered in France a drama nearer to those of contemporary Spain and England. In his tradition were Georges de Scudéry and his sister Madeleine, who both wrote the tragicomedy *Ligdamon et Lidias* (1629). The pastoral *Les Bergeries* (*c.* 1619) by Honorat de Bueil, seigneur de Rancan, and the tragedy *Pyrame et Thisbé* (1621) by Théophile de Viau are in the unclassical group. So is the work of Jean Rotrou, who refused to accept the insistence of the Académie Française that the unities must be maintained; he wrote *La Bague de l'oubli* (1628), a comedy, and the naïve and profound tragedy *Saint-Genest* (1646), which in some ways anticipates the quality of Hugo's romanticism two centuries later.

But the drama actually in existence in France at the time of the critical controversy—about the unities, decorum and the nature of the tragic hero—which developed in the late 1620s had really very little to commend it: this means that the neoclassical reformers were not trying to oust a dominant form of which they disapproved, nor were they trying to revive the academic classicism of the last century. The rules which were being established, supposedly in accordance with Aristotle's *Poetics*, were sincerely envisaged to some extent as a guide to the production of a civilized drama which could be accepted as a not unworthy modern equivalent of the classics. Jean Mairet's *Sophonisbe* (1634) was interpreted as establishing the dominance of the new regular tragedy, soon showing itself in his *Marc-Antoine, ou la Cléopâtre* (*c.* 1635), in *Médée* (1635) by Pierre Corneille and in Georges de Scudéry's *Le Mort de César* (1635). When Corneille's *Cid* (?1637) appeared as a heroic tragicomedy, there was an underlying justification for the ensuing controversy in the fact that this really seemed a retrograde step; and some of the objections of Jean Chapelain and others in the *Sentiments de l'Académie Française sur la tragi-comédie du Cid* (1637) are valid as literary criticism in themselves, although they are not necessarily to be taken as demonstrating the weakness of the tragicomic genre. The concentration and drive of Corneille's succeeding tragedies may well be ascribed to what he learned from neoclassical criticism.

In the middle of the century, however, tragicomedy tinged with the spirit of the new romances became popular again. In part the abbé d'Aubignac's *Pratique du théâtre* (1657), with its discussion of characterization and simplicity, made possible the atmosphere in which Jean Racine developed tragedy past the point to which Corneille had taken it. Racine's verse had more delicacy and precision. At first he followed Corneille in treating grandeur and heroism rather than love; but from *Andromaque* (1667) onward he concentrates on the passion of love, especially in his heroines, who have little choice and are caught up in an action which expresses an inevitability of fate. *Phèdre* (1677) was his last play for the public theatre, although he wrote *Esther* (1689) and *Athalie* (1691) in a different spirit, one of piety.

French comedy was now flowering in the work of Molière, after the fashion earlier in the century for a kind of comedy of manners and intrigue deriving from Spanish examples. Corneille had written a regular comedy, *Le Menteur* (1643), with witty, polished dialogue but not much laughter. Paul Scarron wrote plays of the Spanish type and created a superb comic character, the valet Crispin in *L'Écolier de Salamanque* (1654). Thomas Corneille, the great Corneille's brother, also wrote comedies of intrigue from Spanish sources. This was the situation to be transformed by Molière. He absorbed into his work elements which came from farce and *commedia dell' arte* but makes something of his own out of them, thanks to his dialogue, his characterization, his wit and his ability to achieve a consistent development of incidents and persons interacting on one another. His satire succeeds because he treats permanent human traits, obsessions and pretensions with a mastery springing from keen and true understanding of human motivation and behaviour. A fundamental tolerance of human frailty prevents his sense of the ridiculous ever becoming the bitterness of disgust or hatred in his plays, of which the best known are *Les Précieuses ridicules* (1659), *Tartufe* (1667), *Don Juan* (1665), *Le Misanthrope* (1666), *L'Avare* (1668), *Le Bourgeois Gentilhomme* (1670) and *Le Malade imaginaire* (1673).

7. Germany and Elsewhere.—Northern Europe in the 17th century produced little drama. Sweden had no professional theatre, although in 1609 there was an amateur performance of *Magnus Asterophus* by Johannes Messenius (1579–1636), a writer of formless didactic drama. Georg Stjernhielm wrote masques. In the preceding century comic interludes and farces and romantic comedies in the style of Lope de Vega were written in the Netherlands by Gerbrand Adriaanszoon van Bredero. Pieter Corneliszoon Hooft wrote his *Achilles Polyxena* (printed 1598) on the model of Seneca. Joost van den Vondel was the only playwright of international stature; he translated and imitated Plautus and Terence. *Lucifer* (1654), which was known to Milton, is the finest of his plays on biblical subjects.

Germany also produced very little after the farces of Jakob Ayrer except for the crude, sensational plays of Heinrich Julius, duke of Brunswick, in the same tradition also influenced by the drama of the English comedians. Martin Opitz von Boberfeld, an advocate of classicism, produced lifeless alexandrine translations of Seneca. Andreas Gryphius made similar translations, but improved on these in his original work thanks to English and Dutch influence and particularly to that of the Jesuit drama, which he attempted to rival in his Protestant school drama. *Herr Peter Squentz* (1663) is a satire on the lower middle class, based on the Bottom scenes in Shakespeare's *Midsummer Night's Dream*, and *Horribilicribrifax* (1663) caricatures the boasting soldiery of

the Thirty Years' War. *Die geliebte Dornrose* (1660) is a comedy in dialect. By the end of the century Germany was dominated by plays called *Haupt- und Staatsaktionen*, involving improvisation as in *commedia dell' arte*, but dealing with incidents in high places (hence their name) and allowing opportunities for the popular fooling of the clown "Hanswurst."

8. England: Restoration Drama.—The success of Corneille, Racine and Molière, together with the prestige of France as a European power and the dominating influence of classicism in art and literature as a whole, meant that at least lip service was paid to the principles of neoclassicism in drama all over Europe. In England the native traditions were too strong to allow of anything as completely classical as in France or as colourlessly classical as in other lands; but even there, partly as a result of the court's exile and partly as a natural development out of classical elements in pre-Restoration drama and in English literature in general, some attempt was made at a valid English classicism in drama.

The genre known as rhymed heroic drama certainly derived from an attempt by Roger Boyle, first earl of Orrery, and John Dryden to answer Charles II's query as to whether it would be possible to provide an English equivalent of the French play in classical alexandrines. Nevertheless, the English heroic play as written by Dryden, Sir Robert Howard and Nathaniel Lee was quite unclassical in its bombast and general lack of restraint, concentrating upon expressing the marvelous as well as exaggerating the passions quite unnaturally.

In the English dramatic conflict of love and honour little was truthfully felt or completely imagined. The atmosphere was false and there was uncertainty as to the target at which the dramatist aimed. Dryden's *Tyrannick Love* (1669), *The Conquest of Granada* (1670–71) and *Aureng-Zebe* (1675) and Lee's *The Rival Queens* (1677) have all the characteristics of the genre, to which belongs work by John Banks, Samuel Pordage, Elkanah Settle and even the critic Thomas Rymer. A less bombastic kind of tragedy shows itself in Dryden's blank verse *All for Love* (1677), whose classicism is more assured than that attempted by John Crowne. Thomas Otway failed to reproduce the qualities of Racine in *Alcibiades* (1675) and *Don Carlos* (1676), but found his true romantic and emotional tragic style in *The Orphan* (1680) and *Venice Preserv'd* (1682). Similar tragedy was written by Thomas Southerne, whose *Oroonoko* (1696) and *The Fatal Marriage* (1694; later adapted by David Garrick) were favourites until the 19th century. One famous tragedy, *The Mourning Bride* (1697), came from William Congreve. At the beginning of the 18th century, Nicholas Rowe produced popular tragedies which avoided the excesses of the heroic play; audiences throughout the century responded with satisfaction to *The Ambitious Stepmother* (1700), *Tamerlane* (1702), *The Fair Penitent* (1704) and *Jane Shore* (1714).

The only play which can be claimed to be thoroughly classical is Addison's *Cato* (1713). Although its first success was due to a political crisis (it was interpreted as upholding the Whigs against the Tories in a conflict over the Act of Settlement), it certainly held the stage and was regarded as providing a first-class acting role for a century.

During the same period English comedy combined much that had existed in Jonson and Fletcher with imitations of the Spanish and French, especially of Molière. Thomas Shadwell claimed to be wearing the mantle of Jonson, whose precision and wealth of inspiration and talent he lacked; Aphra Behn and John Crowne produced comedy of intrigue. But the characteristic Restoration form is the comedy of manners, which can be found even in the uncertainties of Dryden's early comedy and tragicomedy. *The Mulberry Garden* (1668), by Sir Charles Sedley, has the witty pair of lovers, the elegant dialogue, the cynical atmosphere of refinement, with a comparatively unimportant plot, which are more pronounced in the comedies of Sir George Etherege, in which the form is established. It throve for some decades in the hands of William Wycherley, Congreve, Sir John Vanbrugh and George Farquhar, in whose *Recruiting Officer* (1706) and *The Beaux' Stratagem* (1707) there is much the same spirit but with a more extended range of characters and scenes of action.

9. Decay of the Neoclassic Drama in the 18th Century.—In France itself after the great period of Corneille, Racine and Molière the second- and third-rate writers fell back on the conventional formulas. For the most part tragedy concentrated on love themes, with plots arranged to show tragic dilemmas arising from conflicting claims of loyalties, political interests and love, all deployed to exhibit the tragic personages wavering, and their respective fates changing from act to act. In some plays, such as those of Prosper Jolyot de Crébillon, situations alter to maintain excitement, atrocities give excuse for sentimentality, and sensation is combined with a superficial formal classical coldness. The aim was to move the audience to pity and terror, but to maintain refinement, while in the plot parents and their children became unwittingly involved in the killing of one another.

This state of drama was reflected in other countries. In Italy nothing of note was produced, though there was lifeless imitation, until Francesco Scipione di Maffei's *Merope* (1713), which was to be an inspiration for Voltaire; otherwise, until the appearance of Alfieri, Italian classicism is well represented by dull work such as that of Antonio Conti (1677–1749). In Spain Molière's influence is to be traced in the successful neoclassic comedies of Leandro Fernández de Moratín later in the 18th century, but otherwise the drama was dull in its subservience to an influence that did not really suit the Spanish genius. This is true of Portugal, too, where there was, however, a little more to show. Antonio José da Silva produced uninspired, cold classical work; but a tragedy, *Ines de Castro*, by Domingos dos Reis Quita (1728–70), led to a much better *Nova Castro* (printed 1803) by João Baptista Gomes. There was also an anonymous tragedy, *Osmia* (1788), in which classicism did not mean lifelessness. Portuguese classicism led to the not unsuccessful *Merope* (printed 1841) and *Catão* (1821) with which visconde de Almeida-Garrett started his play writing.

In Germany, which, because of the effects of the Thirty Years' War, lacked a regular drama of its own, Johann Christoph Gottsched set out deliberately to try to create one on the model of French classicism at the beginning of the 18th century. He translated French playwrights, among them Racine, whom he tried to imitate in the formal and uninspired *Der sterbende Cato* (1732). His German alexandrine couplets had neither the dignity nor the expressiveness of the French in his own work or in his translations of Corneille's *Le Cid* and Racine's *Iphigénie*. In Holland after Vondel classicism produced little except the valueless imitations of the French by *Dichtgenootschappen*, the societies of poets (*see* DUTCH LITERATURE); there was, however, the more successful Pieter Langendijk (1683–1756), who imitated Molière.

Molière, again, was the inspiration of Denmark's Ludvig Holberg, whose comedies (written 1722–27) show great ability, even if they are not in the same class as their models. Nevertheless, he naturalized his borrowings into his own age and country; his weakness derives from an uncertainty of intention beyond that of developing a Danish comedy. Sweden in the first half of the 18th century was dominated by classical tragedy as performed by visiting actors. The only Swedish work of any note is a not very competent attempt in the manner of Racine, *Brynhilda* (1738) by Olof von Dalin.

10. The Late 18th Century: Voltaire and Others.—A second period of classicism developed largely because two outstanding playwrights of different temperaments, but of not entirely differing ideals—Voltaire in France and Alfieri in Italy—found themselves able to express adequately what they needed to in the classical manner. Voltaire dominated the European scene for the whole of his adult life. Throughout his career he looked to Racine and the Greeks as his masters, and it is only natural to find him reacting deliberately against Crébillon at the outset. He took a wider range of subjects and themes than that of his immediate predecessors; where they were restricted almost to love, he brought in other topics of importance to the Europe of the Enlightenment. His greatest dramatic weakness, which makes his tragedies fail in the last resort, derives from his need to expound ideas, as a result of which his characters, while skilfully motivated, tend to be so chiefly in respect of his external principles. He invests his whole

structure of surprises and pathetic utterances with an essentially sophisticated elegance. In this and in extending his range to bring in besides the figures of classical antiquity such personages as Mahomet, Alzire, Zulima, Tancred and the Orphan of China he met to some extent demands that were answered later by romantic dramatists.

Voltaire seems to be responsible for a stronger flicker of classicism in the English theatre in plays which were obviously good vehicles for the tragic actors and actresses throughout the country. Such were Aaron Hill's *Zara* and *Alzira* (both 1736). English versions of other plays by Voltaire, including Arthur Murphy's *The Orphan of China* (1756), held the stage throughout Garrick's lifetime. Meanwhile England continued to produce its own brand of tragedy, well represented by the plays of James Thomson, the author of *Sophonisba* (1730). Thomson's *Edward and Eleanora* (1739) inspired Lessing's *Nathan der Weise* (1779) to some extent.

Voltaire's influence was felt in Sweden in the work of Johann Kellgren, Carl Gustaf af Leopold and Gudmund Adlerbeth. Leopold's *Virginia* (1802) and *Oden eller Asarne Invandring* (1790) are pseudo-classical tragedies, the latter of which won its author the laurel wreath from Virgil's grave, the gift of Gustavus III. Voltaire's influence extended to Russia, where the first tragedy in the French style was written by Aleksandr Sumarokov (1718–77), the self-styled "Racine of the North," who in fact imitated Corneille, Racine and Voltaire and claimed to be imitating Molière in his comedies. Yakov Borisovich Knyazhnin likewise imitated French and also Italian models; his *Dido* (1769) imitated Metastasio and his *Rosslav* (1784) and *Vadim* (1789) were neoclassic. French classicism also dominated the little Polish drama that there was; *Le Cid* had been translated into Polish by Andrzej Morsztyn (*c.* 1613–95) and performed in 1661.

One of the greatest of the classical writers of this age was Vittorio Amedeo Alfieri, the success of whose blank-verse tragedy *Cleopatra* (1775) led him to immerse himself in study of Italian writers of the past and in painstaking reading of the ancient dramatists. His theme was predominantly the overthrow of tyranny, with heroic personages from the ancient world, from the Bible and from European history. But he did not take the romantic way of treating these; his plays were more severe than his models in dispensing with all but the most essential characters and incidents. His blank verse has none of the traditional neoclassic smoothness and elegance, but it is concentrated and expressive. *Saul* (1782) and *Mirra* (1784–86) are considered his best work.

11. A New Development: The Evolution of Middle-Class Drama.—Although neoclassic tragedy still held sway after the period of Corneille and Racine, changing social conditions and a new intellectual atmosphere in Europe associated with the emergence of sentimentalism led to the development of a new type of drama which took contemporary middle-class life and problems as seriously as those of the aristocracy had been treated by traditional tragedy. To some extent the new type of drama had been anticipated in Guarini's defense of his *Pastor fido*. His attackers had used the traditional argument that persons of high and low rank, that a high and a low style of writing, that comic and tragic incidents should not be mixed in one play. His reply was that he had not produced a mixture of the classically comic with the classically tragic, but a new compound in which the spirit of each was blended to produce a genre which was still classic. By allowing the action to lead to reconciliation the satiric sting is taken from comedy and the depth of tragic melancholy from the tragic part. He added that where tragedy and comedy were each restricted to one section of society, tragicomedy, by mixing the high and the low, was able to give a truer picture of the world as it exists, which is the purpose of drama. Guarini's play does not justify his argument; it does not do these things. But something much like them was done by the new middle-class drama which appeared in Europe in the course of the 18th century and which can be seen developing in both tragedy and comedy simultaneously.

The new form has been traced first in certain developments visible in English comedy at about the time of the attack made by Jeremy Collier on the excesses of Restoration drama (1698), a time when there was in any case a change in the moral tone and spirit of English comedy as the result of the middle classes' gain in importance. The new element has been held to be present already in the fact that the wronged wife remains faithful to her husband, not in ignorance of his misdemeanours but in loving forgiveness, in Sir John Vanbrugh's *The Provok'd Wife* (1697). The fact that Susannah Centlivre (1667–1723) took to reclaiming her offenders in her last acts has been likewise ascribed to the new tone, which certainly tinges Richard Steele's *The Funeral* (1701) and *The Lying Lover* (1703, founded on Corneille's *Le Menteur*). Colley Cibber's *The Careless Husband* (1704) is the first definite example of a comedy in which the action treats the implications of a moral sentiment with pathos. Steele followed this beginning with *The Tender Husband* (1705); in this and in *The Conscious Lovers* (1722) social problems rather than wit and intrigue constitute the centre of interest and there is much moralizing, while scenes of pathos lead to a happy ending and express the sentimental spirit of the age. It has been pointed out by historians of English drama that early in the 18th century a tendency toward the treatment of domestic themes already existed in the tragedy of Nicholas Rowe and Thomas Southerne. This tendency is developed fully by Colley Cibber and Steele to produce an artificial weak pathos and tearfulness with no real comic attitude. With Steele the purpose was sincerely moral if artistically inept.

The new form of comedy soon affected France, where Molière had left no real successor. Although Jean François Regnard was not a sentimental writer, he has been considered to have affinities with what was soon to come in England in the style and theme of *Le Joueur* (1696); there is a similar quality in his much livelier and more competent *Le Légataire universel* (1708). Pierre Carlet de Chamblain de Marivaux helped toward the development of sentimental comedy in France, or—to give it its French name—*comédie larmoyante*. He has been compared to a comic equivalent of Racine, for like Racine he polishes his style in a refinement of dialogue; but instead of treating tragic passions, Marivaux deals no less subtly with the development of love in a manner that has charm and sympathy and is amusing but not bitter or satiric. His style is delicate and his plays artificial and fantastic, but their mood is one of happy comedy and their sentiment very near to the sentimentalism of the new form. This form already shows itself in the dullness of the moral sentiments which Philippe Néricault Destouches aimed to express in *Le Glorieux* (1727) and *Le Philosophe marié* (1727); the latter had a great effect when translated into English by John Kelly as *The Married Philosopher* (1732). The best early representative of the new genre is Pierre Claude Nivelle de la Chaussée, often regarded as its father on the grounds that he partook of the qualities of both tragedy and comedy, without creating either in *La Fausse Antipathie* (1733), *Le Préjuge à la mode* (1735) and *L'Homme de fortune* (1751). But before *comédie larmoyante* could develop into the middle-class serious play known as *drame* it was necessary for yet another breach of classical tradition in England to make its effect felt beyond the channel.

In 1731 George Lillo deliberately extended the range of tragedy to bring in persons of the middle class in his *The London Merchant, or The History of George Barnwell* (1731). In his preface he argued that this was not an offense against the dignity of tragedy and that plays "founded on moral tales of private life" were as tragic as those dealing with persons "of superior rank." Whether classical or not, England had adhered to the tradition which could not conceive of tragedy as affecting such a person as a London apprentice and his master. It is true that something approaching this may be discerned in Elizabethan domestic drama; but there it was merely that the characters were not aristocratic; they were treated in the same spirit as if they were, and in much the same style. Lillo knew he was breaking with the traditionally tragic; and Edward Moore, helped by Garrick, followed him in *The Gamester* (1753). Even before *George Barnwell* affected French practice, it was a source of inspiration to Gotthold Ephraim Lessing for his *bürgerliche Trauerspiel* (middle-class tragedy), *Miss Sarah Sampson* (1755).

Two years later came *Le Fils naturel*, written by Denis Diderot,

though it was not acted until 1771. From this and from Diderot's *Le Père de famille* (written 1758, performed 1761), the whole of the genre of *drame* took its tone and colouring in France. Plays were written to enunciate moral truths, to preach the crimes of civilization and conventional society, to advocate the strength and purity of the natural virtues, to express pity for the oppressed and admiration for the solid, serious, virtuous middle-class merchant. To such belong Michel Jean Sedaine's *Le Philosophe sans le savoir* (1765) and Louis Sebastien Mercier's *Jenneval, ou le Barnevelt français* (printed 1769) and *Le Juge* (1774). The link between Lillo and Mercier is obvious. Diderot followed his writing of serious comedy itself with a defense of the genre in his essay *De la poésie dramatique, à Monsieur Grimm* (1758). He finds classical precedent in Terence, whose comedies he insists are not aimed primarily at provoking laughter but at touching the sentiments in scenes which are natural and in tune with the customs of the age in which they were written. The new form was defended also by Pierre Augustin Caron de Beaumarchais, the author of *Le Mariage de Figaro* (1784), in his *Essai sur le genre dramatique sérieux*, which he published with an example, *Eugénie* (1767). He pointed out that while witty lines and stage tricks can blind the audience to the reality of vice and while the sufferings of the traditional tragic heroes have little relation to the facts of living in 18th-century France, the sentimental drama could move by truth and nature and by undisguised moralizing; the very element of emotionalism to which exception is taken today and to which it was taken by some, notably Voltaire, in his own age, is what seems so necessary to Beaumarchais in order that virtue shall be strengthened in the fight against vice.

Serious middle-class drama was not confined to England and France. Lessing followed *Miss Sarah Sampson* with a retelling of the Virginius story, *Emilia Galotti* (1772), and another play of this kind is Schiller's *Kabale und Liebe* (1784). In Russia the influence of Marivaux, Diderot and Beaumarchais led Vladimir Ignatevich Lukin (1737–94) to make an attempt to introduce bourgeois comedy there; it could hardly be expected, however, to live, much less thrive, in a country almost without a bourgeoisie. In Holland the new form took; French examples were translated and imitated. In Italy, despite Goldoni and his followers, the sentimental drama conquered. Typical are *Il delatore* (1800) by Camillo Federici and *La Dama di spirito* (*c.* 1790) by Francesco Cerlone. Even Spain has such works as *El Delincuente honrado* (1774) by Gaspar Melchor de Jovellanos and plays by Nicolas Fernández de Moratín such as *El Viejo y la niña* (1790) and *El Sí de las niñas* (1806).

12. England and Italy: 18th-Century Sentiment and Comedy.—Although England had been a strong influence in the development of the sentimental play, it had opponents there; but the objections were not on classical or aesthetic grounds, but simply against the sentimental spirit itself. Oliver Goldsmith tried to provide an alternative in the shape of *The Good-natured Man* (1768) as an example of what he called "Laughing Comedy" in his "Essay on the Theatre" (1773). Goldsmith's other comedy, *She Stoops to Conquer*, designed to provoke laughter, not pathos or sentimentality, appeared in 1773, the same year as Samuel Foote, "the English Aristophanes," amused his Haymarket audience with *The Handsome Housemaid; or Piety in Pattens* (1773), a satire of the spirit of sentimental drama. The art of Richard Brinsley Sheridan was fundamentally opposed to the atmosphere of lachrymose comedy, whose devotees are ridiculed to some extent in the person of Lydia Languish in *The Rivals* (1775). Sheridan avoided the mixed form himself, preferring to translate the wit and gaiety of Restoration comic dialogue out of its cynicism into something more suited to a society accustomed to genteel comedy.

Plays with a mixture of the laughably comic and the sentimental continued to be written and were popular to the end of the century. Among them are *The Way to Keep Him* (1760) and *The School for Guardians* (1767) by Arthur Murphy and *The Jealous Wife* (1761) by George Colman the Elder, who collaborated with David Garrick in *The Clandestine Marriage* (1766). Another example which held the stage successfully was Thomas Morton's *Speed the Plough* (1700), in which the character "Mrs. Grundy"—later to become symbolic of a type of moral outlook—was introduced to the British public. Hugh Kelly's *False Delicacy* (1768) and Richard Cumberland's *The West Indian* (1771) delighted their time; and the same sentimental spirit dominates Thomas Holcroft's *The Road to Ruin* (1792) and much of the work of Elizabeth Inchbald, particularly *Such Things Are* (1787) and *Lovers' Vows* (1798) derived from *Das Kind der Liebe* (1790) by August von Kotzebue. Toward the end of the century, even George Colman the Younger, who was regarded as the successor to Sheridan in comedy, was providing for his public sentiment rather than wit.

To some extent the sentimental *drame* of the 18th century was more realistic than classical tragedy; it created a tradition of treating middle-class, rather than aristocratic, matters seriously; it showed to the public persons and scenes which could be recognized as part of contemporary life; and it began the process of development toward the prose dialogue of later ages.

Eighteenth-century Italy saw the flowering of more traditional comedy in Gozzi and Goldoni. Count Carlo Gozzi took advantage of the existing *commedia dell' arte* to write fairy tales—*fiabe*—with a satirical purpose, in a strong reaction against the lachrymose spirit of the age. Where Gozzi was an aristocrat who delighted in using the extravagances of the *comedia dell' arte* method, Carlo Goldoni was a bourgeois, dedicated to reform the stage with a regular written comedy. He is credited with more than 300 plays, in many of which he writes his own comedy of manners, observing the ridiculous but not satirizing deeply; although he writes witty dialogue he can also perpetrate the dullest of moralizings. He castigates the aristocrats and approves of middle-class virtues; his men are not so interestingly and completely imagined as his women.

13. Romanticism in Germany and Scandinavia.—As the 18th century progressed, English influence on the drama was felt not only in the form of sentimental comedy but as an alternative to classicism, especially as this was associated with France. It was logical that in Germany politial opposition should combine with an awareness of the difference between the genius of the French and that of the German language to strike at Gottsched's attempt to found a German classical drama on the French model. The rising middle classes of Germany could find much to appeal to them not only in the middle-class sentiment of 18th-century English drama but also in the freedom of earlier playwrights from what were to Germany the fetters and artificialities of neoclassicism.

Shakespeare in France did not arouse a wave of enthusiasm until the early 19th century; but as he became known to the Germans from the time of Lessing onward, if not earlier, it seemed that here was an example of untrammeled genius, showing Germans the way. In 1762 Christoph Martin Wieland started a prose translation which was finished by Johann Joachim Eschenburg in 1782. Shakespearean energy and "nature" proved an inspiration to the movement known as *Sturm und Drang*, which was the title of a play in the new style by Friedrich Maximilian von Klinger. This play, which appeared in 1776, dealt enthusiastically with the American Revolution; in the same year Klinger wrote his most impressive play, *Die Zwillinger*, with fratricide as its subject. Five years earlier, Goethe, who had still to develop into the classicist, had been influenced by Shakespeare's unclassical writing to produce an imitation, *Goetz von Berlichingen* (performed 1773), in which he expressed with energy a nationalist delight in the German middle ages, alternating comic and tragic scenes in the Shakespearean, not the classical manner. *Alarcos* (1802) by Friedrich von Schlegel is so absurd as to be virtually a parody of the genre, and in this respect it is equaled by Clemens Brentano's *Die Gründung Prags* (1814).

But not all the romantics were so absurd or sensational. Heinrich von Kleist, author of the very amusing *Der zerbrochene Krug*, wrote tragedies dealing with the intensity and complexity of passion: *Die Familie Schroffenstein* (1803), *Penthesilea* (1808) and *Das Käthchen von Heilbronn* (1810); in *Der Prinz von Homburg* (1811) he goes much deeper into human psychology. Another outstanding romantic is Franz Grillparzer, an Austrian, whose *Ahnfrau* (1817) is based on a theme in itself absurd. His later

plays are poetic rather than theatrical with the exception, possibly, of *Der Traum ein Leben* (1834). The German romantics tended to ignore the material conditions of the contemporary stage and thus created gigantic poetic plays which in some ways anticipate the writings of the 20th century: such are *Napoleon oder die hundert Tage* (1831), by Christian Dietrich Grabbe, and *Dantons Tod* (1835) and *Woyzeck* (1836), both by Georg Büchner.

Nevertheless it was a lesser dramatist, August von Kotzebue, whose plays were first imitated outside Germany; in the 1790s he reduced Schiller's style of poetry in drama to a form in which it was appreciated by popular audiences. His works can more accurately be called melodramatic in their sensationalism and sentimental philosophizing. His scenes ranged even further than those of Voltaire, of whom in some ways he is the melodramatic equivalent, although the Frenchman firmly believed in the views which he advocated, whereas the German made use of any scrap of enlightened, romantic or humanitarian thinking that would serve his purpose. Of Kotzebue's plays, 36 were translated into English and 20 of these performed. The most popular were *Pizarro* (1799), which Sheridan adapted from *Die Spanier in Peru* (1796), and *The Stranger* (1788; from *Menschen hass und Reue*, 1788), in which John Philip Kemble and Sarah Siddons delighted their devotees as the Stranger and Mrs. Haller.

Romanticism influenced Scandinavian drama earlier than that of most other countries. As early as 1770 in Denmark Johannes Ewald based his prose tragedy *Rolf Krage* on the chronicles of Saxo Grammaticus; four years later his *Balders Dod* (1774), from the same source, was the first Danish play to be written in iambic pentameters. His most famous play is *Fiskerne* (1778), treating the life of a fishing village. Ewald and Adam Gottlob Öhlenschläger were both influenced by Goethe and Schiller. Öhlenschläger wrote two historical tragedies, some plays with love themes and an idyllic pastoral, *Den lille Hyrdedreng* (1818). Johannes Carsten Hauch wrote historical plays which were studies of character. Romantic plays, including *Kong Rene's Datter* (1845; Eng. trans. *King Rene's Daughter*, 1850) were written by Henrik Hertz (1798–1870). Sweden reacted to romanticism as early as Bengt Lidner's *Grefvinnan Spastaras död* (1783). In the next century came Erik Johan Stagnelius with *Martyrerna* (1821) and *Bacchanterna* (1822). These, like the work of P. D. A. Atterbom and Carl J. L. Almquist, were not theatrical enough for performance. The first romantic plays in Swedish suitable for performance were those of Baron Bernard von Beskow (1796–1868), historical plays strongly imitative of Schiller. The historical plays of Frans Hedberg were often acted, as was the musical play *Värmlänningarne* (1846) by Fredrik Dahlgren.

14. France: Melodrama and Romantic Drama.—In France pure romantic drama did not develop until comparatively late. It was preceded, however, by the equivalent of the melodrama of Kotzebue in the work of Guilbert de Pixérécourt (1773–1844), whose *Sélico* (1793) represents adequately his sensational plots, full of tension and theatrical climaxes, adapting themes and subjects of popular novels and with the scene set in France, Scotland, Mexico or Poland. It is considered that the work of Pixérécourt and Kotzebue led to both the kind of play developed by Eugène Scribe and the romantic yet realistic melodrama of 19th-century England. Romanticism proper in the French theatre was released by the impact of Shakespeare, as in Germany. What the art of Racine had degenerated into was avidly replaced by the imitation of Shakespeare, who became a symbol of the freedom of the poetic imagination. The French romantic dramatists did not appreciate the real Shakespearean method, which they mistook for a kind of melodrama to some extent, but with tremendous natural energy and poetic strength such as melodrama could not attain. Romantic drama itself tended to be lyrical and undramatic in the theatrical sense as there was little or no dramatic conflict either between individuals or within them.

In 1821 a French edition of Shakespeare was published; interest was deepened with François Guizot's writings on him, to be increased even more as the result of Stendhal's *Racine et Shakespeare* (1824). Then in the season of 1827–28 Paris was visited by Charles Kemble's company. Victor Hugo had already written his romantic *Oliver Cromwell* in 1824; three years later he issued it with a preface claiming pre-eminence for Shakespeare. Hugo himself wrote a comparatively realistic historical play in 1829. *Un duel sous Richelieu;* in 1830 came the sensation of *Hernani*, in which a combination of sensational incident and fiery sweeping verse expresses the essence of drama in French romantic terms. The furore caused by its performance was less the result of any striking novelty than due to the fact that, as this took place in the Comédie Française, it was regarded by the supporters of classicism as a challenge to be rebutted and by the supporters of romanticism as one to be supported no less vociferously. Hugo's *Ruy Blas* (1838) and *Les Burgraves* (1843) have the same tremendous vitality, mixing the sensation and to some extent the spirit of melodrama with a quality which comes from a poetic capability in the author and which far outstrips that of the writers of melodrama, even though their knowledge of theatrical practicalities may have been greater.

Alfred de Vigny was more sentimentally Byronic. Having translated *Othello* (1829) he tried in his *Chatterton* (1835) to show the action going on morally within the individual, thus anticipating to a certain degree the later impressionist drama. The English players of Shakespeare also made a great impression on Alexandre Dumas *père*, who did not try to establish a poetic theatre so much as to use the means provided by melodrama to develop a more realistic romantic type of historical play with a well-knit plot, as represented by his *Henri III et sa cour* (1829). His *Antony* (1831) is a link in the development of 19th-century realistic drama out of the *drame* of the previous century; this is a play of typically romantic and violent passions but takes place in a middle-class milieu. A contemporary, Alfred de Musset, having failed with his *La Nuit vénitienne* (1830), went on to develop his own unclassical version of the kind of play written by Marivaux, with a touch of the quality of Beaumarchais and of Shakespeare's true sentiment in comedy as opposed to sentimentality.

Romantic experiment stopped with the failure of Hugo's *Les Burgraves*. The romantic play's development into the realistic play of the middle of the century, which in translation and imitation provided vehicles for the English actor-managers, is heralded as early as 1832 by Casimir Delavigne's *Louis XI*, in which he tries to blend romantic novelty of theme and treatment of character with a more conservative spirit nearer classicism.

15. The 18th and Early 19th Centuries: Neoclassic and Romantic Drama.—The prevailing tone in France is shown in the fact that after a failure with *Lucrèce* (1843), an attempt at classical tragedy, François Ponsard was more successful with the more romantic *Agnès de Méranie* (1846) and the historical *Charlotte Corday* (1850). It was this sort of play that was partly the inspiration for such writers in Holland as Hendrik Jan Schimmel, whose *Twee Tudors* (1847) and patriotic dramas achieved some popularity.

In Spain and Portugal the spread of romanticism in drama was delayed by political considerations. Neoclassicism dominated the 18th century, but in its second half theorists had come forward with justifications of the unclassical drama of the Golden Age. These are to be found in the writings of Tomás de Erauso y Zavaleta (1750), Juan Cristóbal Romea y Tapia (1763) and Francisco Nieto de Molina (1768). Calderón, Rojas Zorilla and Moreto were defended by Leandro Fernández de Moratín in *La Comedia nueva* (1792). Although the writers of the Golden Age were being published and performed more, it was not until the end of the reactionary reign of Ferdinand VII (1814–33) that the new romantic drama appeared in Spain. Many translations from Hugo, Dumas and much less competent French romantic dramatists were performed; but the new Spanish plays in this genre were not very successful. Moratín and Manuel Bretón de los Herreros —a neoclassical writer—were at least as well received as Francisco de Paula Martínez de la Rosa's *La Conjuracion de Venecia* (1834), Angel, duque de Riva's *Don Alvaro* (1835) and *Los Amantes de Teruel* (1837) by Juan Eugenio Hartzenbusch. Spanish romantic drama did not entirely displace the neoclassical; later 19th-century Spanish writers tended to draw what they needed from either school, looking for their real inspiration to the playwrights of the

Golden Age of two centuries earlier. Two outstanding romantics were José Zorrilla y Moral, with a very popular new treatment of an old story, *Don Juan Tenorio* (1844), and José Echegaray y Eizaguirre. In the work of Manuel Tamayo y Baus can be seen the alternation of the classical with the romantic typical of his time, with a very able combination of the two in *Un Drama nuevo* (1867).

Portugal produced its first romantic playwright of stature even later than Spain. After the neoclassical attempts already noted João Baptista da Silva Leitão, visconde de Almeida-Garrett, treated patriotic subjects powerfully and skilfully—in prose dialogue, moreover: such are *Um Auto de Gil Vicente* (1838), *Dona Filipa de Vilhena* (1840), *O Alfageme de Santarém* (1841) and *Frei Luís de Sousa* (1844), of which the last is best.

Italy, like the other Latin countries of the south, did not easily succumb to romanticism in its drama, possibly owing to the influence of Alfieri as well as to the fact that a classical way of writing had been traditional there for if anything longer than an unclassical one had been taken for normal in England. Giovanni Pindemonte shows some reaction to the romantic spirit and method in his *Ginevra di Scozia* (1795) and *Lucio Quinzio Cincinnato* (1800), but he is fundamentally a classicist.. Romantic theories of historical drama, in which the influence of Schiller in particular lived, were the inspiration of the greatest of the Italian romantic tragic writers, Alessandro Manzoni in his *Il Conte di Carmagnola* (1820) and *Adelchi* (1822). Giovanni Battista Niccolini, another patriot, who had failed with his classical *Polissena* (1810) to rouse his countrymen to adopt pure Greek rather than neoclassic models, now followed Manzoni's lead with the romantic *Antonio Foscarini* (1827), *Giovanni da Procida* (1830) and *Arnaldo da Brescia* (1843), all patriotically political; of these the last is best. Linked with the Risorgimento were also the undistinguished plays of Silvio Pellico, Carlo Marenco and Carlo Tebaldi Fores.

Romanticism came in Russian drama as the result of melodrama in practice worked upon by the influence of Shakespeare, and the German romanticists and Byron. After Vasili Andreevich Zhukovski and Ivan Andreevich Krylov came the much greater Aleksandr Sergeevich Pushkin, whose *Boris Godonov* (1825) is a romantic Russian version of the Shakespearean verse history play. Schiller is the dominant influence on Pushkin's contemporary Mikhail Yurevich Lermontov in his *Ispantsi* (written 1830), and Shakespeare provides the model for *Maskerad* (written 1835, but not performed until 1852). Other minor authors attempted romantic drama for patriotic purposes, among them the philosopher Aleksei Stepanovich Khomyakov in *Ermak* (1827) and *Dmitri samozvanets* (1832). Patriotism expresses itself in Polish romanticism also, with Alojzy Felinski's *Barbara Radziwillowna* (1811) and with Julius Slowacki, who was inspired by Shakespeare in style and technique in his *Mindowe* (1833), *Balladyna* (1839) and *Mazeppa* (1840). In Hungary, Shakespeare had a similar effect on *Bánk Bán* (written 1815, first performed 1833) by József Katona. Another Hungarian romantic was Károly Kisfaludy, who wrote *Irene* (1821).

16. The 19th Century: The Development of Realistic Drama.—In Europe and drama as a whole the transition from romanticism into realism took place quite logically. Although the two are really fundamentally different in spirit, romanticism was opposed to the old traditions associated with both classicism and the *ancien régime;* it was in some ways an exaggeration of sentimentalism and like the writers of *drame,* of middle-class tragedy and sentimental comedy, the romantic dramatists reacted against the sharp neoclassic division of subject and style into tragic and comic. In addition, however poetic the new movement might be in its dialogue, it had no dogmatic objection to the use of realistic theatrical techniques in performance. As a result, the first wave of realism in 19th-century Europe was not inspired by a consistent program of theatrical and social reform so much as it was a reaction against romantic excesses, mingled with an awareness of much that was wrong with contemporary manners and conventions. Comedy has always been more realistic than tragedy; it tends to show people as they only too ridiculously are, whereas tragedy's tendency is to concentrate on the ideal, on people as they ought to be. In France the new realism was felt in comedy at first, derived partly from the methods of the mixed form *comédie-vaudeville,* and can be seen in the work of Charles Guillaume Étienne (1777–1845) and Louis Benoît Picard (1769–1828). Alexis Jacques Wafflard (1787–1824) is more realistic in his *Un Moment d'imprudence* (1819), and even more vivid with ingenuity of incident is Delavigne's *La Comédie des comédiens* (1820).

In this situation it was possible for Eugène Scribe to develop systematically a practice of constructing efficient working plots for historical dramas, melodramas, tragedies and comedies of intrigue, with the aid of a number of collaborators. The term "the well-made play" given to these productions is enough to indicate their nature. Scribe himself had no feeling for character, but he demonstrated how to make a plot develop; and in some of his work, notably *Un Verre d'eau* (1842), he expressed that element of the realism of the age which aimed at deflating false pretentiousness. Honoré de Balzac, starting with romantic tendencies, eventually showed himself the realist in *Pamela Giraud* (1843), *La Marâtre* (1848) and *Mercadet* (performed 1851; originally *Le Faiseur,* 1830); this last entered the repertoire of the Comédie Française (1869).

Realism developed further in Alexandre Dumas *fils,* who learned from Scribe and yet understood his weaknesses. Dumas took up ideas and developed them skilfully in terms of theatre, manipulating characters and plot, but showing people as created by their environment and with no control over their fate. Gradually moving away from the colourful to the sordid he impressed his contemporaries with what they accepted as powerful treatments of life as it existed. The strength of his dialogue and characterization derive partly from his careful study of Corneille. His range includes *La Dame aux camélias* (1852), *Le Demi-monde* (1855) and *Francillon* (1887), but he steps beyond it with the attempt in *Le Fils naturel* (1858) to write a thesis play for which he had no real profundity. Émile Augier moved to realism by way of romanticism and melodrama, developing the new dramatic style under the influence of Scribe's methods. Augier wrote at first in verse, which he left in his treatment of the clash of ideals in *Le Gendre de M. Poirier* (1854). He had ideas on the state of society, and by means of lifelike pictures of that society he expressed them theatrically in such plays as *Le Mariage d'Olympe* (1855). Here was the combination of brilliance in plotting and characterization and the working out of a thesis that was to develop into later naturalism. The weakness of both Dumas *fils* and Augier lies in their superficiality, however exact their observation of the surface may have been.

In Russia realism also developed by way of melodrama and satiric comedy. There is an element of satiric realism in the comic sketches written by the empress Catherine II the Great in the 1770s, which had been preceded by a similar quality in Denis Ivanovich Fonvizin's *Brigadir* (1780; "The Brigadier-General") and also occurs in Mikhail Matinski's *Sankt-Pëterburgski gostiny dvor* (1781; "The St. Petersburg Arcade") and Vasili Vasilevich Kapnist's *Yabeda* (1793–94; "Chicanery"). In 1821 Aleksandr Sergeevich Griboedov started writing his *Gore ot uma* (1831; "Wit From Woe") in which the verse dialogue did not detract from the fundamental realism of the character portrayal. Although this was more a series of comic scenes than a play, it contributed to the atmosphere out of which emerged the skilfully plotted, fully theatrical satiric realism of *Revizor* (1836; Eng. trans. *The Government Inspector*) by Nikolai Gogol. The tradition was continued by Aleksandr Sukhovo-Kobylin (1817–1903). In the middle of the century Russia was not dominated by the methods of Scribe, largely, it is considered, owing to the more powerful influence of Aleksandr Nikolaevich Ostrovski, who developed the realism of his predecessors by concentrating on character rather than plot. The seeming formlessness of his series of scenes appears to be like that aimed at by those who later talked of drama as a slice of life. But there is no logical exposition of "the theme underneath" as in Zola's conception. Ostrovski had the ability to satirize and sympathize as he attacked middle-class dullness and many aspects of Moscow society; his

best plays are *Groza* (1860; "The Storm") and *Les* (1871; "The Forest").

Although Scribe did not affect Russia, his influence helped to give structural strength in almost every other country. It appears in Spain in the Argentinian Ventura de la Vega's *El hombre del mundo* (1845) and in *Nos más mostrador* (1831) by Mariano José de Larra. In Italy with a comic tradition stemming from Goldoni there was no need of aid from Scribe in play-making, yet he contributed an element to the style of Riccardo Castelvecchio's *La donna romantica e il medico omeopatico* (1858). Poland made something of its own out of what Scribe offered in such writings as *Matzenstwo Apfel* (1887; "The Apfel Marriage") by Count Kazimierz Zalewski. Similarly the Czech dramatist Emanuel Bozdech gave an individual twist to his *Zkouska statinkova* (1874; "The Politician's Trial"). Scribe's effect was felt and absorbed into something fundamentally native in Austria and Hungary. That he had something valid to offer which did not dominate those who made use of his model can be seen in the case of August Blanche's Swedish play *Ett resande teatersällskap* (1842). This is constructed according to the Frenchman's method, yet its atmosphere and personages are utterly Swedish.

German realists, however, hammered out their own drama in the first half of the century, as their social thinking and materialist philosophy began to take effect. There the line of development was through romanticism and melodrama, but not by way of comedy. The movement known as *Junges Deutschland* ("Young Germany") had as one of its aims a truly national and democratic theatre; and Karl Gutzkow with *Uriel Acosta* (1847) and Heinrich Laube tried to provide what they demanded. In the meantime Friedrich Hebbel, influenced by Hegelian thinking, was unsparingly labouring at the development of his talent, concentrating on psychological motivation. His *Judith* (written 1839, acted 1840) and *Genoveva* (1840–41) were still partly in the romantic tradition, but what has been called the first play of German naturalism came in his *Maria Magdalena* (1843), which has a sordid working-class environment and is the expression of a conception of tragedy as caused by the conflict between the individual and society. This conception inspired his medieval German history plays, among which is *Agnes Bernauer* (1855). Where Hebbel's thought was expressed by genuine dramatic ability, Otto Ludwig failed in his *Erbförster* (1850) because of his anxiety to expound his thesis, which prevented him imagining his story in terms of it. In the second half of the century, German realism was affected by the theories which Gustav Freytag, himself a moderately gifted dramatist, put forth in *Die Technik des Dramas* (1863). In it he expounded his theory of structure ("Freytag's Pyramid") and rejected the theory of dramatic conflict held by Ferdinand Brunetière. An Austrian writer of this time of importance to the later development of realistic drama in Germany was Ludwig Anzengruber, whose peasant plays contain dialogue in which he aimed at reproducing the quality of colloquial, even dialect, speech, yet giving something which was more than a mere faithful transcript.

As the century progressed, realism in France developed its next phase, at first in the work of Victorien Sardou, who adapted the methods of Scribe to the demands of a time more accustomed to at least a superficial realism of technique and to a drama which dealt with views then regarded as advanced. Whether the subject was historical or modern, dealing with the strange and bizarre or the contemporary social scene, Sardou welded together the thesis play and the kind of intrigue in which character took second place to action and sensation. Whereas Sardou can be regarded as the heir to Scribe, Henri Becque took over those elements of realistic drama which had been developed by Augier and Dumas *fils*. Becque's drama of ideas tended to be without obtrusive structure; he concentrated upon well-thought-out characterization, in which motivation and actions appeared probable and consistent with one another. These qualities in *Les Corbeaux* (1882) are typical of the comparatively brutal realism of what was called the *comédie rosse*.

But the comedy of intrigue and the *pièce à thèse* were invalidated in one blow by the theorizing of Émile Zola, who insisted that true realism—in his terminology, naturalism—should give as perfect an imitation of life as possible, striving to avoid any sign of artificial structure, of planned intrigue or contrivance, so that the incidents seemed to arise of their own accord as the result of the coming to life in the story of the characters as if they had not been created by an author. His *Thérèse Raquin* (1873) has been called the first tragedy of the French naturalist theatre. Without arranging his facts to fit the needs of a thesis, but by imagining a world in which things happen in accordance with it, which is what he thought of the real world, too, Zola called for a drama that was absolutely true to the facts of existence and which could permit his own time to see itself on the stage.

17. Ibsen: The Play of Ideas.—The most fruitful of the treatises written on the art of drama and the contemporary world in the 19th century may well have been *Das moderne Drama* (1852) by Hermann Hettner, who considered that his friend Hebbel had pointed in the right direction, and that by concentrating on psychological truth and the interplay of social forces it would be possible for dramatists to produce a really significant drama showing the situation of modern man in the modern world. This treatise reinforced in Henrik Ibsen the understanding of the art of drama which he had acquired from the study of Shakespeare, Holberg and Scribe during many years as *Dramaturg* and director of the Bergen theatre, and from his own writings before he developed his naturalistic drama himself.

In *De Unges Forbund* (1869; Eng. trans. *The League of Youth*) and *Samfundets Støtter* (1877; Eng. trans. *Pillars of Society*) he had mastered the art of realistic prose dialogue, but the method was still fundamentally that of Scribe in plot structure, while the tone was comically satirical of social conventions. In *Et Dukkehjem* (1879; Eng. trans. *The Doll's House*) and the plays that followed, the 19th-century ideal of the realistic play embodied itself. Conventional attitudes to matters of importance to society are tested, individuals are shown in organic relationship to their environment and one another, the exposition is not obvious, character and incident seem to grow necessarily intertwined, the convention of five acts is ignored while that of unity of place tends to be observed; and stage directions are important because the whole environment has been imagined as of significance in the fates of the individuals dealt with.

Another Norwegian realist was Bjørnstjerne Bjørnson, lesser than Ibsen yet outstanding in his own right, who wrote realistic plays in the early 1870s when Ibsen's characteristic art had not been developed. With these two there appeared the realistic Swedish dramatist August Strindberg, whose first work was romantically Byronic, but who developed a powerful realism in the 1880s in plays such as *Fadren* (1887; Eng. trans. *The Father*). By the time of *Fröken Julie* (1888; Eng. trans. *Miss Julie*), however, Strindberg was finding the need to extend beyond the range of naturalism; although in this play he manages to imagine a situation in which no exception can be taken on naturalist grounds to the use of music, dancing, and of poetic atmosphere. A much lesser figure was the Norwegian Gunnar Heiberg, whose dialogue was effective, but only *Balkonen* (1894) and *Kjaerlighedens Tragedie* (1904; "Love's Tragedy") show anything like great talent.

The model provided by Ibsen led to a spate of "plays of ideas" by French naturalistic writers, many of whom were associated with André Antoine, whose enthusiasm for the new drama led to the founding of the Théâtre Libre in Paris in 1887. During its seven years of life, foreign naturalist plays, especially those of Ibsen, were given in translation and new French playwrights were encouraged. This group included George de Porto-Riche, François de Curel, Henri Lavedan and Paul Hervieu. The most controversial of these writers was Eugène Brieux, who had the technique and imaginative strength to present problems dramatically in what was the final development of the play of ideas. Contemporaries were startled or stimulated by the boldness with which he dealt with issues that to other writers of the time seemed to be too advanced for theatrical presentation. Although he was potent in stimulating discussion of problems that might otherwise have been ignored by large sections of the public, his thinking was fundamentally commonplace, his methods often too sensational.

The examples of Ibsen and the French dramatists stimulated existing German realism to fresh efforts. On Sept. 29, 1889, Otto Brahm combined with Theodor Wolff and Maximilian Harden to found the Freie Bühne, a theatre on the model of Antoine's in Paris. Brahm admired the art of Anzengruber, Ibsen and Bjørnson and encouraged German writers to treat similarly such topics as abnormalities of conduct, crime, disease and the lives of the proletariat, aiming at natural dialogue and the careful integration of character, incident and environment. Arno Holz and Johannes Schlaf collaborated on *Die Familie Selicke* (1890); and Schlaf alone in *Meister Ölze* (1890) treated the psychological motivation and behaviour of a criminal in a way that offered another subject and model for his fellow writers.

To this group of realistic plays belong the early works of Gerhard Hauptmann, whose *Vor Sonnenaufgang* was played at the Freie Bühne in 1889. At this period he was influenced by Anzengruber and Ibsen; Anzengruber's influence is seen in *Die Weber* (1892), Ibsen's in *Einsame Menschen* (1891) and in stage directions that set a scene necessary for the depiction of the interaction between environment and character. His bourgeois tragedy aimed at treating social problems by an objective depiction of life. Hermann Sudermann, a lesser playwright, tended to treat a lower-middle-class milieu: his *Ehre* (1889) is best known. Succumbing to the influence of Augier and Dumas *fils* as much as that of Ibsen, he falsified situations and sacrificed integrity of imagining for theatrical effect. Moral and social issues were handled in the naturalist manner by Max Halbe (1865–1944), Georg Hirschfeld (1873–1939) and O. E. Hartleben (1864–1905).

In Russia in the second half of the century, realism developed as elsewhere, but in a way that was uniquely Russian. As early as 1850 Ivan Turgenev anticipated the manner of Chekhov in *Mesyats v derevne* (performed 1872; Eng. trans. *A Month in the Country*) in which realistic technique analyzed sentiment, and by means of apparent irrelevance created an imaginative impression of reality. Like Ostrovski's, this is not photographic realism, nor does it wrestle powerfully with violent states of mind, but induces a poetic mood. Lev Tolstoi was nearer to the manner of Hauptmann but with a Christian rather than a pessimistic spirit, if no less brutal, in *Vlast tmy* (1899; "Power of Darkness") and *Plody prosveshcheniya* (1891; "The Fruits of Enlightenment"). But in Anton Chekhov, author of *Vishnevy sad* (1904; Eng. trans. *The Cherry Orchard*), realism deserted the precise certain pronouncements of problems and denunciations of evils for a no less realistic but much more devious inner treatment of character and milieux, producing a seeming formlessness externally. His five great plays and his one-acters show equally a capacity for laughter, which is based on penetration into human foibles but which is tolerant. His achievement is to have been able to write and imagine with superb fidelity to nature, while avoiding the strident, and to have expressed the ideal in a meticulous representation of the real.

18. England in the 19th Century: From Melodrama to Realism.—The development of realism in England has to be seen in relation to what was happening in Europe from the beginning of the century. There was the same development through romanticism and melodrama to a kind of romantic realism; but England produced few playwrights of any worth and the stage depended mainly on translations and imitations, particularly from the French. Apart from Byron, the English romantic writers made no contribution to the theatre; and his *Manfred* (first performed 1834, by Charles Kean) was treated as exalted melodrama by actors later, notably Macready, who found it a useful vehicle. *Sardanapalus* (first performed 1834) was used for their own purposes by this actor and by Charles and Ellen Kean, who made a great spectacle out of it. Byron's *Werner* (first performed 1830) also provided a favourite role well into the century.

For more than three decades the English theatre maintained in its repertoire many of the popular acting roles from the preceding century and in this way provided audiences with poetry despite the fact that contemporary writers were producing little of any worth. Among these the most successful were James Sheridan Knowles with *Caius Gracchus* (1815), *William Tell* (1825), *Virginius* (1820), *The Hunchback* (1832) and *The Wife* (1833). Even in these plays the change in attitude associated with the rise of an industrialist and mercantile society can be seen; in many ways the spirit of middle-class drama inhabits them despite their classical or medieval subjects. Another purveyor of a semblance of poetic drama was Richard Lalor Shiel, whose *Evadne, or The Statue* (1819) held its place in the repertoire for about half a century. To some extent the results of changes taking place on the continent filtered through to England in the work of Edward Bulwer-Lytton, later Lord Lytton: *The Lady of Lyons* (1838), the most popular romantically realistic play of the century in England; *Richelieu* (1839), which was almost as popular; and *Money* (1840) catered to the prevailing taste for sentiment, colour, sensation, realistic staging and powerfully realistic romantic acting. William Charles Macready was genuinely anxious to foster contemporary poetic drama. His association with Robert Browning led to nothing more successful than *A Blot on the Scutcheon* (1843) and *Strafford* (1837); but *Ion* (1836), by Sir Thomas Noon Talfourd, found its way into the repertoire for a number of years.

A landmark in the development of realism in England was provided by Macready's production of *The Patrician's Daughter* (1842) by John Westland Marston. This was an attempt at treating changes in contemporary society in a blank-verse play and the staging was realistic enough to dismay at least one of the performers, Mrs. Warner, when she found herself obliged to carry a parasol just as if she were not taking part in a play. Although it was a popular success, critics objected to the uneasy yoking together of realism and tragedy; obviously, Marston had not thought out his play in terms of contemporary life. Ten years later he provided *Anne Blake*, again a contemporary play, for Charles Kean, who staged this realistically as he had staged *The Wife's Secret* (1846) by G. W. Lovell. By the middle of the century, melodrama was becoming much more realistic in milieu and staging, especially in such plays as *The Octoroon* (1859), *The Colleen Bawn* (1860) and *The Trial of Effie Deans* (1860, from Scott's *Heart of Midlothian*) by Dion Boucicault.

Although the work of Tom Taylor, such as *Still Waters Run Deep* (1855) and *The Ticket-of-Leave Man* (1863), and that of Charles Reade in *Masks and Faces* (with Taylor, 1852) is superficial and sentimental, contriving to present theatrical entertainment rather than expressing powerful convictions, they were preparing the way for T. W. Robertson, who, partly as the result of working with Charles Kean, came to have an organic understanding of a realistic play as something more than a pretext for superficial stage realism. Fortunate enough to find in the management of Sir Squire and Lady Bancroft both practical and theoretical agreement, he came nearer than anyone before him in England to reflect ordinary everyday life. In *Society* (1865), *Ours* (1866), *Caste* (1867) and *School* (1869) he developed an English equivalent of the work of Augier and Dumas *fils*.

Drama in England, however, was not responsive to the influence of realism abroad except in the form of adaptation, translation and in acting and staging. This may well have been due as much as anything to the fact that audiences which were too sophisticated for "transpontine" melodrama were nevertheless quite satisfied with what could be made of mediocre and bad plays by the genius of such actors as Charles Kean and Henry Irving, who managed to convey the sense of reality by the truthful intensity of their acting in such romantic and sentimental, when not sensational, stage pieces as Dion Boucicault's adaptions (1855) of Delavigne's *Louis XI, The Corsican Brothers* (1852; from a novel by Dumas *père*) and Leopold Lewis' *The Bells* (1871). To be sure, Irving was glad of verse plays if he could find them; but Tennyson's *Queen Mary* (1876) and *Becket* (1893), like *Charles I* (1872) by W. G. Wills, look backward and not to the future, or even to contemporary England. In 1879, the year of *The Doll's House*, with a ferment of developments in European drama, it was possible for Matthew Arnold to lament with justification that in England "we have no drama at all."

But in the next 20 years, with the stimulus of foreign models, as the result of the theoretical and critical writings of William

Archer, Sir Edmund Gosse and later George Bernard Shaw and Sir Henry Arthur Jones and with the examples of foreign models to inspire them, a school of realistic dramatists began to develop. It is not unnatural that in a theatre accustomed to melodrama and the refinements on it provided by translations of Sardou, Jones in collaboration with Henry Herman tried to preach a sermon, however sentimentally, with the essentially melodramatic *The Silver King* (1882). Jones responded to the influence of Ibsen two years later with an adaptation of *The Doll's House* entitled *Breaking a Butterfly* (1884). He gradually developed his art along traditional realistic lines in accordance with his conviction that the theatre should be re-formed to become a real force for social reform (a view elaborated in his *Renascence of the English Theatre,* 1895). In plays such as *The Middleman* (1889), *Wealth* (1889), *Michael and His Lost Angel* (1896) and *Mrs. Dane's Defence* (1900) he treated, if sentimentally and superficially, themes and problems of importance to contemporary England. His sense of what was wrong with that society was more completely and truthfully expressed, however, in the comedies *The Masqueraders* (1894) and *The Liars* (1897).

During the 1890s, the problem play developed in England, especially after the founding in 1891 of the Independent Theatre by J. T. Grein (1862–1935) to provide an opportunity for the performance of Ibsen and other realistic playwrights and to encourage new English dramatists. Sir Arthur Wing Pinero, who had mastered the art of the well-made play, now turned to the new field with *The Second Mrs. Tanqueray* (1893), which shows his strength as a competent playwright and his essential weakness in that he had really nothing to say which demanded expression, but had merely exploited an effective technique and a new fashion. In the same decade the first rush of plays of ideas, superficially naturalistic in technique, began to pour from George Bernard Shaw, who, like Brieux, saw the drama as a vehicle for discussing and preaching, but who, unlike Brieux, was vitally involved in the transmission of his ideas. Naturalism in England developed more fully in the next two decades in the work of Harley Granville-Barker as a producer and as the writer of *The Voysey Inheritance* (1905) and *The Madras House* (1910). Among such writers as Alfred Sutro, Stanley Houghton and Harold Brighouse, John Galsworthy stands out. In his unsensational realism he strives by means of what seems a truthful picture of life to involve the emotions and intellect of his audience simultaneously in the perfect dramatic expression of humanitarian liberalism. Sir James Barrie made skilful use of realistic techniques, but for his own purposes, which were more sentimental and fantastical than those of the true naturalist such as Galsworthy.

19. Realistic Drama in Southern and Northern Europe.—The 19th century saw the spread of realism in other countries of Europe. Although the method and style were fundamentally alien to some aspects of Italian culture, Italy had its own blend of the art of Scribe and of romantic melodrama from which evolved plays *a tesi* in which the style was that of *verismo*. Vincenzo Martini wrote plays in which there is some attempt to consider serious social themes: *Una donna di quarant' anni* (1853), *Il cavaliere d'industria* (1854) and *Il marito e l'amante* (1855), treating adultery in an "advanced" way. Scribe gradually overcame Goldoni in the work of Tommaso Gherardi del Testa. *I mariti* (1867) by Achille Torelli belongs to the new genre, which was also tried by Leo di Catelnuovo and Paolo Ferrari in the 1860s and 1870s. In the next two decades realism was adopted by Giuseppe Giacosa, Girolamo Rovetta and Roberto Bracco. *I parasiti* (1899) by Camillo Antona-Traversi bears comparison with realistic drama of other lands.

Spain gave much the same kind of response. From the late 1870s onward José Echegaray y Elizaguirre, who was really by nature a romantic, made attempts at the realistic method. He wrote a number of thesis plays on the model of Dumas *fils;* only in *El Gran galeoto* (1881) and *El Hijo de Don Juan* (1892) does he produce anything like the art of Ibsen, whom he admired. Between 1892 and 1920 a number of thesis plays were written by the novelist Benito Pérez Galdós, of which *Electra* (1901), *Mariucha* (1903), *Barbara* (1905), *Pedro Minio* (1908), *Casandra* (1910) and *Alcestis* (1910) are considered the best. Frederich Soler is memorable for organizing a group, the *Teatra Cataló,* to write Catalan drama. Among them Ignasi Iglesias treated working-class characters seriously. Ángel Guimera wrote tragedies of love among the peasants and fishermen and later, influenced by Hauptmann and Sudermann and the Scandinavians, tried psychological naturalistic drama, not unsuccessfully.

Northern Europe took more naturally to the new drama, even where nothing outstanding was written. In Holland, Herman Heijermans showed an understanding of the techniques of stagecraft and characterization and in *Ahasverus* (1893), *De Meid* (1900) and *Op Hoop van Zegen* (1900) treated social and working-class problems. Belgium had Gustave Vanzype, Paul Spaak and a number of lesser writers. Not unexpectedly, Denmark showed a fierce reaction against romanticism toward the end of the century in the work of Gustav Wied, who wrote *Dansemus* (1905). Other naturalist plays of this period are *En Martyr* (1896) by Sven Lange and *Karen Bornemann* (1907) by Hjalmar Bergstrøm.

20. Drama and Verisimilitude.—Looking back from the state of drama in Europe at the beginning of the 20th century it is possible to see a straight line of development technically as the logical consequence of the conception of the art put forward by Lodovico Castelvetro in *La Poetica di Aristotile vulgarizzata* in 1570. From the fundamental assumption that the business of a poet is to imitate life in his medium, Castelvetro pointed out that the nondramatic poet has only words with which to imitate both words and things. His imitation of words could be verisimilar but not his imitation of things. But the dramatic poet could use words to imitate words and things to imitate things. For Castelvetro the unities were needed in order to aid the dramatist's deception of the audience. He himself was able to defend the use of verse in drama on the ground that it did not destroy illusion. In the theatre it is necessary for the actors to speak more loudly and with larger gestures than in common life; but in common life in that age it was usual to speak verse in much that manner. As a result, Castelvetro argued, verse in drama would sound quite natural. Part of the controversy between Dryden and Sir Robert Howard over the use of rhyme arose as a result of the acceptance of Castelvetro's thesis by Howard. Where Dryden insisted that natural writing meant good writing by literary standards, Howard took it to mean writing which simulated unpremeditated colloquial speech.

As the conception of realism slowly developed, critics began to examine dialogue by the standards of colloquial speech as well as those of good verse and to demand that so far as was possible, motivation and outward behaviour should be more like those of ordinary life. Soliloquy was accepted as a conventional representation of silent thought, but the thought itself must be such as the person concerned might have in the circumstances. So long as it did not seem possible to create naturalistic illusion on the stage in practice, critical pronouncements did not change very much in the actual drama, a point which Samuel Johnson understood when he said that in truth the audience always knew that it was in the theatre. But with technical and scientific advances in the 19th century, it began to seem possible really to put theory into practice and create a consistently naturalistic imitation on the stage. At the same time changes of thinking and of society led to the attitudes of mind that saw in the new techniques the truly dramatic way of showing the age to itself. Now it seemed that the true dramatic way was to give a realistic imitation of life as it is seen and heard outside the theatre, with human beings motivated in the way in which, according to contemporary thinking, human behaviour is motivated, in a world operating according to the laws which such writers as Zola were convinced were the controlling forces in the real world. In this drama there was no room for verse, soliloquy, aside, or obviously theatrical acting or playwriting. Instead of concerning itself in tragedy with the heroes of the past it treated ordinary men and women, mostly of the middle classes, but in some cases belonging to the workers and the outcasts from society.

21. The Reaction to Realistic Drama: 19th and 20th Cen-

turies.—During the 19th century it had seemed impossible for dramatists to treat problems and themes of any real significance to their contemporaries except by increasingly realistic means, until by the 1890s with the culmination of this movement in naturalism verse drama had been discredited. Nevertheless, verse dramatists soon learned that "poetry" was no excuse for slovenliness, triviality or a nostalgic attempt to evade issues of importance in their own time. In the 20th century there have been three main trends: first the immediate poetic reaction, next the kind of unnaturalistic drama associated with Expressionism; and all the time many dramatists continued writing naturalistically and successfully. The avowed rejection of naturalism as sordid and unpoetic was seen in Germany in Hugo von Hoffmansthal's *Gestern* (1891) followed by his verse plays on classical themes. Ludwig Fulda with *Der Talisman* (1893), Wilhelm von Scholz, Karl Gustav Vollmoeller, Edward Stucken and Paul Ernst took part in this reaction, which also affected Hauptmann (*Hanneles Himmelfahrt*, 1893; *Die versunkene Glocke*, 1897; *Der arme Heinrich*, 1902) and Hermann Südermann (*Die drei Reiherfedern*, 1899). Symbolism, unnaturalistic prose and verse were used for medieval and religious themes elsewhere by the Belgian Maurice Maeterlinck, in France by Paul Claudel and Henri Ghéon, with Villiers de l'Isle-Adam's *Axël* (written 1874, produced 1894). The romantic verse dramas of Edmond Rostand reacted from naturalism, too.

In Russia the reaction came in the symbolism of Leonid Andreev and of Fedor Sologub and the poetic drama of Aleksandr Blok. In Spain the plays of Federico García Lorca have a fierce poetic strength. Jacinte Benavente refused to conform to naturalism, as did the Italians Giovanni Verga, Girolamo Rovetta, Giuseppe Giacosa, Sem Benelli, E. L. Morselli and, towering above them, Gabriel d'Annunzio. In England attempts to create a living poetic drama in verse were made by Stephen Philips, Lascelles Abercrombie, John Drinkwater and, later, by Stephen Spender, W. H. Auden and Christopher Isherwood, Christopher Fry and T. S. Eliot. In Ireland J. M. Synge seemed to be finding a way with more success than W. B. Yeats in reaching a large audience. Maxwell Anderson and Archibald MacLeish have written verse drama in the United States. One element in the turning from naturalism is shown in a willingness to imitate medieval and early Renaissance forms, by Hoffmansthal in *Jedermann* (1911, from *Everyman*) and by Eliot in *Murder in the Cathedral* (1935). Yeats and Gordon Bottomley similarly experimented on the model of the Japanese Nō-plays.

Expressionism, the other kind of reaction away from naturalism, is foreshadowed in the plays which Strindberg wrote after 1899 and in the work of Frank Wedekind. Naturalism was related to the conception of reality derived from 19th-century scientific thought. Expressionism and allied kinds derive from the more complex conception which developed with further scientific development, in which new studies of the mind played a great part. The Expressionists proper scorned consistent naturalism and its attempt at illusion: instead, outer form was subordinated to expressing inner reality by the German writers Karl Sternheim, Georg Kaiser, Ernst Toller, Reinhard Sorge, Walter Hasenclever, Reinhard Goering and Fritz von Unruh. To this drama is related the "epic theatre" of Bertolt Brecht, who also used Chinese and Japanese techniques. Expressionism showed itself in the Czech writer Karel Čapek, in Russia in Vladimir Mayakovski and the directors Vsevolod Meyerhold and Aleksandr Tairov, as in the German Erwin Piscator. In the United States it affected Elmer Rice, Thornton Wilder and Tennessee Williams, who have a vitality and talent which are never negligible and often impressive. In England it was seen to some extent in Stephen Spender, Auden and Isherwood, Anne Ridler and Ronald Duncan and in Eliot's *Murder in the Cathedral;* it also tinged the later work of Sean O'Casey. Similar to Expressionism in superficial techniques were French Surrealists and the Italian Grotteschi.

There have been a number of dramatists in the 20th century who without being restricted to any "movement" make use of any techniques which achieve the most complete imaginative expression of their individual aims. Such in France are Henri Lavedan, Jean Giraudoux, Jean Cocteau, Jean Paul Sartre, André Obey; in Switzerland Friedrich Dürrenmatt; in the United States Eugene O'Neill and Arthur Miller; in Italy Luigi Pirandello and Ugo Betti; and in Britain James Bridie and J. B. Priestley.

Naturalism has persisted throughout the 20th century, notably in Maksim Gorki, whose *Na dne* (1902; Eng. trans. *The Lower Depths*) anticipated in theme and technique much written in the 1950s and 1960s by dramatists such as Samuel Beckett, Eugène Ionesco and the English writers of the "kitchen-sink" school (*e.g.*, Arnold Wesker), whose themes and techniques especially resemble those of the German naturalists. In the U.S. little of worth was written until the early 20th century, when European naturalism dominated such writers as W. V. Moody and E. Sheldon. More specifically American and individual is the realism of Sydney Howard and Robert E. Sherwood. It is responsible for the methods of the comedies of manners of Somerset Maugham in England, for the satire and realistic intensity of Carl Zuckmayer in Germany, for the political and religious appeals of Kaj Munk in Denmark. In Ireland it helped to produce the group of dramatists associated with the Abbey theatre, in particular determining the style and aim of the early work of O'Casey. Nevertheless, the Irish dramatic movement was not only nationalistic, it was also a reaction against naturalism in theme and technique. Dominated by W. B. Yeats and Lady Gregory, these dramatists aimed at a serious and valid contemplation of life beyond the themes and techniques of the naturalists, concentrating on form and attempting to vary technique to suit the needs of the individual theme. Here, perhaps, is the fundamental explanation for O'Casey's later styles.

See also references under "Drama" in the Index volume.

(B. L. J.)

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See also F. O. Nolte, *The Early Middle Class Drama, 1696–1774* (1935). (B. L. J.)

DRAMATIC CRITICISM extends from dramatic theory on the one hand to reviews of theatrical performances on the other; however, certain periodical essayists and journalists have written descriptions and discussions of the drama of their day which are of lasting interest and have strongly influenced dramatic theorists and even dramatists. By the 20th century a "drama critic" meant in normal speech a journalist on the staff of a periodical who wrote reviews of stage plays and whose views might or might not be worth noting. Some of these critics merely evaluated a play and a performance in general or possibly in "box-office" terms for the guidance of their readers, while others tried to go further and judged the work and the production by the highest standards.

The earliest theorist of the drama was Aristotle (*q.v.*), whose *Poetics* (*c.* 325 B.C.) laid down, miraculously for its time, the basis of all dramatic theory. His definition of tragedy as "an imitation of an action that is serious, complete and of a certain magnitude . . . in the form of action, not of narrative; through pity and fear affecting the proper purgation (*katharsis*) of these emotions" lies behind all subsequent discussions. The *Tractatus Coislinianus*, a 10th-century manuscript conjecturally related to Aristotle and first printed in 1839 (*see* Lane Cooper, *An Aristotelian Theory of Comedy*, 1924), gives an analysis of comedy that can be supported from Aristophanes, Shakespeare and Molière. Ancient dramatic criticism in action may be seen at its most amusing in *The Frogs* by Aristophanes (*q.v.*). Roman theory is represented by the *Ars poetica* (*c.* 10 B.C.) of Horace (*q.v.*), a clever and superficial work suggesting that "good sense," entertainment combined with instruction and a five-act division were the road to success. In the middle ages theory was concerned mainly with the still popular formal distinction between tragedy with its unhappy ending and comedy with its happy ending. Dante calls his poem a *Comedy* because "in its beginning it is horrible and foul, because it is Hell; in its ending, fortunate, desirable and joyful, because it is Paradise."

First Horace and then—when his work became accessible—Aristotle formed the basis of Renaissance criticism and ultimately of modern theory. The rediscovery of Aristotle's *Poetics* gave a new and fierce life to the discussion of dramatic theory and practice. A Latin translation by Giorgio Valla appeared in 1498, the Aldine *editio princeps* of the Greek text in 1508, Francesco Robertelli's critical edition in 1548 and an Italian translation (the first in any modern tongue) in 1549. Aristotle's cryptic lecture notes needed clarifying and most commentators loyally interpreted, altered and expanded in accordance with contemporary theatrical conditions. Plays were composed on Aristotelian principles. Ludovico Castelvetro (1505–71) was the powerful and individual founder of the Renaissance neoclassical doctrine, which survived until the romantic movements of the mid-18th century. In his commentary *La Poetica di Aristotile vulgarizzata* (1570) he insisted that plays must be acted and not read; that tragedy is concerned with kings and public characters and comedy with low and private people; that tragedy might have either a happy or miserable end, as well as comedy; and in so doing he looked back, unwittingly, to Plato's concluding comment in his *Symposium* "that the genius of comedy was the same with that of tragedy." His farthest-reaching contribution was the formulation of the doctrine of the three unities. Aristotle has only the unity of action and a part of that of time. Castelvetro gave definite shape to the unities of action, time and place.

The Age of Shakespeare.—On the threshold of the great national dramas of England and Spain, Renaissance theory was epitomized in Sir Philip Sidney's *Defence of Poesie* (1595) and in part 1, ch. xlviii of Cervantes' *Don Quixote* (1605). But the world of practice became insistent and Shakespeare's point of view in England was matched by Lope de Vega's *El Arte Nuevo de hacer comédias* ("The New Art of Writing Plays," 1609), in which, on the experience gained from writing 483 plays, he put forward the first classic of box-office criticism: "Since the crowd pays for the comedies, it is fitting to talk foolishly to it to satisfy its taste; give plenty of variety, let women wear men's costumes, keep up the suspense and mystery to the last scene and don't bore your audience with pregnant silences." There is surprisingly little new criticism in the Elizabethans. Ben Jonson's (in *The Discoveries*, 1640) is largely secondhand and Shakespeare's advice on acting (see *Hamlet*, Act III, scene ii), bold and vivid as it is, has Italian forerunners.

The 17th Century.—With the 17th century, the age of criticism, important changes occurred. In France, Jean Chapelain, the abbé D'Aubignac, Jean Racine and above all Pierre Corneille (*qq.v.*) contributed to serious theory. Corneille, in his *Discours* and *Examens* of 1660, for which he claimed "50 years of practical experience of the theatre," took up the problems of decorum, verisimilitude and the three unities, which had already occupied Castelvetro, and gave them new and live interpretation. It was Corneille's alertness of mind, and not his point of view, that dramatists should try to please according to the rules, that stimulated John Dryden (*q.v.*) to write his essay *Of Dramatick Poesie* (1668) and his prefaces modeled after Corneille's *Examens*. Dryden, as befits an individual Englishman, was torn between the formalist or "good sense" view continued by Boileau and René Rapin in France and by Milton and Thomas Rymer (*qq.v.*) in England, and the saner view based on practice, of which he was perhaps the only representative. His views on tragicomedy and on character drawing, by giving chapter and verse, laid the foundation of modern criticism in England, and his definition of action foreshadowed something of Ibsen's attitude. For comedy, Molière in his scanty utterances and William Congreve in his letter *Concerning Humour in Comedy* (1696) express urbanely what can be more robustly gathered from their works.

The 18th and 19th Centuries.—With the decline of drama, adjacent criticism, largely of morals and of theatrical art, became more insistent. Jeremy Collier's *Immorality and Profaneness of the English Stage* (1698) is an important landmark, and Colley Cibber's *Apology* (1740) contains some of the earliest and finest

descriptions of acting. The 17th century was the age of fashionable baroque theatre, the 18th the age of great or much-applauded actors. Diderot's *Paradoxe sur le comédien* (1773–78; publ. 1830) and G. C. Lichtenberg's descriptions of David Garrick in his accounts of visits to England (*see* Lichtenberg's *Visits to England*, ed. by M. L. Mare and W. H. Quarrell, 1938) not only exemplify the interest in acting, but, together with G. E. Lessing's *Hamburgische Dramaturgie* (1767–68), give proof of the growing international interest already shown by Saint-Évremond and Voltaire. The chief contributions of the 18th century are the flood of Shakespearean criticism and the spread of the theatrical periodical. In Germany alone 133 periodicals have been traced between the *Hamburgische Dramaturgie* and the end of the 18th century. Lessing, leaning heavily on English example, did much to overthrow French post-Cartesian standards in favour of Shakespearean grandeur and liberty.

The romantic rejection of neoclassical dogma in favour of a misty and grandiose Nature and a grotesque medievalism gave a new dignity to the emotions and their representation. Lessing, Diderot and A. W. and F. von Schlegel (*qq.v.*) on the continent and in England Samuel Johnson (in one outburst against the unities), Lamb, Hazlitt and above all Coleridge (*qq.v.*) expressed, more or less ripely, the doctrines of the individual, and from their utterances emerged principles which unfortunately were not exemplified in the new drama. The chief result of this activity was the new conception of Hamlet as an amalgam of Byron, Prometheus and Werther. In France alone, with the theory and practice of Victor Hugo (prefaces to *Cromwell*, 1827, and *Hernani*, 1830), was there a satisfactory romantic drama.

The 19th century was dominated by the "well-made play" of Eugène Scribe and Victorien Sardou (*qq.v.*), and Francisque Sarcey was its critical prophet. His *Essai d'une esthétique de théâtre* (1876) discusses the principles by which, for the average audience, reality is replaced by illusion. The newer schools of naturalism and realism endeavoured to restore reality to the theatre, and criticism followed in their wake. Émile Zola wrote much on the theatre and wished his characters to *live* rather than *perform*. Ferdinand Brunetière's *La Loi du théâtre* (1894) introduced a new topic of discussion: "In drama or farce what we ask of the theatre is the spectacle of a *will* striving towards a goal and conscious of the means which it employs."

In Germany Friedrich Hebbel and Gustav Freytag (*qq.v.*) contributed to non-European movements. Ibsen's practice rendered theory unnecessary. The best comments for English readers can be found in C. E. Montague's *Dramatic Values* (1911) and the prefaces and other writings of Bernard Shaw. Expressionism had yet to find its critic. Its theory may be sought in Nietzsche's *Die Geburt der Tragödie* (1872; Eng. trans. *The Birth of Tragedy*, 1909) and in the writings of August Strindberg and Frank Wedekind (*qq.v.*).

The 20th Century.—A remarkable contribution of the early 20th century was the advance in Shakespearean criticism. The pioneer in the 19th century was Coleridge, but nothing really important followed until A. C. Bradley's *Shakespearean Tragedy* (1904), a penetrating analysis of character and its dramatic significance. It held the field until the emergence of the new criticism based on practical knowledge of the theatre, with its insistence on the function and importance of the "producer," a concept which crystallized about 1889. The pioneer productions of William Poel in the Elizabethan manner influenced the practice of Harley Granville-Barker (*q.v.*) at the Savoy theatre (1912–14), and from their practice emerged Granville-Barker's brilliant series of *Prefaces to Shakespeare* (1927–47). (*See* also SHAKESPEARE, WILLIAM: *Literary Criticism*). Gordon Craig's *The Art of the Theatre* (1905) and *Towards a New Theatre* (1913) directly affected Max Rheinhardt's Deutsches Theater in Germany, Konstantin Stanislavski's Moscow Art Theatre (*q.v.*) in the U.S.S.R. and Jacques Copeau's Vieux Colombier in France, and influenced the English theatre through the work of Copeau's pupil, Michel St. Denis, for the Compagnie des Quinze and the Old Vic. From the U.S.S.R. the psychological theories of acting and production held by Stanislavski (*q.v.*) radiated throughout the world and particularly influenced the serious theatre of the U.S. (*see* ACTING, DIRECTION AND PRODUCTION). The directors Vsevolod Meyerhold (*q.v.*), who had been a pupil of Stanislavski, and Aleksandr Taïrov (1885–), of the Moscow Kamerny theatre, did not adhere to the principle of "inner realism" taught by Stanislavski and both worked for a nonrealistic theatre, advocating in writings and through productions a highly stylized kind of drama (*see* THEATRE).

In the 1920s the German Communist playwright Bertolt Brecht (*q.v.*), an admirer of Meyerhold, evolved a non-Aristotelian theory of drama. Drama, as he saw it, "epic drama," should appeal "less to the feelings than to the spectator's reason . . . Instead of sharing an experience the spectator comes to grips with things. At the same time it would be quite wrong to try and deny emotion to this kind of theatre" (translated from a newspaper article by Brecht, 1927, in J. Willett's *The Theatre of Bertolt Brecht*, Methuen, 1959). Brecht developed the idea of "epic" as opposed to "dramatic" theatre, particularly emphasizing the importance of "distancing" the audience from the play and preventing them from identifying themselves with the characters on the stage, in his critical writings (especially "Kleines Organon für das Theater" from *Schriften zum Theater*, 1957), in his own plays and through his work as director of the Berliner Ensemble (1949–56), a company who acted in the German Democratic Republic and in the 1960s, led by Brecht's widow, Helene Weigel, continued to work on the lines he had laid down.

A new element in criticism emerged from the French theatre in the plays and theories of Jean Cocteau, J. P. Sartre and Albert Camus, a new concept of dramatic myth embodied in prose recreations of Greek drama. The re-emergence of poetic drama also produced searching explorations of the fundamentals of poetic drama in the writings of T. S. Eliot, culminating in his *Poetry and Drama* (1951), and in Francis Fergusson's comprehensive and profound *The Idea of a Theater* (1949). Allied to this movement was the critical approach to Shakespeare which laid special emphasis on the dramatic function of poetic imagery, leading to W. H. Clemen's *Shakespeare's Bilder* (1936; rev. and trans. as *The Development of Shakespeare's Imagery*, 1951) and Caroline Spurgeon's *Shakespeare's Imagery* (1935).

A new dimension was added to dramatic criticism by the advance in the art of the cinema, and, particularly in the U.S.S.R., the critical writings of S. M. Eisenstein (*q.v.*), translated into English as *The Film Sense* (1948) and *Film Form* (1951), deepened and enriched the criticism of the theatre.

In the U.S. and Great Britain the drama critics working for daily newspapers and weekly magazines became increasingly important in the early 20th century. Among those who helped to familiarize the public with the new dramatists of the period were Brooks Atkinson, John Mason Brown, George Jean Nathan and Alexander Woollcott in the U.S., and in Britain James Agate, T. C. Worsley, Ivor Brown, Harold Hobson, Desmond MacCarthy, Laurence Kitchin and Kenneth Tynan. Many of them also wrote books and published collections of critical essays, but their most important work was done in their daily or weekly commentaries on the plays of the day and in their attempts to evaluate them in the light of their own conception of what was most lasting in the dramatic critical theory of both past and present.

See also the articles DRAMA; CRITICISM; THEATRE; and articles on the national literatures: ENGLISH LITERATURE; FRENCH LITERATURE; GERMAN LITERATURE; etc..

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DRAMMEN, a town in the county of Buskerud, southern Norway, is situated 32 km. (20 mi.) S.W. of Oslo at the junction of the Dramselv with the Drammen fjord, the western branch of the Oslo fjord. Pop. (1959 est.) 30,657. The town is divided by the river into two sections, Bragernes on the north side and Strömsö and Tangen on the south. In Bragernes is the market place with the town hall, fire station and church. The Drammen museum is in Strömsö. Drammen is an important road and railway junction and centre for one of the richest forest districts of Norway. Along the banks of the Dramselv are many buildings of the Norwegian wood pulp, cellulose and paper industries, whose products comprise the town's leading exports. The town also has several engineering works. Bragernes and Strömsö were given common town privileges in 1715. In 1811 they were united into a municipal town called Drammen. During World War II Drammen was in German hands from April 1940 until May 1945. (J. Sd.)

DRAMMEN RIVER (Dramselv), a river in Norway, rises in the Hallingskarv mountains as Hallingdal river and empties into Drammen fjord at the town of Drammen southwest of Oslo 192 mi. from its source. The name Drammen river refers only to the lowest 5 mi. of the river, but is also used about the whole river system draining into this. Its catchment area of 6,603 sq.mi. extends to the central mountain region of the country and contains wide forested districts with the lakes Randsfjord, Sperillen, Tyrifjord and Krøderen. During the last 25 years of the 19th century the water power of these rivers below the lakes was exploited for manufacturing industry along the river banks. After World War II, large hydroelectric power plants were installed in the upper parts of the river basin, especially in Hallingdal and Valdres. (L. H. Hg.)

DRANCY, a town of Seine *département,* France, lying 6 mi. N.E. by rail of Paris (Gare du Nord). Pop. (1954) 50,599.

It is a dormitory town for Paris and its growth dates from about 1920–21 when, to relieve congestion, intense efforts were made to persuade Parisians to build for themselves in the suburbs. Most of the houses are detached, but the five 14-story blocks of flats built before 1954 are some of the earliest examples in France of vertical development. Since then blocks of 4 to 12 stories have been erected on the few remaining open spaces. There are infant and primary schools, and a *lycée* opened in 1958. Drancy has no significant industries. It is served by road and rail (two stations) and Le Bourget airport is less than 2½ mi. from its centre. The church was rebuilt after the war of 1870 and a castle, destroyed later, has been reconstructed.

DRAPER, HENRY (1837–1882), U.S. physician and amateur astronomer, who obtained, in 1872, the first stellar spectrogram and, Sept. 30, 1880, the first photograph of a nebula, the Orion. He was born in Prince Edward county, Va., on March 7, 1837. Educated at the University of the City of New York (later New York university), he was appointed to the medical staff of Bellevue hospital, New York, in 1859 and became dean of the medical faculty of his university in 1866. He was elected a member of the National Academy of Sciences and of the American Philosophical society in 1877, and of the American Academy of Arts and Sciences in 1881. Draper's father, John William Draper, had obtained the first successful photograph of the moon, and the son also made many contributions to the early history of celestial photography. He introduced the silver-on-glass reflector into the United States and was the first to exploit its photographic possibilities. He died in New York, Nov. 20, 1882. (O. J. E.)

DRAPER, LYMAN COPELAND (1815–1891), founder and corresponding secretary (1854–86) of the State Historical Society of Wisconsin; he made the first significant collection of personal, nonofficial historical manuscripts in America. He was born in New York state on Sept. 4, 1815. After studying at Granville (O.) college, Draper began collecting materials, intending to write a book on the pioneers of the old west—the Allegheny region—primarily in the 18th century. He traveled, afoot and on horseback, over Kentucky, Tennessee, Virginia and Missouri, and among his collections were the papers of Daniel Boone and George Rogers Clark. In 1852 he moved to Wisconsin, where he founded the State Historical Society and became its head. Beginning with 50 books, he built a library that contained 110,000 volumes at the time of his retirement in 1886, and the society which he directed became the model for other state societies throughout the country. He collected and edited ten volumes of *Collections* of Wisconsin history, and continued to add to his personal collection, which passed into the hands of the society after his death, Aug. 26, 1891. He served one term (1857–59) as superintendent of public instruction of Wisconsin. In 1881 he published *King's Mountain and Its Heroes.*

See W. B. Hesseltine, *Pioneer's Mission: The Story of Lyman Copeland Draper* (1954). (W. B. He.)

DRAPER, RUTH (1884–1956), U.S. monologist and monodramatist, was born in New York city Dec. 2, 1884, of a socially prominent family. She began her career by writing sketches about people she knew or had observed and then performing them at parties given in her own home and those of friends. Her only appearance in a full-length play was as the maid in *A Lady's Name* at the Maxine Elliott theatre, New York, May 1, 1916. She made her New York debut as a monologist at the Comedy theatre on Feb. 6, 1917, in a bill of one-acters, one of which, *The Actress,* she herself wrote. Her critical reception was dismal; she received praise only for her own sketch, which confirmed her in the choice of her métier. Her London professional debut in her sketches was made at Aeolian hall, Jan. 29, 1920. From then on she triumphed everywhere in the world until her final performance at the Playhouse in New York city on Dec. 26, 1956. She died in New York city on Dec. 30, 1956. (Ge. F.)

DRAUGHTS: *see* Checkers.

DRAVA (Drave; Ger. Drau), one of the principal right-bank affluents of the Danube. It rises below the Innichner Eck in the Tirol at an altitude of over 4,000 ft., runs eastward and forms the longest longitudinal valley of the Alps, the Drau Thal. The Drava is 447 mi. long. Near Zákány, Hung., it is joined by the Mura (Mur). The valley of the Drava was the chief road through which the invading peoples of the east such as the Huns and the Slavs penetrated the Alpine countries. The middle Drava flows through Carinthia and Slovenia and in this section there are a number of hydroelectric power stations. At its mouth the Drava attains a breadth of 1,055 ft. and a depth of 20 ft. It is navigable for rafts only from Villach, Aus., and for river steamers from Barcs, Hung., a distance of 65 mi. The principal towns on the Drava and its affluents are Klagenfurt and Graz in Austria and Maribor and Osijek in Yugoslavia. *See* Danube. (H. R. Wi.)

DRAVIDIAN, the name applied to the peoples of south and middle India and of those parts of Ceylon where a Dravidian language is spoken. The term is a purely linguistic one, since Dravidian-speaking peoples are of many different racial types. Their origin and early history are obscure, and no specific racial element or prehistoric civilization can be associated with their first appearance in India. The once widely current theory that, previous to the Aryan invasion in the 2nd millennium B.C., Dravidian-speaking peoples also extended over most of northern India and that the indigenous populations mentioned in the Vedic hymns were Dravidians is no longer generally accepted.

As the Dravidian peoples include some of the most highly civilized populations as well as some of the most primitive forest tribes, it is as inappropriate to speak of a specifically Dravidian culture pattern as it is misleading to speak of a Dravidian racial type. Yet, since India's attainment of independence in 1947, a strong feeling of Dravidian nationalism has developed in southern India, and particularly among the Tamils (*q.v.*) of Madras. This has led to an agitation against the introduction of Hindi as the All-India official language, and in its extreme forms even against Vedic Hinduism, which is considered a product of Aryan civilization. The reorganization of political units according to linguistic principles has resulted in the establishment of four predominantly Dravidian-speaking states: Madras, Andhra Pradesh, Mysore and Kerala.

There is no uniform Dravidian religion. Most of the preliterate

Dravidian tribes profess tribal religions centred in the cult of clan ancestors, local deities and such universal goddesses as mother-earth, whereas the higher castes follow the pattern of Brahmanical Hinduism. A characteristic phenomenon is the dichotomy between the cults of the vegetarian Brahmanical gods of northern origin and the indigenous meat-eating deities, who are propitiated with animal sacrifices. The former gods are believed to have consorts, whereas the latter, and particularly the female divinities, are thought to stand alone. Priests of different castes and status minister to these two types of deities, but both are comprised in a universal pantheon, and the two cults are complementary and not antagonistic.

In the 1960s the distinction between Dravidian and Aryan speech was a political issue also in Ceylon, where Tamils settled as early as the 11th century A.D. About 900,000 indigenous Tamil-speakers inhabit the northeastern provinces, and nearly 1,000,000, who immigrated more recently from India, provide most of the plantation labour of the hill regions. Small numbers of Dravidian-speaking Indians have settled also in Malaya, east Africa and other overseas territories.

See also INDIA: *The People.*

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(C. v. F.-H.)

DRAVIDIAN LANGUAGES is the name given to a family of about 20 languages, comprising all those spoken in southern India and others in central and north India. It has been estimated that at mid-20th century there were about 90,000,000 speakers. The territory in which they are spoken includes the northern half of Ceylon and extends northward to an irregular line drawn from a point on the Arabian sea about 100 miles below Goa along the Western Ghats as far as Kolhapur, then northeast through Hyderabad, and farther eastward to the Bay of Bengal. Farther to the north, Dravidian languages are spoken by small tribes in Madhya Pradesh and Orissa, and up to the banks of the Ganges in the Rajmahal hills. A Dravidian language is also spoken by the Brahuis of Baluchistan in West Pakistan. *See* also INDIAN LANGUAGES.

Classification.—The Tamil (*q.v.*) language, which has about 28,000,000 speakers, and Malayalam, which has about 14,000,000 speakers, are two dialects of the same language, which is closely related to Kanarese (about 15,000,000 speakers). Toda and Kota lie geographically between these; Toda is closely related to Tamil, and Kota may be also. Kodagu, lying between Malayalam and Kanarese, is an independent language intermediate between them. Tulu (about 800,000 speakers) and Telugu (about 33,000,000 speakers) diverge from the other South Dravidian languages. Five of the small central languages form a closely related group—Kolami, Naiki, Parji, Ollari and Poya Gadaba. The many Gondi dialects and Konda are closely related, and the latter is also related to Kui and the Kuwi dialects. Kui has some features which relate it closely to Telugu, but in other respects it is one of the most archaic languages of the family. Kurukh and Malto are closely related to each other, and Brahui shows some features relating it to these. The position of Brahui, however, is difficult to determine accurately since its vocabulary has been swamped by Iranian loanwords from Baluchi and even Persian.

The Dravidian languages form an isolated group, and no connection with any other family of languages has been established. Such attempts have been made especially with the Ural-Altaic languages, but the arguments adduced have not proved convincing.

Literature.—Tamil, Malayalam, Kanarese and Telugu are the four literary languages. Tamil literature begins at least as early as the beginning of the Christian era; the others are somewhat later. Even the oldest Dravidian literature is largely indebted to Sanskrit models. The oldest datable specimens of a Dravidian language are the Tamil inscriptions scratched on shards found at Arikamedu near Pondicherry and belonging to the second quarter of the 1st century A.D. These languages are written in alphabets that are ultimately derived from those used in north India, such as Devanagari. They have, however, been much modified and are not now recognizable as related to the northern alphabets. There are three chief alphabets now used: one for Tamil, one for Malayalam and one, with two slightly different variants, for Telugu and Kanarese. Early documents show an even greater number of distinct forms. A Dravidian language may have been spoken by the people of the prehistoric Indus valley culture, but this is no more than a guess.

The Dravidian languages are gradually losing ground in the center and north, where they meet with Indo-Aryan dialects. This process has been going on for millenniums, and all the Dravidian languages in fact have borrowed many Indo-Aryan words. It is possible, however, also to trace a Dravidian element in the Indo-Aryan languages of north India, even as early as Sanskrit.

Main Features.—The Dravidian languages in general are distinguished from those of most other families by the large number of sounds formed in the front of the mouth. All of them have dentals (*e.g., t* and *d*), formed by the tip of the tongue against the back of the upper teeth, contrasting with retroflexes (*e.g., ṭ* and *ḍ*), formed by the tip of the tongue curled back against the centre of the hard palate. The southernmost languages also have alveolars (*e.g., t̲* and *d̲* which are made like English *t* and *d* with the tip of the tongue against the upper gums. These distinctions extend to nasals, liquids and trills. The threefold contrast was found in proto-Dravidian, and most of the languages of the family have identifiable descendants of the contrasting sounds.

In the literary languages the structure of syllables is very simple. Few groups of consonants are found; these are of a limited number of types, and in some of the languages no consonants ever come at the ends of words. Typical is Tamil *avan* "he," which in Kanarese is *avanu;* in Telugu an originally longer form *avanṭu,* because of metathesis of the initial vowel and consonant, became *vāṇḍu.* (Dravidian words in this article have been transcribed in letters of the English alphabet supplemented by additional characters of the International Phonetic alphabet.) This simple structure seems to have been typical of proto-Dravidian. In most of the languages, however, many of the vowels in all but initial syllables have been lost, and long consonant clusters result. Thus Tamil *avan̲* is represented in Kota by *avn,* and the longer form *avan̲tu* became in Naiki *avnd,* whence Kolami *amd* and Parji *ōd;* Tamil *avan̲ukku* "to him" is represented in Kota by *avnk* and in Parji by *ōnug.* Extreme examples appear in Kota and Toda; *e.g.,* Toda *wiθfyk* "for aid" is derived from an earlier *utavikku.* It would not, however, be difficult to find parallels in colloquial Tamil.

All the languages have a considerable inflectional and derivational apparatus consisting of suffixes. Nouns (including pronouns), adjectives and verbs are well differentiated by both their sets of suffixes and their syntax. There is also a highly developed fourth word class which may be called onomatopoeic. It frequently involves complete reduplication, and it has a peculiar syntax; *e.g.,* Telugu *pakapaka* "suddenly bursting out laughing," *garagara* "clean, neat, nice."

Nouns have cases and two numbers, singular and plural; *e.g.,* Tamil *maram* "tree," *marattukku* "to a tree," *marangaḷ* "trees," *marangaḷukku* "to trees." The genitive case, which precedes the governing noun, sometimes is formed by a suffix, but sometimes is merely the stem; *e.g.,* Tamil *mara-ppaṭṭai* "bark of a tree." The last type of construction is the basis of innumerable compounds.

In some of the languages, *e.g.,* classical Tamil and Kanarese and modern Telugu, nouns combine with personal inflections that are identical with or like those found in the verbs, and thereby form sentences; *e.g.,* Kui *ānu kūentenu* "I am a Kui," *āmu kūinganamu* "we are Kuis."

Personal pronouns are similar to nouns in their inflection, but show much irregularity; *e.g.,* Toda *ōn* "I," *enk* "to me." The plural of the first person usually has one form including and another form excluding the person addressed; *e.g.,* Toda *om* "we (including you)," *em* "we (not including you)."

Demonstrative and interrogative pronouns in most of the languages have a gender system. This is generally based on a distinction between male persons, female persons and everything else (nonpersons). The languages differ in the combinations between

these and the two numbers. Tamil, Malayalam, Kanarese and Tulu have forms for a male person, a female person, a nonperson, persons and nonpersons; *e.g.*, Tamil *avan* "that man," *aval* "that woman," *atu* "that animal or thing," *avar* "those persons," *avai* "those animals or things." In Gondi, Kui and the group that includes Kolami, there are forms for a male person, male persons, a singular denoting anything but a male person and a plural denoting anything but male persons. In Telugu and Kurukh there is a skew type of system in which the forms denote a male person, a female person or a nonperson, persons and nonpersons. Toda and Brahui have lost all gender distinctions and have only a singular and a plural form in these pronouns. Verbs very commonly have third person forms agreeing in gender and number with the pronouns.

Verbs show agreement in person and number with the subject, whether it is a noun or pronoun. They are marked by a rather simple system of combined tenses and modalities. In addition, there are negative paradigms. The languages differ considerably in their systems of simple paradigms. Kota has past indicative, nonpast indicative, potential ("I may go"), irrealis ("I would have gone"), future, argumentative ("he went, as I must remind you"), voluntative ("I want to go," "I want you to go"), negative indicative, imperative, prohibitive. Negatives corresponding to the other Kota modes, and many other forms, both positive and negative, are periphrastic syntactic phrases.

All the languages have voice systems in the derivation of verb stems. The commonest type is a system with intransitive versus transitive, and a causative for each of these; *e.g.*, "it broke," "I broke it," "I caused it to or let it break," "I caused someone else to break it."

Kui has a more complicated verb structure than any other language in the family. Derivational suffixes are found in the verb when it has a first or second personal pronoun as direct or indirect object; *e.g.*, *sī-mu* "give (it to him)!," *sī-a-mu* "give (it to me)!" A complex set of derivational suffixes denotes plural action; *i.e.*, action on a number of things or on one thing many times. There are indications that these two features belonged to proto-Dravidian.

In most of the languages, each of the tense-modalities of the verb has beside it an adjective form. The verb form generally ends the sentence or predication; when a predication ends in an adjectival form of a verb, it precedes a noun and qualifies it like a simple adjective. Thus in Telugu *mīru nāku iccina pustakamu* "the book that you gave to me," the first three words are "you to-me gave" and *iccina* "gave" is in an adjectival form, the whole phrase qualifying *pustakamu* "book." This construction translates English clauses with relative pronouns.

The Dravidian languages have many roots which when provided with one set of inflectional suffixes are nouns, with another set verbs; *e.g.*, Tamil *ketu* with intransitive voice conjugation is "to perish," with transitive voice conjugation "to destroy," with noun inflection "peril." Derivational forms added to these make a very complex picture; *e.g.*, Tamil *peru* "great" or "to grow great or numerous," *peru-ku* "to be increased, multiply, prosper," *peru-kku* "to make to increase," *peru-kk-am* "abundance, prosperity," *peru-pp-am* "bigness," *peru-pp-i* "to magnify."

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DRAWING (TECHNIQUES OF). Drawing is the presentation by chiefly linear means of an object, person, landscape, symbol, emotion, idea or scheme. A drawing is often preparatory to further work on a larger scale, but may exist for its own sake. One may draw with a stylus, pen, pencil, brush, crayon, needle, chisel or almost any line-producing object on paper, cloth, parchment, wood, stone, metal or pottery; making lines with a stick on a sandy beach, incising with an awl in walrus ivory or scratching with a diamond on window glass is drawing in a broad sense. The lines may have colour and other colours may be accessory to drawing in the form of wash or pastel, but mainly drawing is thought of as being done with writing materials and being akin to writing; in its coloured varieties it approaches painting, from which it differs most in not covering the support or ground completely; in its three-dimensional varieties, such as engraving, it approaches sculpture.

HISTORY

Artists, and laymen with a temporary artistic or expository intention, have been drawing in some form since the dawn of man; if potmaking is the oldest and most widespread useful art, drawing is its "nonuseful" coeval. Drawing's image-making function as an instrument of magic-religion made it efficacious to primitive man: the cave paintings of France and Spain are largely drawing, and so are more recent Bushman and American Indian rock pictographs. In the orient where, until 19th- and 20th-century westernization, almost all writing was done with a brush, drawing merged into painting, and both were a form of calligraphy. Almost the only oriental examples of drawing in the western sense (as different from painting) were preparations for woodcuts or perhaps for decoration of ceramics.

Western drawing rose when paper began to be fairly common early in the 15th century. Before that, both writing and drawing were "drafted" on wax tablets, chalked boards or other erasable surfaces; manuscript illuminations were prepared by drawing on the spot, and the preliminary drawing was usually completely hidden under colour and gold; a few manuscripts were illustrated with uncoloured drawings.

Cheaper paper made it possible to work out designs in many trial forms for comparison before deciding permanent execution. It was not at first realized that rag paper was almost as stable a material as parchment; and many artists who used paper for trial work might keep a permanent stock book on parchment; but one of the surviving pattern books of Jacopo Bellini (Venetian, *c.* 1400–*c.* 1470) is on parchment, the other on paper. Such *simile* (semipermanent pattern) sheets were a pre-Renaissance studio property.

With the Renaissance grew a more individualistic but widely accepted practice of preparing almost all artistic commissions by stages of drawing as follows: (1) sketches, normally made with the pen, for a whole composition; (2) studies of detail, normally drawn with such a broad medium as black chalk, figures being frequently studied as nudes, and costume studied on further sheets of paper; (3) a definitive scale plan called a *modello* which was a part of the contract between artist and buyer, as a blueprint is part of the contract between builder and householder; (4) a full-sized pattern or cartoon, to be transferred to the panel, canvas or wall by various means, most of which resulted in the cartoon being torn to bits when it was removed.

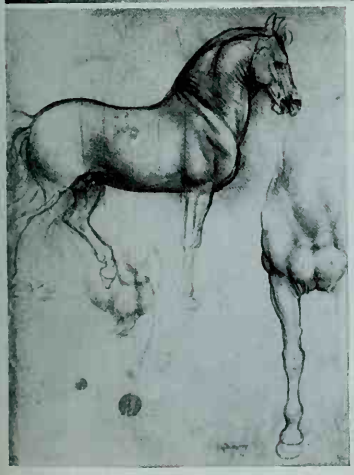
To these must be added the notebook of private observations, which in the 15th century and occasionally thereafter was drawn with silverpoint on leaves prepared with a (sometimes tinted) ground; the copy, usually in pen and often reversed, by which a print maker prepared to reproduce a painting or sculpture; the portrait or landscape made for its own sake and for sale, often in mixed technique; exercises such as life-class nudes which were means to an unspecified end; and architects' designs and drawings for photomechanical reproduction. Print makers' drawings may sometimes be recognized by left-handed action; studies often are found squared for enlargement.

From about 1500 wash was more and more used with pen and ink; while red chalk and blue paper, together with the white high lights which had already been used with silverpoint on tinted grounds, brought in a range of colour as well as strong suggestions of relief or depth. The workshop practice mentioned above broke down in the 19th century; the 20th has seen a growth of drawing independent of painting or sculpture, and of novel techniques.

Of artists whose drawings are numerous enough to allow just appraisal, Antonio Pisanello (*c.* 1395–*c.* 1455) was one of the first, a laborious observer, with pen and silverpoint, of men and animals. Leonardo da Vinci explored landscape, floral and human

Right: Egyptian ostrakon (pottery fragment) showing two bulls fighting. From Thebes, period of the New Kingdom, 1567–1085 B.C. In the Metropolitan Museum of Art, New York. A preparatory or at least a trial drawing, comparable to Egyptian sculptors' trial pieces

Below: A section from the Joshua Roll, 10th century. In the Vatican library. The open manner of drawing accords well with the cursive text



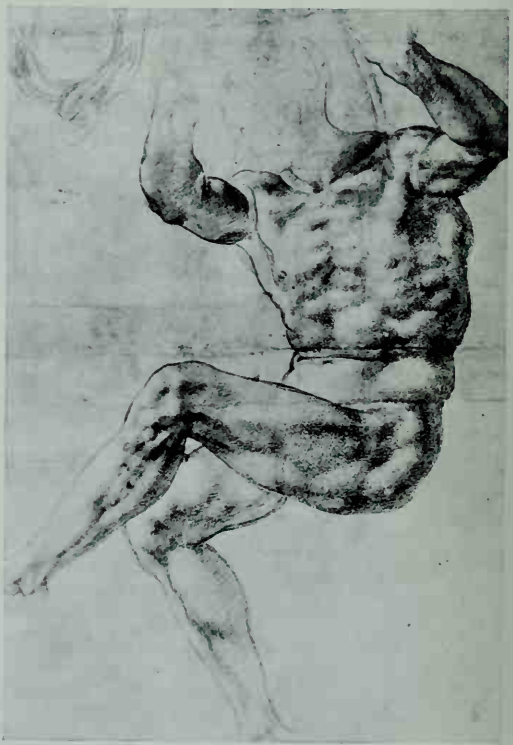
Left and right: Two drawings by Leonardo da Vinci (1452–1519), Italian. In the Royal library, Windsor castle. *Left:* Silverpoint on blue ground; graphic strength with delicate modeling. *Right:* Pen and ink over red chalk notation; note the "rightness" in placement on the page of apparently random details of the Star-of-Bethlehem and other plants

BY COURTESY OF (TOP) THE METROPOLITAN MUSEUM OF ART, N.Y., (CENTRE) THE PIERPONT MORGAN LIBRARY, N.Y., (BOTTOM) H.M. QUEEN ELIZABETH II, CROWN COPYRIGHT RESERVED

DRAWING (TECHNIQUES OF)

"The Dead Christ Lying on a Pall" by Albrecht Dürer (1471–1528), German. In the Cleveland Museum of Art. Charcoal, probably done in Venice under some influence of Mantegna (foreshortening). An early example of signing and dating a drawing, evidence of the rising status of the artist

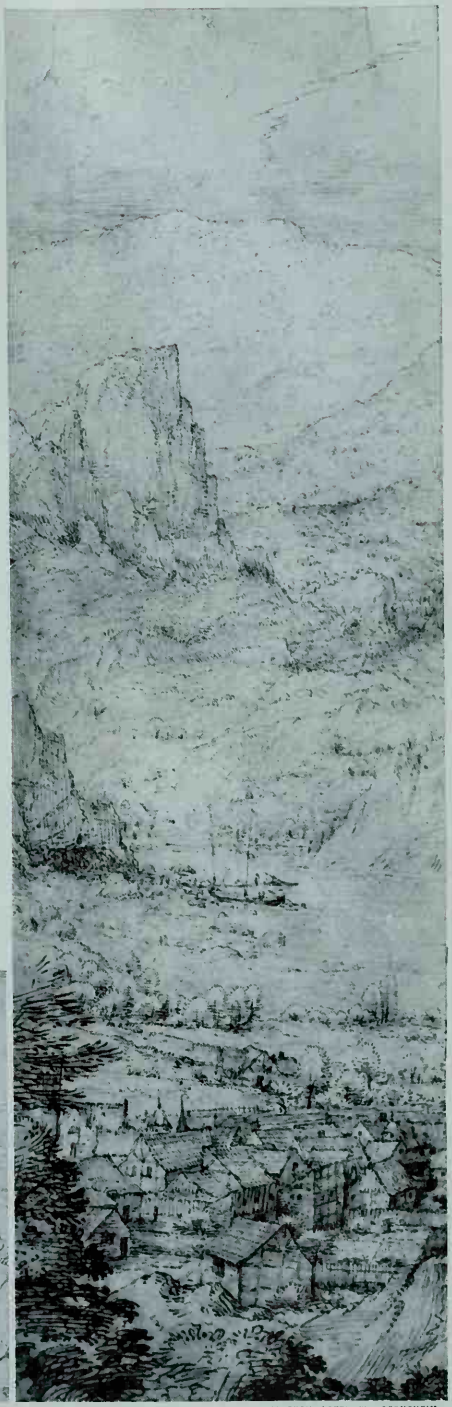
"Study of the Madonna of the Nativity" by Raphael Sanzio (1483–1520), Italian. In the Uffizi gallery. Black chalk. Part of a cartoon for a small painting, heightened with white for pictorial effect and pierced along the chief lines for transfer



Study for the nude above the prophet Daniel in the ceiling fresco of the Sistine chapel, by Michelangelo Buonarroti (1475–1564), Italian. In the Cleveland Museum of Art. Red chalk. The cross-hatching, partly for shade and partly for description of detail, is rubbed in some places to enrich plasticity

BY COURTESY OF (TOP AND RIGHT) THE CLEVELAND MUSEUM OF ART, (TOP, GIFT OF HANNA FUND, 1952; RIGHT, HENRY G. DALTON MEMORIAL, 1940); PHOTOGRAPH, (LEFT) W. GERNSHEIM, LONDON

Portrait, probably of a member of the Fugger family, by Hans Holbein the Elder (c. 1465–1524), German. In the William Rockhill Nelson Gallery of Art, Kansas City, Mo. Silverpoint. The subtlety of modeling is achieved through blending of fine lines; no correction or erasure is possible in this medium



Detail of a landscape by Pieter Brueghel the Elder (c. 1525–69), Flemish. In the Pierpont Morgan library, New York. Pen and ink. Use of the pen in graded weight (the ink also seeming less diluted) from background to foreground

Triple study for a painting of Venus by Peter Paul Rubens (1577–1640), Flemish. In the Frick collection, New York. Pen and ink. Modeling lines of parallel hatching supplement the contours; rhythmic repetition with variants makes a handsome *mise-en-page* (page composition)

BY COURTESY OF (TOP LEFT) WILLIAM ROCKHILL NELSON GALLERY OF ART, KANSAS CITY, (RIGHT) THE PIERPONT MORGAN LIBRARY, N.Y.; PHOTOGRAPH, (BOTTOM LEFT) W. GERNSHEIM, LONDON

DRAWING (TECHNIQUES OF)

"Houtewall near Amsterdam" by Rembrandt van Rijn (1606–69), Dutch. In the Boymans museum, Rotterdam. Pen and bistre wash. An eloquent "scribble" in which the whole is greater than the sum of its parts. The wash, which may be in part an addition, is subordinate to the line

"Cassandra Dragged from the Temple of Pallas" by Anthony Van Dyck (1599–1641), Flemish. In the British museum. Pen and brush. The use of wash is given equal importance to the use of line

BY COURTESY OF (TOP) BOYMANS/VAN BEUNINGEN MUSEUM, ROTTERDAM; PHOTOGRAPH, (BOTTOM) W. GERNSHEIM, LONDON

"Coastal Landscape" by Claude Lorrain (Claude Gellée, 1600–82), French. In the British museum. Pen and ink with bistre and carbon washes. Outdoor observation improved by Claude's compositional devices

"Imaginary Scene with Figures" by Francesco Guardi (1712–93), Italian. In the British museum. Pen and bistre wash. The wash, as both shade and cast shadow, marks successive planes

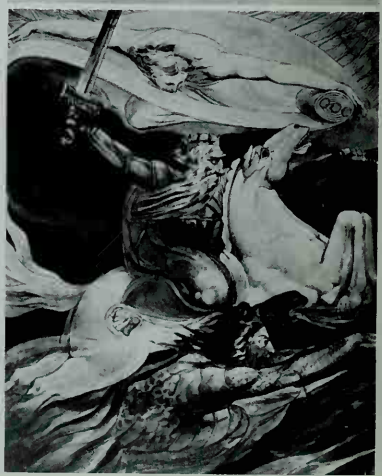
PHOTOGRAPHS, W. GERNSHEIM, LONDON

DRAWING (TECHNIQUES OF)

"Nereids and Tritons" by Giovanni Battista Tiepolo (1696–1770), Italian. In the British museum. Pen and wash. The rapid but sure and knowing use of wash gives illumination and substance within the almost "meaningless" contours

Below: "Three Men Digging" by Francisco Goya y Lucientes (1746–1828), Spanish. In the Metropolitan Museum of Art, New York. Brush drawing. The solid areas are slapped in, not for description but to provide light and dark contrasts in space

Below, right: "Death on the Pale Horse" by William Blake (1757–1827), English. In the Fitzwilliam museum, Cambridge. Pen and ink with water colour, the brush used tightly to detail specific areas. Another drawing made for its own sake, approximating painting on paper



Below: Portrait of the Guillon-Lethière family by Jean Auguste Ingres (1780–1867), French. In the Museum of Fine Arts, Boston. Pencil. An independent drawing prepared for sale; hard and soft pencils used in different areas for texture and colour-suggestion

BY COURTESY OF (CENTRE RIGHT) THE METROPOLITAN MUSEUM OF ART, N.Y., (BOTTOM LEFT) MUSEUM OF FINE ARTS, BOSTON, (BOTTOM RIGHT) REPRODUCED BY PERMISSION OF THE SYNDICS OF THE FITZWILLIAM MUSEUM, CAMBRIDGE, ENG.; PHOTOGRAPH, (TOP) W. GERNSHEIM, LONDON

"Dancer Adjusting Her Slipper" by Edgar Degas (1834–1917), French. In the Metropolitan Museum of Art, New York. Pencil and white chalk on pink paper. Note the corrections in line and the squaring of the page for enlargement

"Hamlet and the Gravediggers" by Eugène Delacroix (1798–1863), French. In a private collection, U.S. Black crayon over pencil notation. The final study for a lithograph

"Le Départ du Train" by Honoré Daumier (1808–79), French. In the Ralph King collection, Cleveland, O. Black crayon and water colour. Strong, active contours given pictorial fullness by the water colour

BY COURTESY OF (TOP LEFT) THE METROPOLITAN MUSEUM OF ART, N.Y., (TOP RIGHT) THE OWNER, (BOTTOM) RALPH KING COLLECTION, CLEVELAND

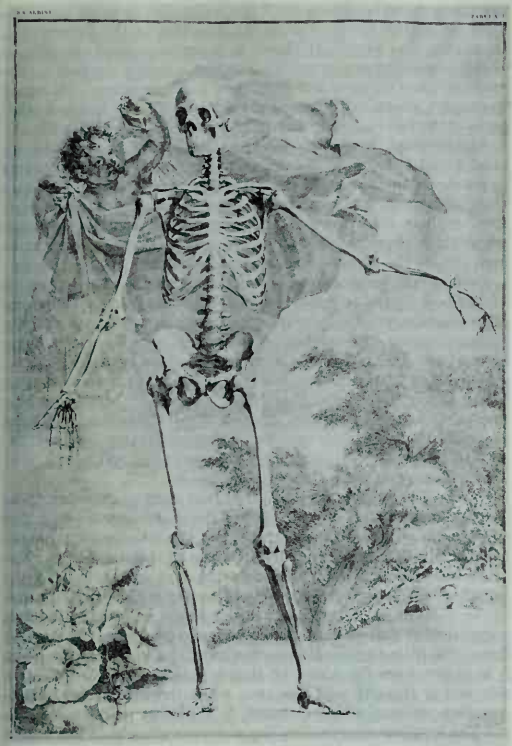
DRAWING (TECHNIQUES OF)

"St. Peter and St. John at the Beautiful Gate of the Temple" by Rembrandt van Rijn (1609–69), Dutch. In the Metropolitan Museum of Art, New York. A pen and wash drawing with bistre used for its warm luminous colour qualities

Study after Michelangelo's "Giorno" by Jacopo Tintoretto (1518–94), Italian. In the Metropolitan Museum of Art, New York. Black and white chalk on blue paper suggest a greater range and variety of colour and give a sense of a third dimension

Draped figure from the school of Raphael, Italian, 16th century. In the Metropolitan Museum of Art, New York. Pen (probably a quill) and bistre combined to give warm and graceful contours

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, N.Y.. (LEFT) ROGERS FUND, 1911, (TOP RIGHT) ROGERS FUND, 1954, (BOTTOM RIGHT) GIFT OF CEPHAS G. THOMPSON, 1887



PRINT BY COURTESY OF THE NEW YORK ACADEMY OF MEDICINE

SKELETON DRAWN AND ENGRAVED BY JAN WANDELAAR IN 1747 FOR TABULA SCELETI ET MUSCULORUM CORPORIS HUMANI BY B. S. ALBINUS

anatomy and meteorology in drawings more numerous than his designs for pictures or his diagramed inventions. Also in the 15th and 16th centuries, Albrecht Dürer, first northerner to fuse his native art with that of Italy, was one of the most prolific and most purely graphic of artists. The younger Hans Holbein left a body of portraits, many drawn with the help of a glass plate and net, which influenced the Clouets in France among others.

In the 16th century Pieter Brueghel, sensitive landscapist, earthy observer of earthy people, underlay Flemish genre drawing. In the 15th and 16th centuries, Raphael, cool and decorous in drawing as he was noble in painting, differed vastly from Michelangelo, whose uneasy temper shows in his tortured monumental figure drawings. In the 16th century Tintoretto and his family circle left quantities of rapid-fire figures in chalk—muscular, almost weightless. In the 16th and 17th centuries Peter Paul Rubens, drawing often with the brush (sometimes in oil colour on panel), also made searching chalk studies, while Sir Anthony van Dyck in the 17th century made northern baroque splendour sensitive with his pen compositions. Their Dutch neighbour Rembrandt was grand in conception, intimate and human in execution, his abrupt pen simplifications warmed by the brush and wash. Nicolas Poussin (1594–1665), an adult Raphael, drew monumentally but hastily for his own use only, while Claude Lorrain (1600–82) created thousands of tender or majestic landscapes, some for immediate sale. Antoine Watteau (1684–1721), starting from a Rubenslike base, led off the French 18th century with his bittersweet, flickering figures in red, black and white chalk, often on blue or tan paper. Giovanni Battista Tiepolo (1692–1769) lighted his soaring compositions and godlike beings with sunlit wash, and this luminosity was taken from Venice to France by Jean Honoré Fragonard (1732–1806) for his genre and landscape. Francesco Guardi (1712–93) was enough younger to profit in his nervous urban seascapes by knowledge of both Watteau and Tiepolo. Canaletto (1697–1768) made endless half-fantastic Venetian views in brown pen lines and cool wash, often for direct sale.

In the 18th and 19th centuries Francisco Goya (1746–1828) used the etching needle as his chief drawing instrument but his brush drawings were stenographically tremendous. Thomas Rowlandson (1756–1827), great comic journalist, was prolific in coloured pen line and water colour. In the 19th century J. A. D. Ingres (1780–1867), classicist and classic of pencil draftsmen, became in his late years almost as romantic as Eugène Delacroix (1798–1863), whose volatile line served a strong and colourful inventive faculty. Honoré Daumier (1808–79), in stature closer to Rembrandt than to Rowlandson, put solid bones under his apparently unmethodical wiggles. Sir John Everett Millais (1829–96), though his own best time was short, was a Pisano with social opinions, and representative of a great school of illustrators. Edgar Degas (1834–1917) was so knowing of structure that when he was old and nearly blind, having to draw with charcoal and pastel in lines a quarter of an inch broad, he could still articulate a figure to perfection and make his "ugly" subjects elegant. Thomas Eakins (1844–1916) used scientific means in the service of an analytical art, and line in neo-Ingres style. Vincent van Gogh (1853–90), using a broad reed pen, overpowered nature. Georges Pierre Seurat (1859–91) made shadows and totems with nonlinear tones and textures. Pablo Picasso (1881–) was the most fertile inventor of his generation in classic pen outline or cubist mass and tone. Paul Klee (1879–1940) was the witty conductor of a "line out for a walk" and maker of new graphic textures. Henry Moore (1898–) used complex, almost corrupt, techniques, to draw figures of eternal weight. Ben Shahn (1898–) could draw a brick wall emotionally or a dead child without comment, though often with oriental suggestions. The lines of Henri Matisse (1869–1954) could be delicate and colour-suggesting or sculptural and sensuous.

(W. A.)

ELEMENTS OF DRAWING

Consideration of drawing here will be confined to the traditional method of drawing which has arisen in western civilization and which has to do with the creation of the illusion of reality. Though the basic elements of this method are simple, it is difficult to communicate them to others by words alone. The principles of drawing cannot be fully grasped until they are experienced through long practice in drawing itself.

Drawing as a Language.—A characteristic of realistic drawing is that ideas are communicated by symbols that give the illusion of three-dimensional form. But doing this is not a simple process. In order to draw a form the artist must be aware that it exists, he must come to an exact conclusion as to its shape, he must come to a decision as to its position in space, he must light it in such a way that it is recognized for what he has in mind. And he must have the skill of hand to render the shape and values he has decided upon.

Before long the beginner will be able to present the conventional symbols for the cube, the cylinder and the sphere. He will soon learn he can give the illusion of any complex form by combining together the simple forms, or parts of the simple forms, of which the complex form is composed.

Context and Juxtaposition.—As soon as the student is able to produce the simple forms he will realize that he has learned the initial words of the visual language. Given the proper context, his simple symbols will express an amazing number of ideas. If he draws a spoon near his cube, the cube will become a lump of sugar; placed on top of a house, the cube becomes a chimney. A wisp of smoke, and his cylinder becomes a cigarette; placed beneath a head it becomes a neck. As for the sphere—a stem and a leaf, and it becomes an apple; placed in the hand of Aphrodite it becomes a golden apple of the Hesperides.

Light.—The artist understands that since light is the creator and destroyer of form, he must be the creator and destroyer of light. He is aware of the sources of light that fall upon a form, of their colour, size and intensity. He is able to regulate these sources, to quench them if he wishes, or to create new ones. He decides upon the number of lights he will throw upon the form; he is apprehensive if he throws three or more. He places high lights upon the form not where he sees them but where he wishes; he does the same with the progression of values that move from these high lights. He knows the difference between colour, shade and cast shadows and knows that cast shadows destroy the form on which they fall.

Line.—By drawing a cube the student may understand some of the significance of line in the creation of the illusion of reality. He will realize then that a line is a symbol for the outer edge of an object, the meeting of planes and the abrupt change of values where planes meet. Line is further used to indicate the abrupt meeting of different colours and to explain the shape of the form over which it moves. A line of varying strength will suggest the changing values that lie upon a form. And of course a line is used to symbolize a line. Often a line fulfills a number of the above conditions at once.

Planes.—It is a convenience to the artist to visualize two-dimensional planes on form for the accentuation of values, the creation or alteration of line and the clarification of thrust or direction. As planes can always be thought of as the surface of masses, their functions may be further clarified by a consideration of the artist's conception of mass.

Mass.—An artist is skilled in visualizing complex forms in terms of simple mass. In drawing the figure the student should practice breaking the body down into simple masses—the head as a box, for instance; the neck as a cylinder; the rib cage as an egg; the fingers as cylinders or long boxes. Such a visualization will solve many problems of proportion because proportion is largely a matter of the relationship of masses each to each in a manner suitable to the artist concerned. Further, the thrust or direction of complex forms may thus be more readily felt. It is easy to ascertain the exact position of a head if the details—eyes, mouth, ears, etc.—are forgotten and the head thought of as a simple block.

Most important, values of light and shade conceived to be lying on the masses may be visualized and transferred to the drawing. For example, in drawing a straight finger, the artist may conceive the finger as a long box, in his mind throw light and reflected light upon it, visualize the resulting values and transfer these values to his drawing of the finger, thus rejecting the values he may actually see upon the finger itself. Lines, too, are frequently drawn as if over a mass conception rather than over the complex form itself. The line of a ribbon around the complex neck may be but a circle around a cylinder.

Thrust or Direction.—In drawing it is necessary to decide on the exact position of forms in space. For instance, if a form is in motion, since it cannot be drawn in two or more places at once, the artist must decide and seize upon a single phase of the motion. Luckily most action has a repetitive quality with a phase of rest at the beginning and end of the action. The woodsman may be rendered with his ax raised or buried in the wood. In continuous action a random phase is seized, accompanied by such obvious symbols as wind-borne drapery or trailing hair. In figure drawing beginners complain about movement of the model; advanced students have already come to decisions as to the directions of the forms involved.

If lights are fixed, values upon a form will vary as the direction of the form changes. If a door is closed, it will retain the values of the wall upon which it is hinged; if opened, it will become lighter or darker than the wall. If the model is posed with one leg forward and one leg back, the front of the forward leg may well be of lighter value than the other. This circumstance may explain the different values to be placed on bodily forms as these forms change direction each to each.

If it is accepted that a line cannot be drawn until the form over which it is to move has been conceived by the artist, then the line cannot be drawn until the artist has decided upon the direction of the form. For as the direction of the form varies, so will the line vary. At times, in order to present the illusion of the true shape of a form, its direction must be altered; a cube rendered head on gives the illusion of a square plane. In regard to drapery, changing thrusts of shoulders, arms and legs and other parts of the body strongly affect the folds. (R. B. He.)

Anatomical Drawing.—For the student of anatomy as applied to art the simple drawing is the most effective in learning to construct the human figure. The eye must follow a line or a plane or a mass, which in construction becomes a moving line, a moving plane, a moving mass. But the mental construction must precede the physical, and in this the concept of mass must come first, that of the plane second, that of line last.

Certain laws enter into the functioning of the various organs of the body, just as pronounced as they are in controlling any other machinery. To the bones, for example, which make up the pressure system, belong the laws of architecture, as in the dome of the head, the arches of the foot, the pillars of the legs, etc.; also the laws of mechanics, such as the hinges of the elbows, the levers of the limbs, etc. Ligaments constitute the retaining or tension system, and express other laws of mechanics. Muscles produce action by their contraction or shortening and are expressed in the laws of dynamics and power, as well as the laws of leverage.

Hand.—In drawing the hand the artist must realize that there is an action and inaction side. When the thumb side is the action side the little finger is the inaction side. The inaction construction line runs straight down the arm to the base of the little finger. The action construction line runs down the arm to the base of the thumb at the wrist; from there out to the middle of the joint, at the widest part of the hand; thence to the knuckle of the first finger, then to that of the second finger, and then joins the inaction line at the little finger. However, with the hand still prone, when it is drawn *from* the body the thumb side becomes the inaction side and is straight with the arm, while the little finger, corresponding previously to the thumb, is at almost right angles with it. The inaction construction line now runs straight to the middle joint of the thumb, while the action line runs to the wrist on the little finger side, thence to the first joint.

Each of the four fingers has three bones. The middle finger is the longest and largest, because in the clasped hand it is opposite the thumb and with it bears the chief burden. The little finger is the smallest and shortest and most freely movable for the opposite reason. The middle joint of each finger is the largest, and, like all the bones of the body, the bones of the finger are narrower in the shaft than at the ends. In the clenched fist it is the end of the bone of the hand that is exposed to make the knuckle. Each of the three joints moves about one right angle except the last, which moves slightly less. The movements of the joints are also limited to one plane, except the lower one, which has also a slight lateral movement, as shown when the fingers are spread.

The centre of all the activities of the fingers, the hand and the forearm is the thumb. The fingers, gathered together, form a corona around its tip. Spread out, they radiate from a common centre at its base; and a line connecting their tips forms a curve whose centre is the same point. This is true of the rows of joints also. The thumb has three joints, and its bones are heavier and its joints more rugged than those of the fingers. It is pyramidal at the base, narrow in the middle, pear-shaped at the end. The ball faces to the front more than sideways. The thumb reaches to the middle joint of the first finger. The last segment bends sharply back, its joint having about one right angle of movement, and only in one plane. The middle segment is square with rounded edges, smaller than the other two, with a small pad. Its joint is also limited to one plane. The basal segment is rounded and bulged on all sides. The joint of its base is a saddle joint, with the free and easy movement of one in a saddle.

Arm.—The forearm has two bones, lying side by side. One, the radius, is large at the wrist and the other, the ulna, is large at the elbow. Diagonally opposite the thumb, on the ulna, is a bump of bone which is the pivot for both the radius and also

the thumb. Muscles must lie above the joint they move, so the muscles that bulge the forearm are mainly the flexors and extensors of the wrist and hand. The flexors and pronators form the inner mass at the elbow, the extensors and supinators form the outer mass.

Both the above masses arise from the condyles of the humerus, which is the bone of the upper arm. The part of the humerus near the shoulder is rounded and enlarged, where it joins the shoulder blade. The lower end is flattened out sideways to give attachment to the ulna and radius, forming the condyles. The shaft itself is straight and nearly round and is entirely covered with muscles except at the condyles.

Shoulder.—The deltoid muscle, triangular in shape, gives form to the shoulder. Just below the base is a ripple which marks the head of the armbone. The masses of the shoulder, arm, forearm and hand do not join directly end to end with each other, but overlap and lie at various angles. They are joined by wedges and wedging movements. Constructing these masses first as blocks, we will have the mass of the shoulder, or deltoid muscle, with its long diameter sloping down and out, leveled off at the end; its broad side facing up and out; its narrow edge straight forward. The mass of the forearm overlaps the end of the arm on the outside by a wedge that rises a third of the way up the arm, reaches a broad apex at the broadest part of the forearm and tapers to the wrist, pointing always to the thumb; and on the inside by a wedge that rises back of the arm and points to the little finger. In the lower half of the forearm, the thin edge of the mass, toward the thumb, is made by a continuation of this wedge from the outside. In the back view of the arm, the mass of the shoulder sits across its top as in the front view.

Neck.—Curving slightly forward, the neck rises from the sloping platform of the shoulders. The strength of the neck is at the back of the head, this portion being somewhat flat and overhung by the base of the skull. The sternomastoid muscles descend from the bony prominences back of the ears to meet almost at the root of the neck, forming a triangle whose base is the canopy of the chin. In this triangle below is the thyroid gland, larger in women, and above it the angular cartilage of the larynx, or Adam's apple, larger in men.

Head.—Both the oval and the cube have been used by artists as a basis for drawing the head, but the cube seems preferable in that the oval is too indefinite and offers no points for comparison, no basis for measurement, and the eye does not fix on any point in a curved line. The block not only carries the sense of mass but provides a ground plan on which any form may be built, as well as its perspective and foreshortening. The element of bilateral symmetry enters the drawing of the head. A vertical line in the centre divides the head or the trunk into parts equal, opposite and complemental. The right eye is the counterpart of the left; the two halves of the nose are symmetrical; the limbs, except for changes of position, are nearly exact though reversed duplicates of each other.

The cranium, the skeleton of the face, and the jaw constitute the masses of the head. Into the rounded mass of the cranium sets the narrower mass of the forehead bounded by the temples at the sides and by the brows below. From the lower outer corners of the forehead the wedge of the cheekbones begins, moves outward and downward until it just passes the curve of the cranium, then down and in, in a long sweep, to the corner of the chin. The two cheekbones together form the central mass of the face, in the middle of which rises the nose.

The planes of the head are those of the forehead, sloping upward and backward to become the cranium. The sides turn sharply to the plane of the temples. The plane of the face, divided by the nose, is broken on each side by a line from the outer corner of the cheekbone to the centre of the upper lip, making two smaller planes. The outer of these tends to become the plane of the jaw, which is again divided, etc. The relations of these masses and planes is to the molding of a head what architecture is to a house. They vary in proportion with each individual and now must be carefully compared with a mental standard.

Eye.—Below the eyebrow, on the lid, are three planes, wedging into each other at different angles. The first is from the bridge of the nose to the eye. The second is from the brow to the cheekbone, which is again divided into two smaller planes, one sloping toward the root of the nose, the other directed toward and joining with the cheekbone. The lower lid is stable; it is the upper lid that moves. It may be wrinkled and slightly lifted inward, bulging below the inner end of the lid. The cornea is always curtained by the upper lid, in part. The immovable masses of the forehead, nose and cheekbones form a strong setting for the most variant and expressive of the features.

Nose.—The bony part of the nose is a very clear wedge, its ridge only half the length of the nose. The cartilaginous portion is quite flexible, the wings being raised in laughter, dilated in heavy breathing, narrowed in distaste, and wings and tips are raised in scorn, wrinkling the skin over the nose.

The ears, the mouth, the lips and the chin, all offer variations in construction, and it is through comparison with others that the art of drawing them can best be acquired.

Trunk.—The upper part of the body is built around a bony cage called the thorax, conical in shape, and flattened in front. The walls of this cage are the ribs, twelve on each side, fastening to the spine behind and to the sternum or breastbone in front. The first seven are called true ribs, the next three false, and the last two floating ribs. The masses of the torso are the chest, the abdomen or pelvis, and between them the epigastrum, the first two comparatively stable, the middle one quite movable. The shoulders are also movable, changing the lines of the first mass and bulging the pectoral muscles, but the mass itself changes little except the slight change in respiration. The mass of the abdomen is even more unchanging.

Torso.—In profile the torso presents three masses: the chest, the waist and the abdomen. The mass of the chest is bounded above by the line of the collarbones; below, by a line following the cartilages of the ribs. This mass is widened by the expansion of the chest in breathing, and the shoulder moves freely over it, carrying the shoulder blade, collarbone and muscles. The back view of the torso presents numerous depressions and prominences, due to its bony structure and the crossing and recrossing of a number of thin layers of muscles. The outside layers manifest themselves only when in action, and for this reason the spine, the shoulder blade, and the hipbone are the landmarks of this region.

Lower Limbs.—The thigh, the leg and the foot constitute the lower limb. The thighbone is the longest and strongest bone of the body, and the mass of the thigh is inclined inward from hip to knee, and is slightly beveled toward the knee from front, back and outside. Below the knee is the shinbone, the ridge of which descends straight down the front of the leg, a sharp edge toward the outside, a flat surface toward the inside, which at the ankle bends in to become the inner anklebone. The outer bone of the foreleg soon overlaid by a gracefully bulging muscular mass, emerges again to become the outer anklebone. Two large muscles form the mass on the back of the leg.

Foot.—In action, the foot comes almost into straight line with the leg, but when settling upon the ground it bends to keep flat with the ground. A series of arches form the symmetry of the foot, the function of these arches being that of weight-bearing. The five arches of the foot converge on the heel, the toes being flying buttresses to them. The balls of the foot form a transverse arch. The inner arches of the foot are successively higher, forming half of a transverse arch whose completion is in the opposite foot. (E. C. Br.; G. B. Br.)

See CRAYON DRAWING; PASTEL; PEN DRAWING; PENCIL DRAWING; ANATOMY, COMPARATIVE. *See* also references under "Drawing (Techniques of)" in the Index volume.

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The catalogues of some of the great collections of old and modern drawings are as useful to artists as to art historians. The outstanding

combinations of text and illustrations include the Berlin Print Room's publications of German and Netherlandish drawings; the catalogue of the Fogg Art Museum of Harvard University; the British Museum catalogues of Netherlandish and Italian drawings; the catalogue of the Ashmolean Museum of Oxford University; the Louvre publications on French and Netherlandish drawings; the series of catalogues of the collection at Windsor Castle; the Albertina catalogues of German, Italian and Netherlandish drawings in Vienna.

Monographs on artists are too numerous to list. Two modern studies of the philosophy and criticism of drawing are Jean de Bosschere, *Essai sur le dialectique du dessin*, and Luigi Grassi, *Storia del disegno* (1947). Valuable related works are E. J. Labarre, *A Dictionary of Paper and Paper-making Terms* (1937), and Frits Lugt, *Les Marques de collections* (1921; supplement 1956).

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DRAWING, ENGINEERING, is the means of communicating the ideas of the engineer, designer or architect to the workmen who must produce a machine part, for example, or to a builder who erects a structure. With the increasing complexity of modern mechanical equipment and structures, it is necessary that the engineer, architect and draftsman have a thorough understanding of the geometric principles of orthographic projection upon which engineering drawing is based. The teaching of technical drawing in schools and colleges has tended strongly, therefore, to rigorous instruction in projection theory (*see* DESCRIPTIVE GEOMETRY).

Classification of Drawings.—The term "graphics" often is used in place of "drawing" because the subject matter has come to include a wide range of material.

Projection drawings are those based upon the geometric principles of projection theory, such as orthographic, axonometric, oblique, or perspective projection, all of which are discussed below. From the viewpoint of usage, these types of drawings may be classified into professional categories, such as machine, structural, map, ship, architectural, aeronautical, piping or electrical drawings. In all of these types the fundamental principles of orthographic projection apply, but the symbols used and the methods of indicating dimensions vary for each class.

Engineers and businessmen use other types of drawings, commonly called charts, graphs or diagrams, which do not involve projection theory. These usually show facts rather than objects. Thus, the familiar bar chart may be used to show comparative production figures, or a curve may be plotted to show data obtained from a tensile test of mild steel. Computation charts, such as nomographs, vector diagrams and network charts, often are used by engineers to simplify calculations (*see* NOMOGRAPHY; VECTOR ANALYSIS).

Instrument drawings are any of the foregoing types made with instruments such as the T square, triangles and compass; these are sometimes called mechanical drawings. Any drawings made by the unaided hand are referred to as freehand drawings.

Selection of Scale.—Since objects are rarely of a size that will permit them to be represented on a drawing at their actual dimensions, it is necessary for the draftsman to reduce, or sometimes enlarge, the size in some definite proportion. When the drawing is the actual size of the object, the scale is said to be "full size" or $1'' = 1''$. When the dimensions are reduced one-half, or $\frac{1}{2}'' = 1''$, the scale is sometimes called "one-half size." Other scales such as $\frac{3}{4}'' = 1''$, $\frac{1}{4}'' = 1''$, and $\frac{1}{8}'' = 1''$ often are used.

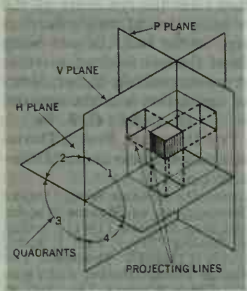

FIG. 1.—PRINCIPAL PLANES OF PROJECTION AND QUADRANTS USED FOR ORTHOGRAPHIC PROJECTION

In architecture and civil engineering, the subject matter of drawings requires even further reductions, and scales such as

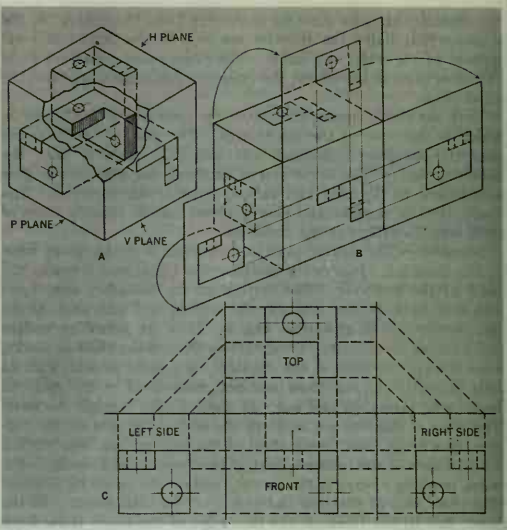

FIG. 2.—REVOLUTION OF PLANES OF PROJECTION FOR THIRD-QUADRANT PROJECTION

$\frac{1}{8}'' = 1'$ and $\frac{1}{4}'' = 1'$ are common. The civil engineer also uses scales with proportions of 20 parts to the inch, and scales for 30, 40, 50 and 60 parts to the inch also are available. These are useful in map drawing and in graphical computation. Decimal scales for $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ and full size drawings also are employed.

Orthographic Projection.—An orthographic projection is a drawing made by projecting lines from the object perpendicular to the plane of projection, as shown in fig. 1. One, two, three or more planes may be used as needed. The three planes of projection most frequently used are called the principal planes of projection and are at right angles to one another. The horizontal plane (the H plane) and the vertical plane (the V plane) divide space into four quadrants. The third or profile plane (P plane) may be at either side; its position does not affect numbering of the quadrants.

In order to get the views into the single plane represented by the sheet of drawing paper, the H plane and P plane are imagined as being revolved away from the object into coincidence with the V plane, as shown in fig. 2(A). The resulting arrangement of views is then as shown in fig. 2(B). For most work only one of the side views needs to be shown. This arrangement, for third-quadrant projection, has come to be standard practice in the United States, Canada and the military services of Great Britain. The first-quadrant arrangement of views shown in fig. 3 is used in continental Europe and for ordinary industrial drawings in Great Britain.

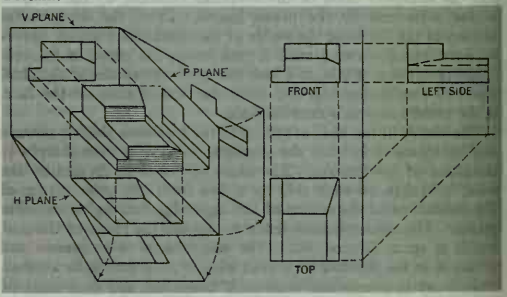

FIG. 3.—REVOLUTION OF PLANES OF PROJECTION FOR FIRST-QUADRANT PROJECTION

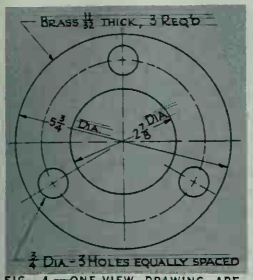

FIG. 4.—ONE-VIEW DRAWING ADEQUATELY DEPICTS A FLAT GASKET

With the standard arrangement of views shown in figs. 2 and 3 it can be seen that (1) the front and top views are always in vertical alignment and the front and side views are always in horizontal alignment; (2) for third-quadrant projections (fig. 3) the plane of projection is always between the observer and the object, while for first-quadrant projections the object is between the observer and the plane; (3) in both cases the planes are revolved away from the object into coincidence with the V plane.

Selection of Views.—The purpose of all projective drawings is to represent accurately the shape of an object. For a simple object such as a gasket, one view may be enough. In fig. 4 one view shows the shape of the part; the thickness is given by a note and thus all the necessary information is provided. Even somewhat more complex objects frequently can be described by only two views, as in fig. 5. In industry it is always desirable to keep drafting costs as low as possible; and hence unnecessary views should not be made. The engineer, however, must be certain that his drawings describe the shape of the object in such a way that it cannot be misunderstood. In the drawing reproduced in fig. 6, for example, it might be assumed that the front and top views describe a cube; however, it is apparent that these views could equally well describe any of the five shapes shown in the side views. It is obvious that the objects shown in figs. 2, 3, and 7 require three views.

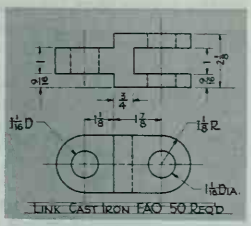

FIG. 5.—FRONT AND TOP VIEWS ADEQUATELY DEPICT LINK; SIDE VIEW IS UNNECESSARY

On many objects there are lines or edges that cannot be seen but must nevertheless be shown to give a complete description of the object. These are represented by dashed lines, as shown in fig. 5 and 7. When choosing the views of an object it is best to select the ones having the least number of hidden lines; thus, in fig. 2 the left side view would be selected rather than the right.

Auxiliary Views.—Many objects have oblique faces that will not show their true shapes in any of the three principal views. In such cases an auxiliary or helping plane may be set up to obtain the true shape.

For an auxiliary view to be effective, the plane upon which the face is projected must fulfill two conditions: (1) it must be perpendicular to one of the planes already in use, and (2) it must have a definite relationship to the object; *i.e.*, if the true shape is desired, the plane must be parallel to the face while also fulfilling condition (1).

In fig. 8 it is obvious that neither the top nor side views shows the true shape of the face MNOP. However, that face does show edgeways in the front view, and thus it can be projected onto a parallel auxiliary plane, represented edgeways by the line V–1, placed at any convenient distance. Projections are made

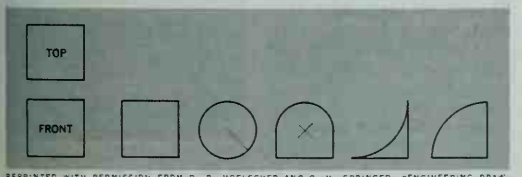

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FIG. 6.—AMBIGUOUS FRONT AND TOP VIEWS: SIDE VIEW COULD BE ANY OF THOSE SHOWN AT RIGHT

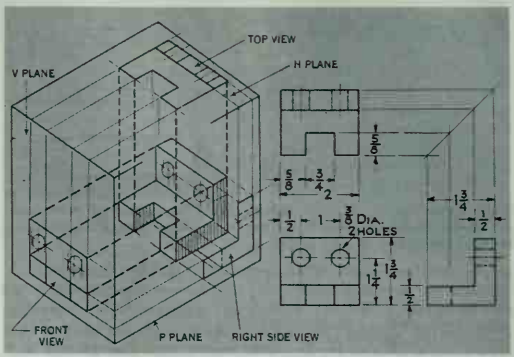


FIG. 7.—THEORETICAL METHOD (LEFT) OF PROJECTING A THIRD-QUADRANT, THREE-VIEW DRAWING AND (RIGHT) COMPLETED DRAWING WITH UNIDIRECTIONAL DIMENSIONING

from the front view and the measurements *a* and *b* are obtained from either the top or side view since they are the same in either case.

Sectional Views.—An object that has open spaces within it sometimes presents such a maze of hidden lines that the drawing is difficult to understand. When this occurs it is customary to make a sectional view, *i.e.*, a view in which a part of the object is removed so that the interior can be seen. For a full-sectioned view, the cutting plane is imagined as passing through the centre of the object, the front half of which is removed, as shown in fig. 9. Where material is cut the area is crosshatched by light lines sloping at 45°. When the section is made through an assembly drawing, the crosshatching is sloped in different directions for each separate part cut, but always in the same direction for different areas of the same part. Solid shafts, bolts and screws are not sectioned, even though the cutting plane passes through them.

In fig. 10 the left quarter of the front of the object has been removed, giving a front view that shows the left half in section and the right half as an outside view. Such a drawing is said to be a half-sectioned view. In the top view of fig. 10 the front portion of the object has been broken off to conserve space; this is a common practice for symmetrical objects. The entire top view could be shown if desired.

When it is necessary to show the shape of a member, a cutting plane is passed through the member at right angles to its length and the plane is then revolved 90°, as shown for the spoke in fig. 11. However, instead of revolving the section in place, the location of the cutting plane may be shown on the view and the cross section then may be drawn at a convenient place elsewhere on the sheet, as shown for the rim of the wheel in fig. 11. The section may be made at the same scale or larger if desired. If it is made larger, the new scale should be noted on the drawing.

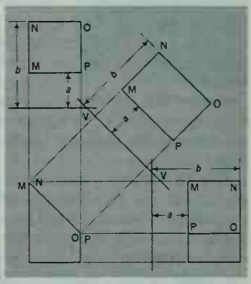


FIG. 8.—USE OF AUXILIARY PROJECTION TO OBTAIN TRUE SHAPE OF FACE MNOP

When important details cannot be shown by passing a plane straight through the object, the plane may be offset at right angles, as in fig. 12, or it may be bent or turned so that it passes through important features. One part of the plane is always parallel to one of the principal planes. The bent portion is then imagined as being rotated so that it is parallel to the same plane, as in fig. 13. The location of the cutting plane must be shown on the adjacent view by heavy dash lines.

Assembly Drawing.—As its name implies, an assembly drawing shows the parts of a machine or structure put together in their

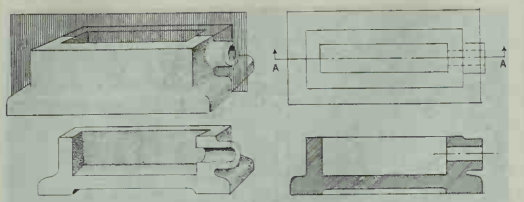


FIG. 9.—IMAGINARY CUTTING PLANE (LEFT) IS EMPLOYED FOR FULL-SECTIONED DRAWINGS (RIGHT), IN WHICH THE LOWER DRAWING SHOWS A SECTION THROUGH THE LINE A–A

proper working order. When applied to a building framework or a bridge, the assembly drawing is called an erection diagram. Assembly drawings serve a variety of purposes. The beginning design layout is usually an assembly sketch. On the basis of this sketch, computations can be made to determine the strength and stability of parts. The parts are then drawn and dimensioned in detail, and finally an assembly drawing is prepared. This drawing, with all parts numbered, is used to assemble the machine. On such a drawing there may also be a bill of materials, listing such standard items as bolts, screws, washers and pins, for which separate drawings are not made.

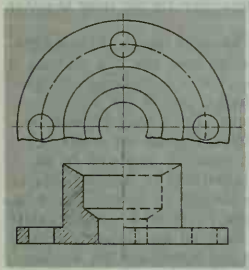


FIG. 10.—HALF-SECTIONED VIEW: TO CONSERVE SPACE, DRAFTSMAN SHOWS ONLY REAR PORTION OF SYMMETRICAL OBJECT

Symbols.—In order to save drafting time many standard parts are represented by symbols, such as those for screw threads shown in fig. 14. In the schematic representation the helical curve of the screw is represented by a straight line, for both the crest and root of the thread, at right angles to the length of the bolt or nut.

The type of thread and the class of fit are indicated by a note on the drawing. The first number of the note gives the outside diameter of the thread, and the second gives the number of threads per inch. The letters UNC mean that the thread is of the unified national coarse form (a standard accepted in the United States, Canada and Great Britain), and the last number and letter specify the class of fit (2 is the class for ordinary machine work). The letter A indicates an exterior thread and B means an interior thread.

Similar simplifications have been made for gear teeth, for cross-hatching to show various types of materials, for plumbing fittings and fixtures, for electrical wiring diagrams, and many other applications.

Dimensioning.—Before a drawing can serve a useful purpose, the size of the object shown and all of its parts must be given by means of dimensions and notes. The draftsman, to become proficient in dimensioning practice, must understand shop processes and construction methods, but certain dimensioning practices have been standardized throughout the United States, Great Britain and Canada. These can be found in the publications of the American Standards association (see *Bibliography*).

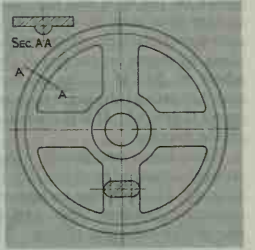


FIG. 11.—REVOLVED SECTION (LOWER SPOKE) AND REMOVED SECTION (THROUGH WHEEL RIM AT A–A); REMOVED SECTION IS DRAWN TO LARGER SCALE

Two methods of placing dimensions on a drawing are in use. In the aligned system the dimensions are lettered in the same direction as the dimension line (fig. 4 and 5). Horizontal dimensions read from the bottom of the sheet, and vertical dimensions read from the right side of the drawing. Inclined dimensions must also be aligned with their dimension lines. In the undirectional system, which is simpler to make and to read, all numerals read from the bottom of the sheet, as shown in fig. 7. For either system, the following rules should be observed.

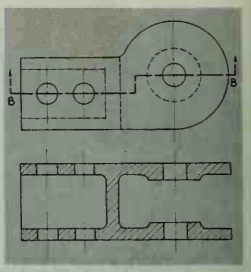


FIG. 12.—OFFSET SECTION TAKEN THROUGH LINE B–B

(1) Extension lines, dimension lines and leaders should be light, solid lines (fig. 15). (2) Extension lines should begin about $\frac{1}{16}$ in. from the view and end about $\frac{1}{8}$ in. beyond the dimension line. (3) Dimension lines in machine drawing are broken near the midpoint and the numerals inserted in the space. In structural and architectural drawing it is the usual practice to draw a continuous dimension line and place the numerals above the line. (4) In architectural and structural work, feet and inches are indicated thus: 5′ 2″. If the dimension is in even feet, it is written 6′ 0″. If desired, the inch symbol (″) may be omitted. (5) In machine drawing, dimensions are usually all in inches, and so the inch symbol is not used. (6) When fractions are used, the bar is always aligned with the dimension line, never slanted or omitted. (7) In machine drawing there is a strong trend toward the exclusive use of decimal fractions. (8) Arrowheads are placed at the end of dimension lines to show the extent of the dimension. They are small, black and about one-third as wide as long. (9) Leaders from a dimension or note should be made as in fig. 15. When leaders refer to holes, they should touch the circle and point in a radical direction toward the centre.

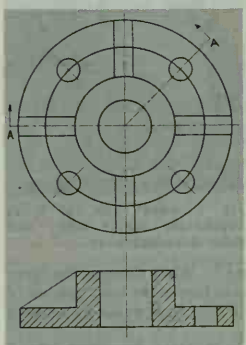
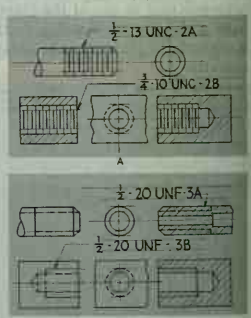


FIG. 13.—ALIGNED SECTION THROUGH A–A

Positioning of Dimensions.—There are six important rules for the placing of dimensions on a drawing. (1) As far as possible, dimensions should be placed outside the views. They may be placed within a view only if greater clearness results. (2) Dimensions should be placed between views. (3) The first dimension line should be placed $\frac{3}{8}$ to $\frac{1}{2}$ in. from the view to which it applies. (4) Successive dimension lines should not be closer than $\frac{1}{4}$ in. to each other. (5) Dimensions should never be put along centre lines. (6) Hidden lines should not be dimensioned, if it can be avoided. The centre line of a hidden hole is regarded as a hidden line.

Selecting Dimensions.—Two factors are involved in the dimensioning of an object: the size of its parts and the location of the parts relative to one another. (1) Circles are specified by diameters, cylindrical shafts or holes by diameters and lengths. (2) Sizes of circles such as rounded corners or fillets are specified by giving the radius followed by the abbreviation R or Rad. (3) Compound curves composed of a series of circular arcs are dimensioned by giving the radius of



A.S.A. Y-14.6–1957, COURTESY OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

FIG. 14.—STANDARD THREAD SYMBOLS: (A) SCHEMATIC; (B) SIMPLIFIED REPRESENTATIONS

each arc and the location of its centre in two directions, usually at right angles to each other. (4) Noncircular curves are dimensioned by co-ordinates to points along the curve. (5) Angles may be dimensioned in several ways, as shown in fig. 16.

Toleranced Dimensions.—In the manufacturing process it is impossible to make large numbers of parts to an exact dimension. It is therefore necessary, in the mass production industries, to allow some leeway in producing a part, such as a cylindrical wrist pin to attach a piston to its connecting rod in an automobile engine. To permit interchangeable assembly, any wrist pin must fit the holes in any piston, as well as the hole in any connecting rod. The problem of making parts fit together involves tolerances, allowances and limits, which are defined as follows: (1) tolerance is the amount of variation permitted in the size of a part; (2) allowance is the intentional difference in the size of two mating parts; it may be either positive, providing a clearance fit, or negative, producing an interference fit; (3) limits are the extreme permissible dimensions of a part; two limits are always involved, an upper and a lower, and the difference between them is the tolerance.

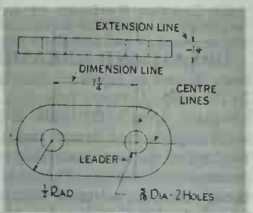


FIG. 15.—DEFINITIONS OF TERMS USED IN DIMENSIONING DRAWINGS

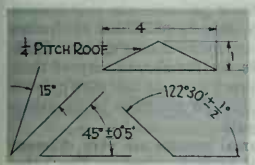


FIG. 16.—METHODS OF DIMENSIONING ANGLES

There are three systems of specifying tolerances on drawings. The bilateral system, in which the deviation on both sides of the basic dimension is shown (fig. 17[A]), is most often used for location dimensions. The unilateral system, in which the allowable deviation is indicated from one side of the basic dimension (fig. 17[B]), is frequently used for close-fitting shafts and holes. The limit system, in which the limits of deviation are given, rather than the basic dimension, is shown in fig. 17(C).

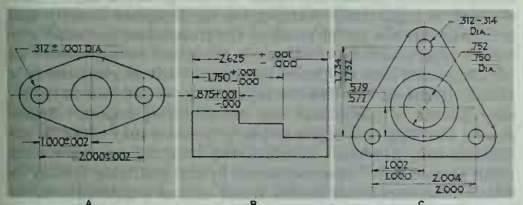


FIG. 17.—THREE METHODS OF INDICATING TOLERANCES: (A) BILATERAL DIMENSIONING; (B) UNILATERAL DIMENSIONING; (C) LIMIT SYSTEM

Pictorial Drawing.—Although most engineering drawings are made in multiview orthographic projection, the engineer finds pictorial drawing useful for a number of purposes. For those who cannot understand the two- and three-view drawings that show only one face of an object at a time, the pictorial forms are very helpful.

There are three types of pictorial drawings: perspective, used mainly by architects, which is described and illustrated in the articles PERSPECTIVE and ARCHITECTURAL RENDERING; axonometric projection, which is a one-plane orthographic projection; and oblique projection, in which the projecting lines are at an angle (other than 90°) to the plane of projection.

Axonometric Projection.—If a plane is imagined as being set up obliquely to the three principal planes of projection (fig. 18) and the object is projected upon this plane at right angles, an axonometric projection results. The axonometric projection may be of three types: isometric, dimetric or trimetric.

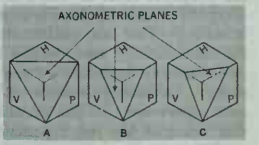


FIG. 18.—POSITION OF PROJECTING PLANE FOR THREE TYPES OF AXONOMETRIC PROJECTION: (A) ISOMETRIC; (B) DIMETRIC; (C) TRIMETRIC

When the axonometric plane makes equal angles with the three principal planes (fig. 18[A]), an isometric projection is obtained. From a study of this projection, rules have been established for making isometric drawings, as of the cube in fig. 19(A). The three edges of the cube are all the same length; consequently, an object like that in fig. 20 can be drawn by making measurements along or parallel to the three axes, using the same scale in all of them.

If the axonometric plane is tilted so that it makes equal angles with any two of the principal planes and a different angle with the third (fig. 18[B]), a dimetric projection is obtained. Dimetric drawings are made in the same manner as isometrics except that different scales must be used on the axes, as shown in fig. 19(C) and 19(D). These drawings are usually more realistic than isometrics. When the axonometric plane is unequally inclined to each of the three principal planes (fig. 18[C]), a trimetric projection results. This type requires a different scale on each axis and is more tedious to draw; hence, trimetric drawings are not often used.

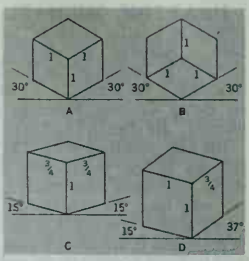


FIG. 19.—AXES AND SCALES FOR ISOMETRIC AND DIMETRIC PROJECTION: (A) ISOMETRIC PROJECTION OF CUBE; (B) SAME PROJECTION WITH AXES REVERSED; (C) AND (D) DIMETRIC PROJECTIONS WITH DIFFERENT SCALES ON AXES

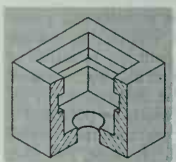


FIG. 20.—ISOMETRIC HALF-SECTION

Oblique Projection.—If an object, in its usual position for orthographic projection upon the three principal planes, is viewed at an angle oblique to the vertical plane, three faces of the object can be projected or can be seen in one view. If the angle of viewing is at 45° to the vertical plane, the front face of the object projects in its true shape, since it is parallel to the plane of projection. The third axis, which is perpendicular to the plane, also projects in its true length as in fig. 21. Hence, equal measurements can be made on all three axes, just as in isometric projection. Two of the axes are always at right angles to each other. An oblique projection of this type is called a cavalier projection or drawing. This type of drawing is sometimes unpleasing because the depth seems to be exaggerated. The visual effect can be reduced somewhat by employing another type of oblique projection in which the scale on the receding axis is just one-half that on the front face. This is called a cabinet drawing. Scales such as $\frac{5}{8}$ or $\frac{3}{4}$ can be used on the receding axis to give a more pleasing effect. The receding axis may be at any angle with the horizontal, but 30° and 45° are most often used.

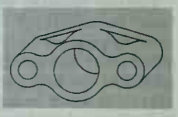


FIG. 21.—OBLIQUE PROJECTION

BIBLIOGRAPHY.—R. P. Hoelscher and C. H. Springer, *Engineering Drawing and Geometry*, 2nd ed. (1961); E. G. Paré, *Engineering Drawing* (1958); R. S. Forbes, *Examples in Technical Drawing* (1957); F. E. Giesecke *et al.*, *Technical Drawing*, 4th ed. (1958); American Standards Association, *Y14, Standard Drafting Manual; Y15, Charts and Graphs; B1, Screw Threads.* (R. P. Ho.)

DRAWING AND QUARTERING, part of the penalty anciently ordained in England for treason. Until 1870 the full punishment for the crime was that the culprit be dragged on a hurdle to the place of execution; that he be hanged by the neck but not till he was dead; that he should be disemboweled or drawn and his entrails burned before his eyes; that his head be cut off and his body divided into four parts or quartered.

This brutal penalty was first inflicted in 1283 on the Welsh prince David, and in 1305 on Sir William Wallace. Edward Marcus Despard and his six accomplices were in 1803 hanged, drawn and quartered for conspiring to assassinate George III. The sentence was last passed (though not carried out) upon the Fenians Burke and O'Brien in 1867.

DRAYTON, MICHAEL (1563–1631), English poet described by Charles Lamb as "panegyrist of my native earth," was born at Hartshill, Warwickshire, in 1563. He spent his early years in the service of the Goodere family, to whom he owed his education. He remained a lifelong friend of Anne, daughter of Sir Henry Goodere, whom he celebrated as *Idea*, but he never married. He died in London in 1631.

His first published work, *The Harmony of the Church* (1591), contains biblical paraphrases in an antiquated style. His next works conformed more nearly to contemporary fashion: in pastoral, with *Idea, The Shepherd's Garland* (1593); in sonnet, with *Idea's Mirror* (1594); in erotic idyll, with *Endymion and Phoebe* (1595); and in historical heroic poem, with *Robert, Duke of Normandy* (1596) and *Mortimeriados* (1596). The last, originally written in rhyme royal, was recast in ottava rima and renamed *The Barons' Wars* (1603). Drayton gave this characteristically professional reason for the revision: "The often harmony (of the seven-line stanza) softened the verse more than the majesty of the subject would permit. Therefore I chose Ariosto's stanza, of all other the most complete and best proportioned."

Drayton's most original poems of this period are *England's Heroical Epistles* (1597), a series of pairs of letters exchanged between famous lovers, which remained the most popular of his poems throughout the 17th century.

Drayton, like most other poets, acclaimed in verse the accession of King James I but, unlike all others, was tactless enough in *To the Majesty of King James* (1603) to omit any reference to Queen Elizabeth I. For this he "instantly saw all his long nourished hopes even buried alive before his face." The disappointment affected his poetry of the next few years, in which he published a deliberately obscure satire, *The Owl* (1604); degraded the graceful *Endymion and Phoebe* into an even more difficult satire, *The Man in the Moon* (1606); and contrived a portentous heroic poem, *Moses in a Map of His Miracles* (1604). He recovered himself with his first collected *Poems* (1605), and in *Poems Lyric and Pastoral* (1606) he introduced a new mode into English poetry with the "odes," modeled on Horace. The most famous, "The Ballad of Agincourt," shows Drayton's gift for pure narrative. Unfortunately, when he attempted the complexity of epic, he did not combine this gift successfully with the insight into character shown in the *Heroical Epistles*.

Further collected editions culminated in his most important book, *Poems* (1619). Here Drayton reprinted most of what he chose to preserve from his earlier poems, often much revised, and added many fine new poems and sonnets. He had also meanwhile published the first part of his most ambitious work, *Polyolbion* (1612), in which he intended to record that Elizabethan discovery of England, of the beauty of the countryside, the romantic fascination of ruined abbeys and spoiled forests, its history and legend and active present life. But he was too eager to cram everything in, so that the poem tends to run aground on the shoals of detail to which his alexandrines are too accommodating.

Drayton was not exhausted by this "Herculean toil"; he produced a second part in 1622, and in his old age wrote some of his most delightful poetry, especially the fairy poem *Nymphidia* (1627), with its mock-heroic undertones, and the charming *The Muses Elizium* (1630), where he is at last content with the cool, sequestered world of his imagination. The admirable *Elegies Upon Sundry Occasions* (1627), addressed to his friends, often suggest, with their easy, polished couplets, the manner of the Augustans.

Drayton's best poetry is, in the fullest sense, patriotic: the poetry of a man who is continually discovering new enchantments in the English scene or in English history; whose patriotism is a matter more of pleasure than of pride. His sonnets owe less to continental models than do those of most of his contemporaries; his pastorals, "bold upon a new strain," are set in no fancied Arcadia; his Ovidian epistles are written by men and women famous in the history of England. This discovery of an independent English tradition is among the most important for Drayton's generation; to its celebration no man more consistently devoted greater gifts than Drayton.

See *Complete Works*, ed. by J. W. Hebel, 5 vol. (1931–41); *Poems* (selection) ed. by John Buxton, Muses' Library (1953); B. H. Newdigate, *Drayton and His Circle* (1941). (E. J. M. Bn.)

DREAM AND DREAMING. Traditionally, dreams have been defined as states of consciousness taking place during sleep. In the light of critical reflection, however, this definition is hardly adequate. Not every state of awareness occurring during sleep is classifiable as a dream state; nor is sleep in the conventional meaning of the term invariably necessary for the production of the dream consciousness. People often hear a telephone ringing even though they are asleep or dozing. Upon being fully roused, they find that what they heard in the sleep or quasi-sleep state corresponds with external reality, since the telephone is still ringing. Such correct apprehension of a genuine event is obviously not to be classified as a dream even though sleep and the apprehension were concomitant.

An essential characteristic of the dream is thus a manifest discrepancy between dream images and external reality. In other words, dreams are illusory or hallucinatory experiences and just because such experiences can take place in the absence of ordinary sleep, the adequacy of the traditional definition is to be questioned. The experiences of some mentally sick patients, who misconstrue their hallucinations as real events, may be classified as dreams despite the fact that the patients are by no means asleep. Their hallucinations are often responsible for the abnormality of their speech and conduct. In common speech it is said that such persons are living in a dreamworld, and they do not have to be asleep in order to live in such a dreamworld.

The ordinary daydreams of normal persons are very different from the hallucinated fantasies of mental patients. The latter act as if the fantasies are genuine occurrences taking place in the immediate present. The fantasied events of the daydream, on the other hand, are not confused with reality. They are experienced as what might once have taken place or what might yet still take place. In contrast to night dreams, daydreams thus are either relegated to the past or projected into the future; their temporal locus is rarely the present. Like night dreams, however, daydreams are products of different instigating wishes, concerns, interests and kindred dynamic factors. Some daydreams, for example, centre around the theme of the "good old days"; here the motive might be a yearning for the imagined security and presumed carefree joy of youth as the frustrations and other distresses experienced by children are minimized or repressed. In the conquering-hero daydream the sting of failure gives rise to a fantasy by means of which the failure is converted into an imaginary success of spectacular and self-glorifying import. Analogously, the sting of a reprimand or a rejection may result in the suffering-hero daydream in which the imagined agony or even death of the "hero" is accompanied by the gratifying fantasy in which those responsible for the rebuff express anguished remorse and plead for forgiveness. A third type of common daydream is what might be termed the debating-hero daydream, also prompted often by the sting of failure or reproof or disparaging criticism; in fantasy the aggrieved person anticipates the supposititious argument in which he will become embroiled should he undertake his own defense, the fantasy often following the pattern of "if he says, then I'll say," in which the "hero" imagines himself formulating brilliantly effective and even crushing rejoinders.

In the light of the foregoing considerations it is possible to formulate a more exact definition of the concept of dreaming. A dream is to be regarded as an illusory or hallucinatory experience the temporal locus of which is the present and which is usually accepted as real or as having genuinely existential status at the time it occurs. This last qualification is necessary in order to allow for the relatively rare dreams in which the dreamer is actually or incipiently cognizant of the fact that he might be having a dream. Ordinarily, however, it is not until fully alert consciousness supervenes that the dreamer recognizes the unreal status of that which he has just experienced in his dream.

(This unreality of dream events is also suggested by the derivation of the word dream, which is traced through the Anglo-Saxon to the root meaning of the modern German word *Traum;* this is in

turn related to the German verb *trügen*, which means "to deceive." By stressing the role of illusory and hallucinatory factors in the dream experience the definition formulated above tends to preserve the idea of deception implicit in the root meaning of the word.)

PSYCHOLOGICAL INVESTIGATION

Interest in the nature and significance of dreaming dates from antiquity. Divination by means of dreams, a recognized art in ancient times, was called oneiromancy (from the Greek *oneiron*, "dream"), and for the unsophisticated in all ages dreams have possessed significance of a sort that enabled the oneiromancer to have his art taken seriously. Even today so-called dream books are purchased by the credulous for the purpose of ascertaining the presumed prophetic meaning of given dream symbols.

Scientific study of dream phenomena was initiated in 1861 with the publication of A. Maury's study of sleep and dreams. Later investigators devoted themselves to similar application of scientific method to problems of dream psychology. For the most part these problems have had little in common with the beliefs which the credulous of all ages have tended to associate with dreams. Instead they have had to do with questions so framed as to be amenable to study by the methods of science. The following are examples:

1. What are the roles of internal and external stimuli in the production of dreams?
2. Is dream imagery different in kind from that of imaginative productions in daydreams and creative thinking?
3. What is the relationship between depth of sleep and incidence of dreams?
4. How long do dreams last?
5. Are dreams revelatory of conscious and unconscious desires and personal conflicts?
6. Can dream symbols be interpreted in dependable fashion?
7. Are dreams produced during hypnotic sleep different from those occurring normally?
8. Do the dreams of the blind and deaf differ from those of persons with normal vision and hearing?
9. Do the frequency and nature of dreaming vary with age?
10. Does dreaming serve any useful function?

In order to find the answers to questions of the foregoing sort, students of dream psychology have had recourse to varying techniques of investigation. Some have endeavoured to influence the dream consciousness by pinching the sleeping subject or bringing odoriferous substances close to his nostrils. The experimenter would then either arouse the subject for the purpose of securing an immediate report on his dream life or else wait until he awakened spontaneously to furnish such a report. Some experimenters applied stimuli to themselves prior to falling asleep. For example, one investigator would knot a string around his finger or keep a metronome ticking and prepare himself to observe the possible influence of such tactual and auditory disturbances on his dreams. (Self-observation of this kind is rendered more reliable if the experimenter keeps a pencil and notebook handy so that he can write down his observations immediately upon awakening; for dreams are fleeting, and delay in recording may render it impossible to remember more than a few fragments of what had been a relatively complex dream.)

A few psychologists have used a method of experimental induction of dreams during hypnosis. In this technique hypnosis (*q.v.*) is induced by any one of the traditional routine procedures, and then the hypnotized subject is told that he will soon find himself experiencing a dream. A suggestion of this kind arouses a definite set to dream. Once this set is aroused the experimenter introduces various disturbances calculated to induce a dream. He may sound a buzzer, call out a person's name, hold a bottle of perfume near the subject's nostrils, stroke the skin surface with a tuft of cotton, change the position of the subject's arm or leg or introduce any other kind of disturbance. Some psychologists have awakened the hypnotized subject in order to get his dream report. This is not necessary in most instances since the hypnotized subject may be made to respond to the suggestion that he supply an account of each dream as soon as he has experienced it. A co-operative subject does this without awakening from the hypnotic state. In this way a whole series of dreams may be collected during a single experimental session. By means of this technique it is also possible to get an approximate measure of the duration of a dream. All that is required is to set a stop watch in motion when the dream stimulus is applied and to stop the watch as soon as the subject starts his account. Using this method it was found by one investigator that the hypnotic dream averages about 30 seconds. The hypnotic technique also has been used to influence the course of ordinary night dreams. This is accomplished by giving the subject a posthypnotic suggestion to dream about some specific theme on a particular night and to report the resulting dream to the investigator.

During the 1950s Nathaniel Kleitman and his collaborators developed an objective method for the study of dreaming. This involved obtaining records of the eye movements of sleeping subjects along with simultaneously recorded brain waves. In the course of numerous experimental sessions, it became clear that sleep was characterized by periods of rapid eye movements (REM's) at approximately regular intervals. Each such period was followed by one of no rapid eye movements (NREM's). Moreover, the brain wave pattern for the REM period differed from the NREM period, the latter pattern being more characteristic of deep sleep and the former of lighter sleep. When subjects were awakened in conjunction with these periods and instructed to record their dreams, it was found that dreaming was definitely more frequent during the REM periods than during the NREM periods. For example, in one series of studies using nine subjects, a total of 152 dreams was recalled in association with REM periods, and only 39 such periods were devoid of dream recall. In contrast to this, the same group of subjects had no recall of dreams for 149 NREM periods, and only 11 instances of dreaming were reported for these periods.

Dreaming, known to be characterized by predominant visual imagery, thus can be presumed to be taking place when the two sets of recording instruments show rapid eye movements and the kind of brain waves indicative of light sleep. In the absence of rapid eye movements, along with increasing depth of sleep, there is less likelihood of activation of the dream process.

Kleitman's introduction of objective procedures prepared the way for further experimental studies of dream phenomena. It was no longer necessary to rely on the delayed reports of subjects describing dreams of the previous night; by the Kleitman method the sleeper is awakened according to the REM pattern, and his description of dream events is automatically recorded. Since this occurs in a laboratory setting, it is possible to control environmental variables affecting the sleeper, and to study the effects of drugs, stress, personal conflict and other conditions on dream content.

NATURE OF DREAMS

Content.—It is a commonplace observation that the sequence of events in a dream episode is more bizarre than that characteristic of waking consciousness. The dreamer's control of attention, judgment, imagery and other mental functions is much reduced or altogether absent. The dream is something that happens to him as opposed to something that he does for himself or to himself. To a large extent he is a passive observer of events sweeping over him. These events are presented in the form of a phantasmagoric play of images. This should not be construed to mean that the images are exclusively visual, for psychological studies have demonstrated the variegated nature of dream imagery. Although visual and auditory imagery seems to predominate, as it does in waking life, any other kind of imagery may be woven into the fabric of the dream. In only one respect does dream imagery seem to differ significantly from the spontaneous utilization of imagery in waking life: coloured or chromatic images are not common in dreams. Events in the dream are more likely to appear in gray pictures rather than in colours. Occasionally it has been implied that the perception of coloured images is altogether absent from the dream process, but this is not in accord with fact. Coloured images do occur, but they are far less common than the ubiquity of colour in waking experience would lead one to expect. The reason for this is unknown.

In general, whatever form of imagery is experienced during waking life can also be experienced during sleep. This means

that persons suffering from congenital absence of a given sense modality can never experience the sensations and images characteristic of that modality. Because of this the congenitally deaf never have auditory imagery in their dream patterns. Similarly, the dreams of the congenitally blind are devoid of visual imagery. However, such imagery is present if the loss of vision took place after several years of visual experience. The first five to seven years seem to be critical in this respect; blindness occurring after the seventh year does not result in loss of capacity to experience visual images. In cases of early loss of both vision and hearing, dream imagery is restricted to the unimpaired sense modalities. Helen Keller in writing about her own dreams in *The World I Live In* gave a classic account of the dream life of one so handicapped:

> I smell and taste much as in my waking hours, but the sense of touch plays a less important part. In sleep I almost never grope. No one guides me. Even in a crowded street I am self-sufficient, and I enjoy an independence quite foreign to my physical life.

That kinesthetic and tactual imagery did nevertheless constitute active dream processes for Miss Keller is exemplified by the following passage:

> Once in a dream I held in my hands a pearl. I have no memory-vision of a real pearl. The one I saw in my dream must, therefore, have been a creation of my imagination. It was a *smooth,* exquisitely *molded* crystal . . . My pearl was *dew* and fire, the *velvety* green of moss, the *soft* whiteness of lilies . . . (Italics added.)

This passage is of special psychological interest because it indicates the way in which her use of the vocabulary of colour is seemingly an outgrowth of the tactual characteristics of objects. The velvety feel suggests green, softness suggests white.

Dream content, of course, is not static but dynamic, akin to living a story or experiencing an event. Material for the dream story comes from stimuli impinging on the dreamer at the moment as well as from his store of past experiences and contemporary interests and urges. Often events from the dreamer's remote past may be reactivated in the dream and play a vivid role. Sometimes such reactivated experience parallels the original one without much distortion. At other times the dream experience may involve a transposition of earlier and more recent images into a novel and unique pattern of happenings.

In either case, dream content is a product of the dreamer's recent or remoter past and not a foreshadowing of events to come. This is brought out by comparing the dreams of children with those of adults; very young children, for example, are likely to dream of wizards and fairies, and the older child of school examinations and athletic heroes. Children of the destitute are likely to dream of wonderful toys, hungry persons of food, homesick soldiers of their families and prisoners of freedom. The wish is father to the dream as well as to the thought. Desires, worries and tensions may also have a direct bearing on the kind of dream content experienced.

It seems safe to assert that the language of the dream is more pictorial than linguistic. Verbal images do not occur frequently or prominently in the course of dream content. The paucity of verbal content means, of course, that critical analysis or subtle reasoning is not likely to occur in dreams. Language seems to be an almost indispensable tool for such refined mental operations. Because of the restricted role of language in the dream, the thinking of the dreamer is largely limited to that which can be symbolized by nonverbal means.

Structure.—An ordinary daydream is often regarded as a matter of idle association or reverie. The sight of a box of candy, for example, induces one to think of eating between meals, and this recalls visions of parental scoldings for raiding the icebox and this, in turn, reminds one that electrical refrigeration is an improvement over the old-fashioned box, etc. In schematic terms this amounts to saying that the structure of waking association of a random sort follows the pattern of item A arousing B, B eliciting C, C provoking D, etc. Is this type of structure also the structure of the dream pattern? Is the dream merely a sequence of idle associations instigated in a sleeping person by a chance stimulus such as a clanging ambulance bell or a clogged nostril? To find the answer, the pattern of such free association must be compared with those dream patterns resulting from known forms of experimentally controlled stimulation. Examination of hypnotic dreams aroused by simple stimuli demonstrates that dreaming is not merely a matter of free association. Although such stimuli provoke the dream pattern, the relationship between the instigating factors and the resulting pattern of response is not a simple A-B-C-D sequence.

In the dream the instigating stimulus becomes a constituent feature of the pattern, though it is buried within the pattern in such fashion that knowledge of the dream alone is not sufficient to make it possible to identify the antecedent stimulus. It is as if a cause were to be engulfed by its effect. An example of what this means is supplied by the hypnotic dream of one subject who dreamed that he was in a hospital and was visited by his sweetheart who sat down next to his bed and stroked his hand. This particular dream had been touched off when the experimenter stroked the back of the subject's hand with a tuft of absorbent cotton. Here the cotton as cause was experienced toward the end rather than at the beginning of the dream. Another hypnotized subject dreamed that he was dressed in his track suit and running for exercise when he chanced to see a dead horse by the side of the road. In this instance two stimuli had been applied simultaneously: pressure on the sole of the hypnotized subject's shoe along with a whiff of asafetida. The former stimulus was responsible for the idea of running and the latter for that of the dead horse; but both ideas were woven into the pattern of the dream, and even though their provocative stimuli had been presented concurrently the resulting images were not concurrent until the close of the dream.

Dreams as Trial Percepts.—The fact that dreams seem to be characterized by a type of structure in which the consequences of the provocative stimuli come to be constituent features of a larger dream context is of considerable theoretic importance. It suggests that some dreams are to be explained as attempts by the dreamer to account for an ambiguous or dimly apprehended stimulus pattern in terms of whatever backgrounds of experience happen to be touched off by the stimuli in question. This phase of the dream process is analogous to the common, waking experience of being startled by a strange sound while absorbed in a novel. A what-can-that-be attitude, as opposed to the attitude of free association, comes to dominate consciousness. For the time being the novel is relegated to a subordinate position. As the strange sound is repeated, various possibilities suggest themselves: an intruder in the attic, somebody tinkering with a car outdoors, a rattling venetian blind, etc. These possibilities are rejected almost as soon as they occur because the troublesome noise fails to accord with these possibilities. Then the startled reader recalls having set a trap in the attic a few days earlier. The curious noise is now recognized as that of a rat dragging a trap across the attic floor. This interpretation agrees with the unique characteristics of the startling noise and the problem is regarded as solved. It is solved by means of a series of trial percepts brought to bear on the situation.

This utilization of trial percepts may help to account for many dreams. In sleep many stimuli that would evoke immediate recognition on the part of a waking person are blurred or ambiguous because so much relevant sensory material is excluded by the heightened sensory thresholds characteristic of sleep. Only fragments of a given total stimulus pattern are experienced by the sleeper. The what-can-that-be mental set is aroused because of the strangeness of such fractured stimulation. It is like trying to read a book printed with broken type. Imaginative guesswork has to replace clear-cut, facile perception. The dreamer, in other words, being cut off from the world of reality by heightened sensory thresholds, accepts those few sensory fragments that break through to awareness as being the core of genuine happenings interpreted in the light of whatever trial percepts are brought into play. But such interpretation differs from the same process carried out by a fully alert person; for the dreamer fails to recognize the trial or hypothetical character of the series of interpretations. What the alert person knows to be merely a suggestion or a possibility is accepted as actual fact by the dissociated consciousness of the dreamer.

THEORIES OF DREAMS

Dream consciousness, to employ a grammatical metaphor, tends to be in the present indicative. The past, the future, the perfect and the subjunctive are not utilized. For the dreamer the cognitive equivalents of "it might be," "it's as if" or "maybe this is" are largely nonexistent. The dream world is a world of the present in which what happens takes place here and now and in which all hypotheses are facts and all imaginative guesses genuine realities. This also suggests one other respect in which dream consciousness differs from waking consciousness: the optative or wishing mood may play a more exclusive role in the perceptual life of the dreamer. This is to say that often what the dreamer perceives as fact is a product of what he wishes were a fact, or fears might be a fact.

Freud.—Discovery of these optative factors and analysis of their implications can be regarded as the heart of Sigmund Freud's contribution to the psychology of dreaming. His views on the subject were expounded originally in *The Interpretation of Dreams,* first published in 1900. Many critics regard this as Freud's outstanding work, and Freud himself once expressed the opinion that "the most valuable" of his discoveries are to be found in it. An enormous literature grew up in connection with Freud's brilliant approach to the dream problem. (*See* also PSYCHOANALYSIS.)

Freud was primarily interested in the dream as an expression of dynamic trends in the life of the dreamer. It was as though he had asked, "What can this dream mean in terms of this patient's longings, desires, wishes or urges?" An approach of this kind tends to view dreams as products of the optative mood. It is concerned with the assumption that dreams are to be regarded as expressions of balked wishes or frustrated yearnings. Freud regarded the dream as supplying a "royal road" to the realm of unconscious motivation. For him dreams were either actual or attempted wish fulfillments. He conceived of the sleeping person as largely cut off from external stimulation, with the critical functions of waking consciousness also excluded for the most part, so that internal tensions, the repressed but regnant strivings of the unconscious, could find vicarious expression in the symbolism of the dream. A vicarious outlet of this kind, he held, makes its appearance in sleep because the mind's forces of inhibition are also dozing. Illicit impulses consequently would be expected to meet with less resistance from such a somnolent conscience.

In terms of later Freudian theory, this policing function of conscience was attributed to the superego and the source of the illicit unconscious impulses was the id. In brief, because sleep deactivates superego functions, frustrated id impulses have a better chance of expressing themselves in the drama of the dream.

To understand the drama of the dream, as Freud saw it, it is necessary to become familiar with certain distinctions he introduced. The story of a dream as it is told by the dreamer upon awakening is not the whole story nor the real story. Such a story supplies what Freud called the manifest content of the dream. He contrasted this with the latent content of the dream. Freudian dream interpretation thus calls for penetration of the disguise of the manifest content of dream imagery in order to get to the core of latent dream motivation.

Freudian theory attributes certain characteristic dodges to the strategy of id impulses. One of these is condensation or the process of giving expression to more than one impulse by means of a single dream image or symbol. This process is akin to what psychoanalysts sometimes call overdetermination, meaning that a multiplicity of motives may be responsible for a single act or a given symptom. Another of these dodges or dynamisms is that of displacement or the shift of emphasis from a revealing symbol or figure to a neutral one. For a woman to report experiencing a patriotic thrill as she perceived the British flag in her dream might serve as an example of this provided that in the course of her free associations to the idea of this flag she comes to confess a secret love for a Londoner named John. The flag, the Union Jack, would then be interpreted as a disguised expression of her unconscious longing for closer ties with John. What was experienced as a patriotic thrill in the manifest content had been a more personalized, libidinous thrill in the latent stage of its origin. Instead of expressing this erotic longing directly by means of a dream image of John, the impulse was displaced from John to the seemingly harmless image of the British flag. In actual dream interpretation the Freudian analyst thus has to work back from the symbolism of the manifest content to the motivational sources in the latent content.

In doing this he must not only guard against being misled by the distortions resulting from condensation and displacement but also against those caused by what Freud called secondary elaboration. This refers to inaccuracies in the report of the dream as made by the dreamer in order to make the account more coherent or more plausible. In other words, even the manifest content is apt to be distorted in the process of telling about the dream. Significant items may be left out and new ones may be added quite unconsciously as the narrator strives to make his story more dramatic or more plausible. Such secondary elaborations must be recognized and stripped away before the analyst can probe into the unconscious determinants of the dream.

This probing is accomplished by having the patient react to specific items in the manifest dream content with whatever ideas such items chance to arouse. According to Freudian teaching, the resulting train of free associations will expose a track leading to the unconscious tension responsible both for some of the patient's neurotic symptoms and for some of the vagaries of his dream life. Furthermore, as a result of analyzing a tremendous number of dreams, Freud found what he took to be a fairly stereotyped relationship between certain dream symbols and certain unconscious wishes. He then felt justified in speeding up the process of dream interpretation whenever such fixed symbols occurred by decoding them immediately without having recourse to the often tediously circuitous free-association route. The vast majority of these standardized symbols were taken to be expressions of infantile or childish notions of sexuality. Notions of this kind are especially subject to repression because their early manifestation tends to provoke the shocked or horrified disapproval of parents. It does not take the young child long to learn of the strength and sternness of society's code of sex taboos. What he does not dare express simply has to be repressed. It is consequently easy to understand, say the Freudians, why so much of the dynamics of unconscious motivation has to do with impulses harking back to the dawn of sex curiosity. And it is precisely such impulses which Freud regarded as playing such an important role not only in neurotic behaviour but also in dream symbolism.

Critique of Freud's Theory.—There can be no question about the brilliance, boldness and originality of Freud's contribution to the psychology of dreaming. Even though adumbrations of parts of his theory can be found in earlier writers, especially Plato, no previous worker dealt with dream phenomena with such profundity of psychological insight and with such speculative daring. No serious student of such phenomena can afford to neglect these insights and speculations. Almost all modern studies are grounded in them, even those of students who have repudiated or modified the Freudian theory.

Only a bare outline of the more salient points of dream theory controversy can be introduced here. One of these has to do with Freud's idea of stereotyped dream symbols, which is rejected by most competent students. For example, the Freudian idea of the inevitable and certain phallic import of a snake symbol is no longer endorsed. Sometimes, of course, such a symbol may have such import in a particular dream of a particular individual; but not every manifestation of this symbol in the case of any individual's dream is to be linked with phallic implications as a routine interpretation. After all, a snake may be symbolic of deception or of undulation or of the phylum of Reptilia or of the Garden of Eden or a host of other notions, so that to restrict its symbolic significance to representation of the male sex organ exclusively is hardly warranted. Criticism of this sort can be applied to all other allegedly fixed dream symbols.

Freud's technique of getting at motivational determinants by means of free association has also been exposed to criticism. Some critics have called attention to the difficulty of finding out when

to call a halt in the onward flow of the patient's associations. How is one to recognize the terminus of latent content? Others have maintained that even if latent content is reached by such a train of associations, it would not follow that dream formation had taken the same associative pathway in the reverse direction. For example, a woman may dream of a game of cards in which she holds four aces. By means of free association the latter item may induce her to think in successive fashion of the Four Horsemen of the Apocalypse, a eucalyptus tree, a shoe tree, a shoe salesman and, finally, the owner of a shoe store whom she met at a dance some months previously. Let it be further assumed that she admits having found him a very attractive person. Does it follow, the critics of this point ask, that her supposititious desire to "win the hand" of this attractive man expressed itself in the dream by the reverse sequence of associations going from the unconscious desire for the man, to a shoe salesman, to a shoe tree, to a eucalyptus tree, to the Four Horsemen of the Apocalypse and ending with the thrill of holding a hand with four aces? Evidence justifying an affirmative answer to this question has not been supplied to the satisfaction of these critics.

An additional phase of Freud's theory to which many critics objected was his emphasis on unconscious, infantile sexuality as a preponderant source of potent dream instigation. These critics regard such emphasis as decidedly exaggerated. They would enlarge the scope of potential dream motivation to include all of man's lusts, aspirations, ambitions, fears, cravings and strivings. The life of conation, both conscious and unconscious, is not to be compressed within the narrow confines of a child's frustrated sex curiosity.

Freud himself was not unmindful of some of these objections and sought to answer them. His followers no longer accept the early formulation of the theory in its orthodox form. Few, if any, for instance, endorse the doctrine of fixed dream symbolism.

The attack on Freud's theory has been severe, but certain basic features of his formulation seem to have survived adverse criticism. These include Freud's emphasis on the need for a distinction between manifest and latent content; the role of such dynamisms as displacement and condensation; and what may possibly constitute his most penetrating insight: recognition of dreaming as a dramatic projection and distorted expression of underlying personal conflicts. By thus envisaging the dream as a product of motivational tensions Freud paved the way for the development of numerous other so-called projective techniques for studying the complexities of human motivation. These are methods calculated to induce people to reveal their inner preoccupations and personal conflicts by the kinds of stories they invent to account for the meaning of pictures shown to them, by the figures they project into meaningless graphic representations of clouds or ink blots, by what they choose to draw or model when supplied with crayons or clay, or by the way in which children "play house" when manipulating dolls symbolic of a family group. All such methods may be regarded as outgrowths of Freud's teaching regarding the psychological significance of the dream fantasy.

A Bipartite Theory.—It would be misleading to think of every dream as a projection of unconscious personality conflicts. A satisfactory theory of dreams must account for all dream phenomena. As a consequence, the Freudian view requires supplementation.

Dreams may be regarded as products of two sets of factors: (1) the stream of impulses reaching the sensory areas of the brain that chance to spill over the heightened sensory thresholds of the sleeping person; and (2) motivational tensions which, figuratively speaking, are clamouring for expression. By taking account of these two sets of factors it ought to be possible to explain the nature of all dreaming at least in terms of a first approximation to probable scientific fact.

Understanding of this bipartite approach to dream phenomena is facilitated by consideration of one of the above-mentioned projective techniques. When a person is confronted with an ink blot on a sheet of paper and asked what the blot might be or what it makes him think of, two kinds of replies might be forthcoming. By noting the outline of the blot he might find enough resemblance to the coast line of Australia to venture the guess that the blot can be taken to be a map of that continent. Such a response is not so much a projection of his personal troubles as it is a product of his general intellectual background. It is a product of the what-can-this-be type of mental set induced by strange or ambiguous stimulus patterns. It is more or less implicit in every act of difficult perception such as trying to recall what friend a stranger seen on the train resembles or what a strange noise coming from the attic might mean. What a person does under such circumstances is to try out various possible suggestions supplied by his background of relevant experience until he stumbles on something that fits the perplexing pattern. The motivation back of such effort is often little more than intellectual curiosity of the kind involved in solving crossword puzzles, watching a steam shovel operate or reading the headlines of a newspaper. No crucial personality conflicts are revealed by perceptual acts of this sort.

Many dreams can be regarded as products of this kind of perceptual effort induced by the ambiguous nature of sensory patterns experienced by the sleeper. More ambiguity occurs in sleeping than in waking because so much of the total perceptual field is cut off. This truncated stimulus pattern is not easily recognizable precisely because it is a distortion of the familiar whole of waking perception. It is this novel stimulus pattern to which the dreamer responds with the what-can-it-be attitude. The consequent dream formation may be regarded as a series of trial percepts—many of them bizarre—brought to bear on what amounts to a bizarre problem.

The motivational tensions that the bipartite theory would utilize in accounting for dreams may also be exemplified by means of the ink-blot technique. If a dark smudge on the blot were to remind a subject of black despair or of sudden death or of the dark forces of evil or of conspirators whispering in the night, then a different set of psychological factors would be involved. In such a case the subject would be projecting his own worries on to the blot material. Projection of this kind would constitute a species of tension-release for him. What he attributes to the blot would be more a sign of what is going on within him than a description or an explanation of the blot as a visual object.

Under the circumstances it should be clear why trial percepts are closer to perceptual reality than are processes of tension-release. The tenuous nexus between provocative stimulus and tension-release may account for the bizarre character of many dreams. It is akin to the incongruity observable in connection with many everyday emotional outbursts in which worried or irritable people give vent to pent-up feelings which are touched off by annoyances disproportionately trivial as compared with the magnitude of the resulting emotional upheaval.

In the light of the bipartite theory dreams are products of tension-release and of trial perception. Sometimes one set of factors may be responsible for a given dream, sometimes another set, and often both sets of factors may be operating conjointly. These possibilities may be illustrated by the dream of the chemist F. A. Kekulé whose theory of the benzene ring was a product of what Kekulé observed in a dream at a time when he was working on his textbook of chemistry. The writing, he reported,

> did not go well . . . I turned the chair to the fireplace and sank into a half sleep. The atoms flitted before my eyes . . . wriggling and turning like snakes. And see, what was that? One of the snakes seized its own tail and the image whirled scornfully before my eyes. As though from a flash of lightning I awoke. I occupied the rest of the night in working out the consequence of the hypothesis.

The dream had supplied Kekulé with a picture of the benzene ring. It may be presumed that preoccupation with a difficult chemical problem had resulted in the kind of tension that goes with personally significant unsolved problems. It may also be presumed that flickering flames from the fireplace touched off vague visual impressions that gave rise to a trial percept congruent with the dozing chemist's tension. Flickering lights were perceived as dancing atoms. This trial percept was governed by the "wish" to overcome an impasse in his writing. Both motivational and perceptual factors thus can be seen as operative in this dream.

There is no way of telling from direct scrutiny of a given dream whether it was the consequence of a trial percept or a function of

tension-release or whether both factors were involved. To settle questions of this sort the investigator must know more about the inner life of the dreamer than bare knowledge of a single dream can supply.

See also references under "Dream and Dreaming" in the Index volume.

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DREDGES AND DREDGING. The word dredge is derived from a form of the word draw, which refers to the pulling of devices over underwater areas to be excavated. Dredging has four principal objectives: (1) to develop and maintain greater water depths than exist naturally, chiefly for canals, rivers and harbours; (2) to raise the level of lowlands and thus create new land areas and improve drainage and sanitation; (3) to construct dams, dikes and other control works for streams and seashore; and (4) to recover subaqueous deposits or marine life having commercial value, such as precious metals and minerals, shellfish for food and pearls, coral and sponges, sand and gravel, and fertilizer.

The noun dredge (British, dredger) refers herein only to large floating contrivances utilized in underwater excavation engineering; the term dredging is restricted to the procedures used to excavate relatively large quantities of subaqueous materials. Other concepts, including land dredges and special equipment utilized in oceanography, are not treated here.

Dredging is an ancient art. The Assyrians and Chinese used spoon-and-bag devices to clear waterways thousands of years ago. In Italy Leonardo da Vinci devised ways to drain marshes and improve harbours; in Holland large areas have for centuries been wrested from the sea by dredging processes. Henry Emile Bazin of France invented a hydraulic pump in 1836, and in 1867 employed centrifugal dredge pumps in excavating the Suez canal. A suction dredge was built in England in 1861, and a self-propelled hydraulic seagoing hopper dredge was employed in the United States for dredging at Charleston, S.C., in 1855.

Dredge designs have improved along with advances in general technology and have also been promoted by demands of shippers and others interested in improved waterways and water fronts. Early devices were for relatively shallow depths and of small capacity and were operated by the muscle power of men and horses. Devices in one country have often been improved in another, largely because of the characteristics of materials encountered.

Dredges are classed as mechanical and hydraulic. Many special types in both classes, and ingenious combinations of the two, have been devised. A great variety of auxiliary devices (rotating cutters, teeth, scrapers, water jets and disks) have been devised to increase dredge efficiency. Likewise, numerous arrangements have been resorted to for holding dredges in a horizontal position and on an even keel.

Mechanical power for dredges has covered a wide range: boilers (low and high pressure; wood, coal and oil burning), steam engines (reciprocating and turbine), internal-combustion engines (diesel, gasoline and naphtha), hydraulic and pneumatic pressure systems, and electric power from shore. Applications of mechanical energy have generally conformed to existing marine practices. All types of dredges may have living quarters aboard.

BASIC TYPES OF DREDGES

Though dredges have been constructed to remove many kinds of deposits, the bulk of material removed has consisted of sand and mud. Production rates of all types of dredges are governed by the character and depth of bed materials, quality and design of machinery, type and amount of power, distance and elevation of discharge point, operator skill, percentage of solids in mixtures and weather and water conditions. Basic types of dredges are generally recognizable from the nomenclature applied to them, such as dipper, grab, ladder, scraper and hydraulic. There are classes within types, and adaptations and combinations of different basic types. Sizes are usually designated as follows: for dipper, grab and scraper dredges, the volume of excavating container; for ladder dredges, the number and volume of individual buckets; for pipeline dredges, diameter of pump discharge; for hopper dredges, total load-carrying volume of hoppers in cubic yards or tons.

Selection of the proper dredging plant for efficient and economical production under a great variety of conditions requires experience and sound judgment. The dipper dredge is capable of excavating practically all classes of material, except hard rock, at 50-ft. depths. The grab dredge, by virtue of its construction, can dredge at great depths. The bucket ladder dredge is favourably adapted for work within the limit of its ladder length for nearly all materials, and for preparing a level bottom. It is popular in Europe and Asia. Dredges of this design have excavated at depths exceeding 100 ft. The scraper dredge is most useful on projects where a long outreach is needed. When the discharge point is reasonably close to the excavation point, and materials are dredgeable hydraulically, the suction-type dredge is usually selected. Whether of pipeline or hopper arrangement, this type of dredge is superior in performance and unit operating cost when large quantities of soft material are involved. Seagoing hopper dredges of the hydraulic class are most efficient for work in exposed or rough sea locations.

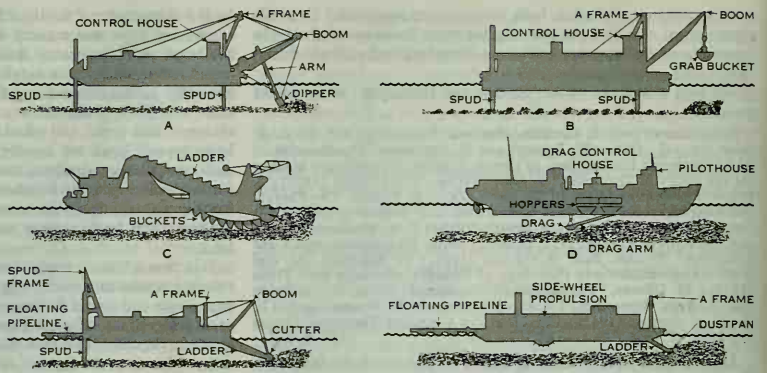
Dipper Dredge.—This dredge is essentially a power shovel mounted on a barge for marine use. Its origin is credited to William S. Otis in 1837. Distinctive features are the bucket and its arm, the boom which supports and guides the arm and is mounted to work around a wide arc and the mechanism that gives excavating movement to the bucket. In operation the dipper is "crowded" into material to be excavated; normally, spoil is dumped into scows for towing to disposal sites. The bucket has a hinged bottom or trap door, which is released to dump a load. To counteract digging reaction, the dredge is usually pinioned to the bottom by large stakes called spuds, and may be only partially water-borne. The dipper dredge will excavate almost any material except solid rock, but is limited in depth by the lengths of boom and dippper arm. Dipper teeth may be added for disintegrated rock and conglomerate masses. The entire dredge must be ruggedly built to withstand severe operating stresses.

Grab Dredge.—This type is also called a grapple, clamshell, orange peel or bucket. It lowers, closes and raises a single bucket by means of flexible cables. It is, in essence, a barge-mounted derrick. In operation the bucket is dropped to the bottom in opened position and bites because of its weight and the action of the bucket-closing mechanism. Some have one line while others operate with two (one each for closing and hoisting). Dredgings are discharged by releasing the bucket-closing line. When constructed in two halves, the bucket is called a clamshell; when consisting of more than two parts, it is referred to as an orange peel; when tongs are used, it is called a grapple. The greatest advantage of the dredge is that the depth to which it can work is practically unlimited. It can also operate in restricted areas. The chief disadvantages are that it leaves an irregular bottom, and the bucket may spin, thereby fouling the lines. Boulders weighing up to 70 tons were excavated by grab dredge at Hell Gate, N.Y.

Ladder Dredge.—The characteristic feature of this type of dredge, also called an elevator, is a continuous chain of buckets rotating around a rigid adjustable frame called the ladder. When the ladder is lowered into operating position the buckets descend empty along the underside of the ladder; at the bottom position the bucket lips dig into material as the chain turns, and the loaded buckets ascend along the upper side of the ladder. As each bucket turns at the uppermost position preparatory to descending,

it spills its contents by gravity into a chute (British, shoot), which, in turn, may be used to direct disposal of the spoil. It may be directed into the vessel's own hopper for transport to the dump area, and the vessel is then known as a seagoing hopper dredge in regions where operated. It may be directed into a barge or scow located alongside, to be towed away or pumped through a pipeline leading to the disposal area. Revolving members at the ends of the ladder are called tumblers; normally, the top tumbler, through gearing, drives the chain of buckets. The conventional ladder is hinged at the top of a high structure and extends downward through a well in the dredge hull at an angle of about 45°.

The lower end of the ladder is supported by cables that serve to adjust dredging or to elevate the ladder above the water surface.



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DRAWING OF DREDGES IN WORKING POSITIONS

(A) Dipper dredge with spuds lowered and dipper in excavating position; (B) grab dredge with spuds lowered and bucket in raised position; (C) bucket-ladder dredge in dredging position; (D) suction-type seagoing hopper dredge with drag lowered to dredging depth; (E) cutterhead hydraulic dredge with spud lowered and ladder in position for excavation, showing floating pipeline through which mixture of material is discharged by means of large centrifugal pump; (F) shallow-draft dustpan hydraulic dredge in operating position, showing floating pipeline which enables vessel to discharge hydraulic mixture to distant point

Many European bucket ladder dredges are of seagoing type and are used for work in exposed locations. In the United States this type of dredge is used principally for mining and for the recovery of sand and gravel for construction purposes; in the latter case, screening and cleaning equipment is located on the vessel, while unwanted materials pass overboard. Experimental gold dredges of the ladder type introduced into Australia and New Zealand in the 1860s were improved for similar use in California and Alaska. Mining dredges initially worked in river bottoms but they may operate away from streams, carrying ponds or lagoons along as they advance. Rubber conveyer belts are used with mining dredges for stacking rock tailings. The efficiency of the ladder dredge depends on the capacity and number of buckets, the speed of the buckets over the tumblers and the dredging depth, in addition to factors inherent in the machinery design and type of prime mover and the efficacy of disposal methods. A disadvantage is that loose material tends to wash out of the moving buckets.

Scraper Dredge.—The scraper dredge, also called a dragline, handles material with a scoop suspended from a swinging boom. The scoop is drawn forward by a line attached to the front, while a second line attached at the rear holds the scoop at the proper angle to slice the earth away as the device is pulled along. When filled, the scoop is lifted to the peak with both lines taut. After being swung around to a desired position, the scoop dumps automatically when the drag or hauling line is released.

Hydraulic Dredge.—A dredge of this type, also called a suction dredge, makes use of airtight suction piping and a centrifugal pump. In the pump casing an impeller, by its action, draws from the bottom and expels by centrifugal action a mixture composed of solids, water and gases. As a partial vacuum is created within the pump, atmospheric pressure on the outside water surface acts to force water through the only available route, the suction pipe. As the water rushes through the mouth of the drag, it carries in quantities of solid particles. Single or multiple pump installations are in use. Hydraulic dredges have successfully handled solids up to 20% concentration, depending upon the "voids ratio" of materials. In Europe, where loose material is encountered and ground profile is not important, a cutterhead may not be needed; in the United States cutters are required for the bulk of new-work hydraulic dredging because of soil characteristics. Several forms of suction dredges have been developed, but all utilize the hydraulic principle, namely a centrifugal pump, the inlet to which is at the centre of rotation and the discharge of which is at the casing periphery. The basic form, with plain or slightly modified drag opening, is used throughout the world, but three distinct varieties have been evolved in the United States—the cutterhead, the dustpan and the seagoing hopper dredge.

The cutterhead dredge has a rotating cutter installed at the outer end of a movable frame called the ladder. The cutter is actuated by a shaft that runs the length of the ladder. Also installed on the ladder is a suction pipe which leads from just behind the cutter to a centrifugal dredging pump inside the hull. Compacted material released by cutter action forms a mixture with surrounding water, and is then handled hydraulically through a pipeline leading to the disposal area. Control of the dredge is by lever, push button or switch from a central vantage point. Some dredges of this type are self-propelled; small ones are portable. Monthly production rates range from about 20,000 cu.yd. of solids for a 6-in. dredge to over 200,000 cu.yd. for a 16-in. dredge working 24 hours a day. Pipelines may vary in length from a few hundred feet with a 6-in. dredge for handling heavy material to several miles with a 30-in. dredge handling lighter material. A cutterhead dredge operating in the Panama canal lifted material a height of 137 ft. with the aid of booster stations.

The dustpan dredge was developed under the auspices of the Mississippi River commission during the period of 1891–96 for quick removal of large deposits of alluvium, principally where sand bars accumulate at crossings (where the natural channel shifts from near one bank to the other). The typical dustpan dredge is self-propelled for rapid transfer between work sites, but having once been placed in dredging position, it operates much the same as other stationary dredges. The suction opening at the lower end of the ladder is greatly expanded horizontally to form a dustpan that may be up to 36 ft. in width by 1 ft. in height. Hydraulic features are quite large (up to 34 in. in diameter) in order to move large quantities of material quickly. Multiple high-velocity water jets located in the suction head loosen material being attacked. Otherwise, except that floating discharge line only is used, the functioning is similar to that of a cutterhead-type hydraulic dredge. Spoil is deposited in shallow areas at considerable distances (up to 1,000 ft.) from the dredging site to minimize the drifting back of the material into the marked navigation channel. The dustpan ladder extends forward during dredging. As a rule, dustpan dredging is done on falling river stages, where low water depths are expected to be deficient. Some are radial feeding; others have swinging ladders.

The seagoing hopper dredge of the hydraulic type has been developed almost exclusively by the U.S. army corps of engineers. Normally it operates within navigable rivers and harbours, and

goes to sea only for dumping purposes or to navigate between ports. It has the molded hull and lines of a self-propelled ocean vessel and is equipped with special apparatus and machinery for removing material from a channel bottom or ocean bed and carrying it in compartments called hoppers to another location for disposal. Hinged-leaf, conical and cylindrical hopper doors or opening devices are power operated. Hopper dredges of American design raise spoil by large centrifugal pumps, by which bed material is mixed with water and drawn upward through large tubular drag arms, while the drags maintain contact with the bottom. The mixture is discharged into hoppers where the solids settle and excess water passes overboard via troughs. After a load is obtained, the drag arms are raised and the vessel proceeds at a relatively high speed to a disposal site where, usually, the spoil material is released through bottom-dump doors. After the hoppers are emptied and the bottom doors closed, the ship is returned to the dredging area to repeat the cycle of operation.

Material is usually deposited into deep water to ensure permanent removal, although some dredges of this type are equipped for repumping material, either directly or through a separate rehandler into which the hopper dredge first disgorges its load. Hopper dredges built in the United States have trailing drag arms (over the stern, at ship's side or through a centre well) and move ahead at an average dredging speed of from two to three miles an hour. Also, they have pilothouse control and twin screws and rudders, and are cut away aft to improve maneuverability. The advantages of this style of dredge are: (1) it can work effectively, safely and economically in waters exposed to the open sea; (2) it can transfer quickly, at low cost, to other dredging sites; (3) it does not interfere with or obstruct navigation; (4) it quickly improves the entire dredging area because of removal of successive layers from shoal; (5) it is independent of delays from inoperable attendant plant; (6) it can usually make a central cut to induce natural scour; (7) it discourages spot shoaling by making a series of long shallow cuts; (8) it can be used for agitation dredging, with or without filling hopper, if material is slow settling; (9) it requires no expensive upland spoil-discharge area. A disadvantage is that the actual dredging is interrupted to go to the disposal area. Hopper dredge operations have been greatly improved by such steps as the unwatering of the hoppers (to minimize dilution), installation of gas ejectors (to prevent choking of the pump because of excessive quantities of entrained gas) and determining the most economic loading time. Economic loading of hopper dredges is based on the determination of that pumping time which, in each case, results in removal of the maximum amount of spoil material in a given time. Involved are times for loading, turning, traveling to and from the disposal area and dumping. Proper selection of drag from several available designs (fixed, adjustable and self-adjusting) contributes toward more effective results. The combined area of drag opening is about four times the cross-section area of suction pipe.

AUXILIARY APPLIANCES AND ATTENDANT PLANT

Dredging operations often require the employment of attendant plant, such as tugboats for maneuvering nonself-propelled dredges and the spoil containers, and rehandlers or boosters in pipelines. Nonself-propelled dredging equipment requires a power vessel to get into and from dredging sites.

Supplementary items that may be required in connection with operating dredges (except those of hydraulic seagoing hopper type) are scows or barges (towed or self-propelled; self-dumping or clammed out), pontoon-mounted sections of discharge pipeline, anchor barges, elbow barges, end barges, quarter boats (if no crew accommodation exists otherwise), fuel and water barges, supply tenders, personnel launches and sounding equipment. Several kinds of built-in spuds (bank, digging, walking) are used to hold stationary dredges in place while working; in addition, anchors, piling and winches are extensively utilized to swing or position dredging plant. Pipeline sections are joined by rigid flanges, flexible rubber sleeves or steel ball joints. In dealing with removal of underwater hard rock, British engineers employ rock breakers (heavy pointed bars or chisels for dropping until shattering occurs); U.S. engineers almost always use drill boat and blasting charges for this work.

SURVEYS AND SUPPLEMENTARY ENGINEERING

Surveys are an integral part of dredging. They include the making of hydrographic surveys to determine water depths at precise locations, gauging tidal heights and velocities, sampling of material in channel beds and positioning buoys to mark a dredging area. Topographic survey work involves sextant targets, shore-based ranges and shore-line features. Disposal areas may be designated in deep or shallow water or ashore, depending upon the type of dredge, availability of space, economy considerations and permanence of retention. Structures such as dikes (including sheet piling, for retaining solids), sluiceways (for runoff of excess liquid) and trestles (if required) are constructed as adjuncts to disposal ashore by pipeline dredge. The foregoing data are shown on maps and described in specifications prepared for proposed work. After the site has been explored and the work laid out, plant is assembled and the actual dredging begins. It is desirable to place a resident inspector on the job to ensure compliance with dredging specifications, for numerous details, aside from operating dredging machinery, require attention (sampling, testing, soils data, dredging aids, measurements, computations, reports, supply and personnel problems, and related items). When solids are stirred up intentionally, or are pumped overboard after economic loads have been obtained, and these solids drift away through current or tidal action to be deposited outside the channel in quantities that are beneficial, the operation is called agitation dredging. Influencing factors are the settling rates of solid particles, velocity and direction of current, stage and set of tide and littoral drift. Agitation dredging should not be performed if conditions would cause stirred-up material to return to the project area or to where future excavation is planned.

DETERMINATION OF WORK DONE

Surveys showing conditions before and after dredging are used to compute place measure of the work performed. Modern depth sounding and computations of quantities of material may be accomplished electronically. Material moved may also be measured "in the loose" by determining the amount of solids actually issuing from the dredge, either from known capacities of floating containers or by surveying the spoil deposited. Various rules of thumb have been employed to learn the performance of a dredge at any given moment, such as watching the rate at which buckets travel over a ladder, counting the dips or grabs per hour or estimating the velocity and concentration of solids flowing from a pipeline. Compacted *in situ* material may expand 50% in handling. An instrument known as a yardage meter, based on displacement changes, gives instantaneous readings of loading on American hopper dredges.

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DRED SCOTT DECISION, a decision by the U.S. supreme court announced on March 6, 1857, that added fuel to the bitter sectional controversy over slavery and pushed the nation further along the road to civil war. The opinions of a majority of the justices covered three main points: (1) Negroes were not citizens and therefore could not sue in the federal courts; (2) a slave's residence in a free state did not make him a free man; (3) the Missouri Compromise of 1820, which had forbidden slavery in that part of the Louisiana Purchase (except Missouri) lying north of latitude 36° 30′, was an unconstitutional exercise of congressional power.

The decision concerned the status of an illiterate Negro slave, Dred Scott, who was purchased in 1833 by a U.S. army surgeon, John Emerson. In 1834 he was taken by his master from Missouri, a slave state, to Illinois, a free state. He was later taken to Ft. Snelling in the northern part of the Louisiana Purchase. Emerson returned to St. Louis with Dred Scott in 1838. In 1846, with the help of antislavery lawyers, Scott sued for his own and

his family's freedom in the Missouri state courts on the ground that his residence in a free state and a free territory had made him a free man. The Missouri supreme court ruled against Scott and the case was eventually taken into the federal courts. Scott's owner by this time, Emerson having died, was a citizen of another state, John F. A. Sanford of New York. (Sanford's name was incorrectly spelled in the official record as "Sandford" and the case is usually cited as *Dred Scott* v. *Sandford.*) Scott claimed that as a citizen of Missouri he was entitled to sue a citizen of another state in the federal courts.

Each member of the supreme court wrote a separate opinion. Most agreed wholly or in part with the opinion written by the chief justice, Roger B. Taney, and his opinion is usually referred to as the opinion of the court. Taney declared that Dred Scott was not entitled to sue in the federal courts because he was not a citizen as that term was understood at the time the constitution was adopted. The case might have been dismissed on this narrow ground but Taney went on to make certain further observations (*obiter dicta*) about the case. He asserted that Dred Scott had not become a free man by virtue of his residence in territory declared free by the Missouri Compromise because in passing that legislation congress had exceeded its constitutional powers. (The Missouri Compromise was no longer on the statute books as it had been repealed by the Kansas-Nebraska act of 1854.) According to Taney, congress had no power to forbid slavery in the territories because slaves were property and property rights were protected by the constitution. This was the first time since *Marbury* v. *Madison* (1803) that the supreme court had declared an act of congress unconstitutional. Taney's opinion stated that Dred Scott was still a slave because the courts of Missouri, where he lived, had so ruled.

The Dred Scott decision dealt a serious blow to the antislavery forces that had hoped to keep slavery out of the territories, and particularly to Sen. Stephen A. Douglas' doctrine of "popular sovereignty" by which the residents of a territory were to be free to decide for or against slavery. Republican newspapers denounced the decision and spoke of the mounting danger of the slaveholding interest, while Democratic papers generally defended the decision. Though Chief Justice Taney and his colleagues had hoped by their decision to put the slavery issue to rest, they actually fanned the flames of sectional conflict. As for Dred Scott, the pawn in the case, he was freed by his owner soon after the decision and earned his living as a hotel porter in St. Louis until his death on Sept. 17, 1858. After the American Civil War ended, the questions at issue in the Dred Scott case were settled by the 13th amendment to the federal constitution that freed the slaves and the 14th amendment that made them citizens.

See V. C. Hopkins, *Dred Scott's Case* (1951); Charles Warren, *The Supreme Court in United States History,* rev. ed. (1937). (H. C. T.)

DREES, WILLEM (1886–), Dutch statesman and Socialist leader, prime minister from 1948 to 1958, was born in Amsterdam on July 5, 1886. Educated at a commercial school, he was appointed stenographer to the Netherlands states-general (parliament) in 1907. He entered politics by joining the Labour (Social Democratic) party and was elected member of The Hague municipal council in 1913 and of the lower chamber in 1933. From 1939 he was chairman of the Labour group in the lower chamber. When the Germans occupied his country in World War II, he contacted other leaders of the forbidden political parties to organize resistance, but was soon arrested and sent to the Buchenwald concentration camp. Released in 1941, he rejoined the resistance and presided over the Vaderlandsche Comité which had to prepare the first governmental measures after liberation. After the German capitulation in 1945 Drees served as minister of social affairs in the governments of Willem Schermerhorn (1945–46) and Louis Beel (1946–48). In 1946, meanwhile, he and Schermerhorn, a left-wing Liberal, had combined to form a new Socialist party, the Party of Labour. On this party and on the Catholic People's party his successive governments from Aug. 6, 1948, to Dec. 12, 1958, mainly relied. As minister of social affairs in his first government he promulgated a series of laws and regulations on labour conditions and social insurance. As prime minister he was chairman of the Round Table conference which granted independence to Indonesia in 1949. At home his aim was to build a welfare state; in foreign affairs he firmly adhered to the Atlantic alliance. In a debate over new tax proposals the Catholic People's party broke the coalition in 1958 and this ended the political activity of Drees. (F. DE J.)

DREISER, THEODORE (1871–1945), U.S. author distinguished for his realistic novels of tragic lives, was born at Terre Haute, Ind., on Aug. 27, 1871. The son of a German immigrant who after an initial success in the new world had failed in business, Dreiser was reared in poverty. His later fascination with fine clothes and other success symbols, as well as the dread of hunger and cold that pervades all his writings, have their roots deep in his childhood experience. Because his father was an ardent Catholic, Dreiser was sent to parochial schools until he was 14. A brief attendance at public schools in Warsaw, Ind., and a year (1889–90) at the University of Indiana concluded his formal schooling. For a dozen years Dreiser was a newspaperman in Chicago, St. Louis, Pittsburgh and New York, and a free-lance magazine writer of sufficient renown to be included in the first edition of *Who's Who in America* in 1899. Through the influence of his brother, Paul Dresser (*sic*), the composer of many popular songs of the day, including "My Gal Sal" and "On the Banks of the Wabash," Dreiser also served for a time as editor of the magazine *Ev'ry Month,* put out by a sheet music publisher.

In 1900, on the recommendation of Frank Norris, the publishing firm of Doubleday contracted to bring out Dreiser's first novel, *Sister Carrie.* For some reason—probably the horror of Mrs. Doubleday—the publisher changed his mind about the book, printed only 1,000 copies and made no effort to promote it in any way. The psychological effect of this disappointment drove Dreiser into a nervous breakdown and the contemplation of suicide. When he regained his health, he went back to magazine work, becoming by 1910 the $10,000-a-year editor of the Butterick "Trio" of women's magazines. But with the publication of his second novel, *Jennie Gerhardt,* in 1911, Dreiser decided to devote himself entirely to writing. In 1912 he brought out *The Financier,* first of a trilogy of novels about a business superman whose career in many respects resembled that of Charles T. Yerkes, the street-car magnate. The second of the series, *The Titan,* followed two years later. In 1915 came *The "Genius,"* a novel which reflects both autobiography and an unguarded enthusiasm for Nietzsche. It aroused a tremendous critical controversy, culminating with an effort by the New York Society for the Prevention of Vice to intimidate the publisher into withdrawing the book. H. L. Mencken, despite his dissatisfaction with the novel, rallied to Dreiser's defense and circulated a petition of protest that was signed by such writers as Willa Cather, Robert Frost, Ezra Pound and Edwin Arlington Robinson. *A Traveler at Forty* and *A Hoosier Holiday,* long volumes of travel description, philosophical reflection and nostalgic memory, were also results of Dreiser's amazing productivity during this period. With *The Hand of the Potter* (1918) he ventured into playwriting, but could not find a producer; and a 1921 production by the Provincetown Players was not a success. *Free, and Other Stories* (1918), his first collection of short stories, included two of his finest, "The Lost Phoebe" and "The Second Choice." In the years 1919–29 he continued to write in the variety of forms with which he had previously experimented: travel book, autobiography, philosophical essay, short story and novel. *Twelve Men* (1919), a collection of vigorous sketches of men whom Dreiser had known, is perhaps his most interesting venture into autobiography and deserves to be better known. *An American Tragedy* (1925), based on the Grace Brown murder case, brought Dreiser wider recognition as a novelist than he had ever before known. Dramatized by Patrick Kearney, the novel became a Broadway hit, and Hollywood twice made a film of the book. Between *Tragic America* (1932), a social commentary, and *America Is Worth Saving* (1941), a plea for isolationism, no book came from Dreiser's pen. Two posthumous novels, *The Bulwark* (1946) and *The Stoic* (1947), the third of the businessman trilogy, were Dreiser's final literary testaments.

In 1917, Mencken said of Dreiser's writing that it "often takes

on the character of an actual siege operation, with tunnelings, drumfire, assaults in close order, and hand-to-hand fighting." Dreiser was, said Mencken, "the Hindenburg of the novel." (*A Book of Prefaces,* New York, Alfred A. Knopf, Inc.) But if Dreiser's style was massively clumsy and his diction often trite, he understood supremely well the psychology of the outsider in the rising American cities, his loneliness, his desires, and the cost exacted of him for the realization of his dreams.

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(K. S. LN.)

DRENTHE, a province of the northeastern Netherlands, is bordered northwest by Friesland, south and southwest by Overijssel, southeast by Germany, north and northeast by Gronigen. Area 1,011 sq.mi. Pop. (1957 est.) 301,814, mostly rural.

In contrast with the marshlands farther north, the province forms a low plateau, mostly between 30 and 60 ft. high but reaching nearly 100 ft. in the ridge of the Hondsrug in the east. The plateau surface is ground moraine and fluvioglacial deposits, mostly coarse sands; alluvium covers the valley floors and raised bogs occupy large areas in the south. The streams are short and flow in shallow valleys; much of the drainage, even outside the peat, is canalized. The southern streams are all collected at two points on the southern borders—Meppel and Coevorden—whence they communicate with the Zwarte Water and the Vecht respectively by means of the Meppeler Diep and the Coevorden canal. The Steenwijker Aa, however, enters the Ijsselmeer independently. The northern rivers all flow into Groningen.

Prehistoric settlement on the plateau began early. Mesolithic occupation sites existed at Anlo, Diever and Oosterwolde. Neolithic colonists brought agriculture to the area and erected at least 54 megalithic structures (*hunebedden*); they also planned many trackways and built wooden causeways over boggy areas. Agriculturalists of this and later periods cut much of the existing open woodland and thus extended the area of heathland. Agricultural activity continued in the succeeding Bronze and Iron Ages, though the climate was drier and settlement probably less dense. Some Iron Age (La Tène) fields still remain.

Saxon invasions came in the 5th and 6th centuries A.D., and the area was later governed by counts under the Frankish and German kings. Between 1046 and 1522 the countship was part of the bishopric of Utrecht, but in 1536 it was incorporated in the Habsburg dominions. Although it took part in the revolt of the Netherlands, Drenthe was not separately represented in the states-general until 1796. The province was under French rule between 1795 and 1813 and was occupied by the Germans between 1940 and 1945.

During the middle ages population on the heathlands remained low and settlement scattered. Wolves and other wild beasts were not eliminated until 1800. Rye was the chief grain crop, but potatoes were of increasing importance from the 18th century. Cattle and horses were kept in limited numbers on the valley pastures and flocks of poor-grade sheep grazed the heathlands. In the 19th century systematic attempts to convert heathlands to agricultural use increased, using heavy dressings of urban compost. Three new settlements were established for paupers, the largest being Frederiksoord, and four for criminals; *e.g.,* Aardsche Veld. Reclamation continued irregularly from that time; in 1926 the Zwindersche Veld between Coevorden and Hoogeveen was enclosed.

The flocks of sheep have disappeared, and cattle and swine are the chief livestock. Mixed farming, with rye as the principal grain, remains general. Milk products are important and dairy factories have been established in many villages. One-sixth of the area, chiefly lowland, is in market gardens or orchards. Much of the heathland reclaimed after the end of the 19th century has been laid to grass. Nearly one-third of the surface of the province is still *Calluna* heathland, covering large areas with little interruption, as in the Ellertsveld. Some heath is in reservations, near Dwingelo, some in military training grounds. Afforestation, begun privately before 1800, and after 1905 under provincial control, has been considerable.

Raised bogs (*hoogveenen*) cover substantial areas of Drenthe, though less than in Groningen to the east. Turfs were being cut for sale by monastic houses as early as 1193, but medieval interest in the bogs was confined to unregularized peat cutting for fuel. Attempts to cut all the peat from an area and convert it to agricultural use began later—at Ruinerwold and Hoogeveen in the 17th century, Smilde and Hijkershulde in the 18th and at least nine different districts in the 19th. The 19th-century pauper colonies reclaimed bog at Veenhuizen, the convict settlers at Vledderveen. Whereas on the southern border of the province the former peat bogs (*veenkoloniën*) have been converted into grassland, those on the eastern and western sides of the plateau are arable land, with rye, oats and potatoes as the principal crops. Only in the extreme southeastern corner of Drenthe is the digging of peat carried on.

Drenthe has a long tradition of cottage industry; *e.g.,* spinning, weaving and ropemaking. Processing agricultural products was by 1960 the chief industry and was widely distributed; potato flour and strawboard are two important products. Meppel, the port of Drenthe, has shipbuilding and pharmaceutical chemicals, Hoogeveen aluminum products and ceramics, Assen clothing and printing. Emmen is being developed as a "new town" with nylon, chemical and timber industries. Oil deposits, found near Oud Schoonebeek in 1944, produce more than 1,000,000 metric tons annually.

(J. T. C.)

DRESDEN, a city of Germany which after partition of the nation following World War II became capital of Dresden *Bezirk* in the German Democratic Republic. Prior to 1952, it was capital of the former *Land* of Saxony. It lies in the broad basin of the Elbe river between Meissen and Pirna, 111 mi. S. of Berlin by rail. The estimated population in 1959 was 493,515.

Dresden was once called "Florence on the Elbe" before the widespread destruction sustained during the war and was numbered among the most beautiful cities in the world, noted for its architecture and great art treasures. On Feb. 13, 1945, the city was devastated by phosphorus and high-explosive bombs. Since then it has been to a great extent reconstructed, with modern buildings, broad streets, squares and green open spaces, while as far as possible the character of the old town has been preserved. This baroque city is spread along the Elbe valley, to the north of which are the Lössnitz ridges, the woods of the Dresdener Heide and the steep slopes of the Lausitz (Lusatia) granite plateau, while to the south are the foothills of the Erzgebirge. The sheltering hills contribute to the mild climate; the average annual temperature is 50° F. North of the river, on the right bank, is Neustadt (so-called "new town" but really the older part), and to the south is Altstadt ("old town") with old and new suburbs. Four road bridges and a railway bridge connect the two parts of the town. The central bridge was the Augustusbrücke, originally built in 1727–31 but now superseded by a wider one called the Dimitroff bridge. The centre of the old town is still the Altmarkt, which retains the characteristic silhouette of its towers, and the Postplatz, Pirnaische Platz, Pragerstrasse, Wiener Platz, the Neumarkt, Theaterplatz, Neustädter Markt and the Strasse der Befreiung (formerly Haupstrasse of Neustadt) remain important points in the city's layout.

Dresden's churches suffered severely during World War II. The Frauenkirche (1726–43) with its cupola, built by George Bähr, was almost totally destroyed but has been included in the plan for Dresden's reconstruction. Many notable churches have been restored. These include the rococo Hofkirche with its slender tower nearly 300 ft. high (built by C. Chiaveri 1739–51), the twin-towered Sophienkirche on the Postplatz, the baroque Dreikönigskirche in the new town and the Kreuzkirche on the Altmarkt where, besides regular church services, the concerts of the famous Dresden Kreuzchor take place.

Many historic secular buildings were also damaged. Among these was the Georgenschloss, the former royal palace in the Altstadt, built in 1530–35 by Duke George the Bearded and thoroughly restored between 1890 and 1902 in German Renaissance style. The George gate (Georgentor), also damaged, was

COURTESY OF PRESSE-UND INFORMATIONSAMT DER BUNDESREGIERUNG

VIEW OF ALTSTADT ("OLD TOWN"), DRESDEN, GER., FROM THE RIGHT BANK OF THE ELBE SHOWING HOFKIRCHE TO THE RIGHT OF THE DIMITROFF BRIDGE AND FRAUENKIRCHE TO THE LEFT

widened to allow vehicular traffic to pass through it and beneath the royal apartments from the centre of the town to the Augustusbrücke. The whole is surmounted by a lofty tower (387 ft.), the highest in the city.

Dresden has several world-famous museums and galleries. The Zwinger, originally planned by M. D. Pöppelmann as forecourt for a castle, houses a number of valuable collections including pewter and porcelain. There are zoological and mineralogical museums and a room containing instruments used in mathematical and physical science. In the open space north of the Zwinger a Renaissance style building was erected in 1846, the exterior of which is adorned by statues sculptured by E. Rietschel and E. J. Hähnel of Michelangelo, Raphael, Giotto, Dante, Goethe and other famous artists and poets. This building, the Semper gallery, was destroyed in 1945 and reopened in 1960, the 400th anniversary of the foundation of the Dresden art collections. It contains Dresden's famous pictures, among which are many great paintings of the Italian, Dutch and Flemish schools. The gem of the collection is Raphael's "Madonna di San Sisto" for which a room is set apart. This and other art treasures, taken by the Russians in 1945, were returned ten years later. There are famous paintings by Correggio, Titian, Paolo Veronese, Andrea del Sarto, Rubens, Van Dyck and Rembrandt as well as those of many modern painters. The chapel of the Georgenschloss contains pictures by Rembrandt, Nicolas Poussin, Guido Reni and Annibale Carracci. The Japanese palace, overlooking the river from the north bank, formerly housed a library of 3,000 manuscripts and 20,000 maps. It now houses collections of coins and porcelain, including pieces from the far east, Sèvres and Meissen.

Dresden is also a city of music with a great operatic tradition. Both Weber and Wagner conducted there where operas by Richard Strauss and others had their first performances. The opera house was completed in 1878 in the Renaissance style according to G. Semper's design. It stands on the western side of the Theaterplatz overlooking the river.

The city has a long tradition of learning, particularly in the scientific and technical fields. The technical college, destroyed in World War II, has been rebuilt and much expanded. Other colleges in the city are for the study of music, medicine, plastic arts and transport. There are a teachers' training college and a celebrated academy of painting. The Central Institute for Nuclear Physics is not far from the town. The Deutsche Hygiene museum has an international reputation, particularly for its manufacture of transparent plastic anatomical models, which are exported all over the world.

Parkland, wooded on the northern bank, and many public and private gardens contribute to the city's beauty. There are also several historic parks, notably the Grosser Garten, southeast of Altstadt. In this park, which was laid out in 1676 by John George II, are the botanical and zoological gardens, and in the centre of it stands the Lustschloss built in 1670–80. The Freilicht-theater ("open-air theatre"), completed in 1956, is also there. The hunting lodge Moritzburg lies 8 mi. N.W. of Dresden, surrounded by small lakes. The city has sports grounds and swimming pools.

Industry and Communications.—The city's industry developed only in the middle of the 19th century but expanded greatly after World War II. There is no heavy industry but a wide variety of goods are manufactured, including precision tools and optical instruments, radio and electrical equipment, electrical transformers and X-ray apparatus, sewing and adding machines, typewriters, cigarettes, cardboard and foodstuffs. There is extensive market gardening, and camellias, azaleas, rhododendrons and roses are cultivated for export. The industry with which Dresden's name is primarily connected, however, is the manufacture of china, especially figurines. Known as Dresden or Meissen china, the industry originated in Dresden but was removed to Meissen, 15 mi. N.W., in 1710. (*See* POTTERY AND PORCELAIN.)

Dresden lies at the centre of an extensive railway system, which places it in communication with the chief cities of northern and central Germany as well as with the southeast. It is a junction on the grand trunk lines Berlin-Vienna and Wroclaw (Breslau)-Görlitz-Dresden to Karl-Marx-Stadt. The Elbe connects directly with the inland waterway system as far as Hamburg and into Czechoslovakia. The Nürnberg-Hof Autobahn divides, north of Dresden, into two branches leading to Görlitz and Berlin. Services of the German Democratic Republic's *Lufthansa* operate from the airport, Dresden-Klotzsche.

HISTORY

The Dresden area was once a settlement of Slav villages, one of which, on the right bank of the Elbe, was called Dresdany, meaning "forest dwellers on the plain." The town on the left bank was founded by Margrave Dietrich as a German colonial town. Although, in fact, of earlier origin, the Slav village came to be known as Neustadt, and the later Germanic settlement as Altstadt. The first authentic mention of the town Dresden is in 1216. Decisive factors in the choice of position for the settlement were the ford over the Elbe, which was part of a trading road, the flood-free situation, the natural protection afforded by lakes and ponds and the development of trade and mining in the Erzgebirge. There is no reliable reference to a bridge over the river, however, until 1287. It became the capital of Henry the Illustrious, margrave of Meissen, in 1270, but for some time after his death belonged first to Wenceslaus I, king of Bohemia, and next to the margrave of Brandenburg. Early in the 14th century it was restored to the margrave of Meissen. On the division of Saxony in 1485 it fell to the Albertine line. Having been burned almost to the ground in 1491, it was rebuilt, and in the 16th century it became a capital town and the fortifications were begun. Dresden accepted the Reformation in 1539. The fusion of old and new Dresden took place between 1680 and 1700. In the 17th century John George II greatly improved the town; it took on its baroque character in the first half of the 18th century, when Augustus I and Augustus II, kings of Poland as well as electors of Saxony, modernized it. The Neustadt, which had been burned down in 1685, was founded again by Augustus I on a plan designed by Wolf Kaspar Klengel. He also founded Friedrichstadt on the broad promontory to the northwest of the Altstadt. The treaty of Dresden, signed on Dec. 25, 1745, between Prussia, Saxony and Austria, ended the second Silesian War and confirmed Silesia as Prussian.

Under bombardment during the Seven Years' War, two-thirds of Dresden was destroyed. In 1813 Napoleon made the town a centre of military operations and there, on Aug. 26 and 27, he won his last great battle. The dismantling of the medieval fortifications, begun by the French in 1810, was completed by 1830, and gardens and promenades were made. Many buildings were completed or founded by King Anthony (1755–1836), from whom Antonstadt on the north bank derives its name. Dresden again suffered severely during the revolution of 1849, and in 1866 it was occupied by the Prussians, who did not finally evacuate it until the spring of the following year. (*See* GERMANY: *History*.) The city's prosperity grew rapidly during the 19th century, accelerated

by the completion of railways connecting it with Berlin and Leipzig. The same century saw the growth of industrial suburbs, mostly on the left bank.

World War I brought street fighting in 1919. In World War II Allied bomb raids in 1945 caused extensive devastation, with a death toll of 35,000 (Russian-East German estimate), or 135,000 according to later independent investigation. Dresden was occupied by Soviet troops on May 8, 1945. Since 1945 a great deal of rebuilding has taken place. (Js. B.)

Battle of Dresden.—The battle of Dresden, the last of the great Napoleonic victories, was fought on Aug. 26 and 27, 1813. The intervention of Austria in the War of Liberation and the consequent advance of the allies under the Austrian field marshal Prince Karl Philipp Schwarzenberg from Prague upon Dresden recalled Napoleon from Silesia, where he was engaged against the Prussians and Russians under Gebhard Lebrecht von Blücher. Only by a narrow margin of time was he able to bring back sufficient troops for the first day's battle. He detached a column under Dominique René Vandamme to the mountains to interpose between Schwarzenberg and Prague (*see* NAPOLEONIC WARS); the rest of the army pressed on by forced marches for Dresden, around which a position for the whole army had been chosen and fortified; at the moment it was held by fewer than 20,000 men under Laurent de Gouvion Saint-Cyr, who retired there from the mountains, leaving a garrison in Königstein, and had repeatedly sent reports to the emperor about the allied masses gathering to the south.

The battle began late in the afternoon, for Schwarzenberg waited as long as possible for the corps of Klenau, which formed his extreme left wing on the Freiberg road. At last, about 6 P.M., he decided to wait no longer and six heavy columns of attack advanced against the suburbs defended by Saint-Cyr and now also by the leading troops of the main army. Three hundred guns covered the assault, and Dresden was set on fire in places by the cannonade, while the French columns marched unceasingly over the bridges and through the Altstadt. On the right the Russians under Ludwig Adolf Peter Wittgenstein advanced from Striesen, the Prussians under Friedrich Kleist von Nollendorf through the Grosser Garten, while Prussians under Prince Augustus and Austrians under Hieronymus, Count von Colloredo-Mansfeld, moved upon the Moczinski redoubt, which was the scene of the most desperate fighting and repeatedly changed hands. The attack to the west was carried out by the other Austrian corps; Klenau, however, was still far distant. In the end, the French defenses remained unshaken. Michel Ney led a counterattack against the allies' left, the Moczinski redoubt was definitely recaptured from Colloredo-Mansfeld and the Prussians were driven out of the Grosser Garten. The coup of the allies had failed, for every hour saw the arrival of fresh Napoleonic forces, and the Austrian leader withdrew to the heights again. He was prepared to fight another battle—indeed he could scarcely have avoided it had he wished to do so, for behind him lay the mountain defiles, toward which Vandamme was marching with all speed.

Napoleon's plan for the 27th was, as usual, simple in its outline. As at Friedland, a ravine separated a part of the hostile line of battle from the rest. The villages west of the Plauen ravine and even Löbda were occupied in the early morning by General Metzko with the leading division of Klenau's corps from Freiberg, and upon Metzko Napoleon intended first to throw the weight of his attack, giving to Claude Victor's infantry and the cavalry of Joachim Murat the task of overwhelming the isolated Austrians. The centre, aided by the defenses of the Dresden suburbs, could hold its own, as the events of the 26th had shown; the left, now under Ney, with whom served François Kellermann's cavalry and the Young Guard, was to attack Wittgenstein's Russians on the Pirna road. Thus, for once, Napoleon decided to attack both flanks of the enemy. His motives in so doing have been much discussed by the critics; Vandamme's movements, it may be suggested, contributed to the French emperor's plan, which if carried out would open the Pirna road. Still, the left attack may have had a purely tactical object, for in that quarter was the main body of the Prussians and Russians, and Napoleon's method was always to concentrate the fury of the attack on the heaviest masses of the enemy; *i.e.*, the best target for his own artillery. A heavy rainstorm during the night seriously affected troop movements on the following day, but to Napoleon's advantage, for his more mobile artillery, reinforced by every horse available in and about Dresden, was still able to move where the allied guns sank in mud. Further, if the cavalry had to walk, or at most trot through the fields the opposing infantry were almost always unable to fire their muskets. "You cannot fire; surrender," said Murat to an Austrian battalion in the battle. "Never," they replied; "you cannot charge us." On the appearance of Murat's horse artillery, however, they surrendered. Under such conditions, Metzko, unsupported either by Klenau or the main army beyond the ravine, was an easy victim. Victor from Löbda drove in the advanced posts and assaulted the line of villages Wolfnitz-Töltschen; Metzko had to retire to the higher ground southwest of the first line, and Murat, with an overwhelming cavalry force from Cotta and Burgstädl, outflanked his left, broke up whole battalions and finally, in conjunction with the renewed frontal attack of Victor's infantry, annihilated the division. The Austrian corps of Ignace Gyulai arrived too late to save it.

Meanwhile Ney on the other flank, with his left on the Pillnitz road and his right on the Grosser Garten, had opened his attack. The Russians offered a strenuous resistance defending Seidnitz, Gross Döbritz and Reick, and Ney was so far advanced that several generals at the allied headquarters suggested a counterattack of the centre by way of Strehlen so as to cut off the French left from Dresden. This plan was adopted, but failed because of various misunderstandings. Thus the allied centre remained inactive all day, cannonaded by the Dresden redoubts. One significant incident took place there. Tsar Alexander I, the king of Prussia, Schwarzenberg and a large headquarter staff watched the fighting from a hill near Räcknitz and offered an easy mark to the French guns.

In default of formed bodies to fire at, the latter had for a moment ceased fire; Napoleon, riding by, half carelessly told them to reopen, and one of their first shots, directed at 2,000 yd. range against the mass of officers on the sky line, mortally wounded Gen. Jean Victor Moreau, who was standing by Alexander. A council of war followed. The tsar was for continuing the fight; Schwarzenberg, however, knowing the exhaustion of his troops, decided to retreat. As at Bautzen, the French cavalry was unable to make any effective pursuit.

See also references under "Dresden" in the Index volume.

DRESS and its numerous synonyms—clothes, garments, apparel, attire, etc.—refers to the covering used for the human body. The varieties of dress (from the French *dresser*, "to set out," "to arrange") worn by human beings, now and in the past, are so numerous that it is not possible to deal with all of them. Thus, this article does not consider the national or regional costumes of the various peasant peoples of Europe or other parts of the world, or the garb of modern primitive peoples of Africa, the Americas and Asia. It deals chiefly with three main aspects of the subject of dress: (1) that of the ancient Mediterranean world; (2) that of western Europe (chiefly England and France), considered as standard for Europe and America, from the middle ages to contemporary times; and (3) that of the far east. The article is outlined as follows:

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I. ORIGINS

1. Motivation.—Modern anthropologists have exploded the idea long held by westerners that the wearing of clothes originated solely in an impulse of modesty. Indeed, notions of modesty vary so widely over time and place that it is very difficult to regard them as anything more than arbitrary conventions. An Arab woman caught without her veil will lift her skirt (thereby exposing her body) in order to cover her face. The Chinese long regarded the exposure of the feet as indecent. Even as late as the early 20th century a European woman who revealed a considerable portion of her bosom in evening dress was embarrassed if she was thought to be showing an ankle.

Those who discard the modesty theory of the origin of clothing are likely to accept the idea that clothes were invented for protection against the elements. But as the earliest civilizations developed for the most part in warm climates, this, too, is unlikely. Protection against insect bites seems a more probable motive. Furthermore, early hunters must have found it convenient to tie weapons, game, etc., to the body rather than to carry them. A bag or pouch hung from a waistband thus was a real advance; it lasted in male attire until the invention of pockets in the 17th century, and survives today in the Scotsman's sporran.

Another motive for dress was vanity. It is probably safe to say that among the acts that distinguish man from the animals one is the adornment of the body: staining or scarification of the skin, putting feathers in the hair or hanging an ornament in the pierced lobe of an ear. All such actions spring from a psychological need that animals do not experience, and clothes, even in their most primitive form, are essentially a reaction to it.

Clothes are pride-enhancing. The man who has "a feather in his cap" (or in his hair) has both increased his apparent height and augmented his self-confidence. But if a man sticks too many feathers in his hair he is likely to arouse the jealousy of other men. He has to fight to defend his right to wear them, and very soon only the successful fighters are allowed to wear feathers in any number. Even today it seems reasonable that the admiral should have more gold braid round his sleeve than the lieutenant does. Men's clothes throughout history and prehistory are founded on this hierarchical principle, which explains their seemingly inevitable tendency to formalize, even to fossilize, as emblems of rank.

Women's clothes, in general, have followed a different principle, one of seduction. To the modern mind the taking off of clothes has an erotic significance; the primitive mind thinks just the opposite. A psychologist of dress, John Flügel, has sought to explain the perpetual changes of female fashion by what he calls the shifting erogenous zone. According to his theory the whole of the female body (in contradistinction to the male body) is "eroticized"; that is to say, any portion of it is attractive to the opposite sex. But it is impossible for the mind to grasp an "eroticization" that extends over the whole body, and so attention is directed to various regions in turn. A hidden charm acquires erotic capital during the period of its eclipse, and this can be exploited, when the time arrives, by uncovering it, or by draping clothes tightly over it, or by drawing attention to it in one of the many ways that dress designers perfectly well understand. This exploiting of the shifting erogenous zone is what is known as fashion.

2. Fashion.—It is plain, however, that fashion, in the modern sense, has not been operative always or everywhere. In peasant communities, although sexual attractiveness plays some part in the selection of a wife, other motives commonly outweigh it: strength to work and bear children, and a good dowry. Female peasant dress therefore is only partly founded on seduction. Where women are secluded in harems or covered with veils in public, the seduction principle again cannot operate. Fashion is essentially competitive. Even in as advanced a civilization as that of ancient Greece there was no fashion among respectable married women; it could flourish only among the hetaerae. Its final emergence as a historical phenomenon took place about the middle of the 14th century, in the luxurious courts of France and Burgundy, where women competed for the attention of the ruler by inventing, or having invented for them, the three most potent weapons in the armoury of fashion: tight lacing, décolletage and striking headdresses. These were naturally denounced by the clergy, and indeed fashion has been looked at askance by moralists of all ages, who see in it an encouragement of the lust of the eye and the pride of life. This point of view is perfectly correct: those are the purposes of fashion.

Pride of life (the hierarchical principle), the lust of the eye (the seduction principle), with the utility principle as counterpoise, regulate all the phenomena of fashion. Men's clothes, in general, are governed by the hierarchical principle, slightly modified by utility; women's clothes are governed by the seduction principle slightly modified by utility. In practice, however, class distinction has never been entirely absent from women's clothes, and the erotic element took a long time to disappear from men's clothes; even today, when it seems almost entirely submerged, it can be noted occasionally in, for example, the criminal fringes of society.

Another factor to be considered in fashion is that of national costumes. The Renaissance was essentially a "triumph of time" (to use Petrarch's phrase) over place. In the middle ages a man's or a woman's costume hardly changed in a lifetime; but to travel to the next village, still more to a neighbouring country, was to find everything different. Then, with increasing ease of communication, costume tended increasingly to be the same at any moment over the whole of western Europe but to change rapidly in time.

The prestige of Louis XIV ensured that fashionable clothes were the same everywhere in his day. To be in the mode was to dress like the courtiers of Versailles, to change as they changed. This French domination over the dress of both men and women lasted for about a century. Women's clothes continue to be inspired by France, but the inspiration of men's clothes passed to England about the time of the French Revolution. The clothes of every westernized man today are derived from the sporting costume of the English country gentleman of about 1780. Full evening dress for men is a fossilized version of the late 18th-century hunting coat; the top hat was originally a crash helmet. Men's clothes, being essentially class conscious, are deliberately made unsuitable for any active pursuit, and the usual way to alter them is to allow a new sports costume to become formal in its turn. This process continues today.

Women's clothes were class conscious until the end of the 18th century, but decreasingly so as the seduction principle became accepted. Some curious compromises occurred on the way. The Elizabethan ruff, for example, is essentially "hierarchical," being so uncomfortable and easily soiled that it could be worn only by the upper classes. But the erotic element forced its way through, and while Elizabethan male courtiers wore ruffs all the way round their necks, the queen herself wore a divided ruff to permit exposure of the bosom. With the invention of the fashion plate in the late 18th century, fashion spread throughout society ever more

rapidly, until in contemporary times the only advantage a rich woman can have over her poorer sisters is slightly better materials and about a month's start. The erogenous zone has shifted wildly. In the Edwardian period emphasis was on the bosom; in the 1920s bosoms were abolished (even to the point of wearing "flatteners") and legs became the focus of interest. In the 1930s women's clothes seemed designed to be seen from the back; after World War II the bosom—or rather the breasts—once more was accentuated. However, many women began to wear trousers for work or for shopping, and it seems possible that in the future women's clothes may be divided into practical work garments and frankly erotic leisure-time garments. In men's clothes, the erotic element, absent for so long, may also tend to return.

3. Primitive Man.—Most of the motives toward clothing described above continue to operate. We still seek to increase our self-confidence, soothe our vanity, improve our shape, attract the opposite sex, demonstrate our membership of a caste. One primitive motive, however, is so remote from our conceptions that a considerable effort of the imagination is needed in order to understand it at all. This is the motive of protection against magic.

Primitive people were dominated by fears, and in particular by fear of that form of malevolent magic known as the evil eye. A mere look from an evilly disposed person might strike a man with disease or weakness or, worst of all, sterility. This danger could be averted by the use of amulets, objects selected for the most part for supposed resemblance to the sexual parts. Most important of these was the cowrie shell, which was thought to resemble the external female genitalia, the portal by which a child entered the world—that is, the giver of life. Such shells have been found among the prized possessions of primitive people all over the world, even in places far distant from their sources of origin. The cowrie shell, being so potent a protection against sterility, was naturally hung as near as possible to the organs of reproduction, and girdles and aprons of these shells were worn before the idea of clothing, as such, had arisen at all. With the advent of clothes, amulets shrank to the position of decoration; *i.e.*, jewelry.

The impulse of decoration was, of course, always present, even before clothes were invented. It had a life-enhancing value, and it is often difficult to distinguish motives of vanity from those of protection magic. A necklace of the teeth of tigers or other strong beasts, for example, was both an amulet and an ornament. As Hilaire Hiler has observed:

> Suppose a bear's tooth to be worn by an individual as an indication of his prowess as a hunter, purely from the standpoint of trophyism; this would automatically suggest his ability as a food provider and thus indirectly at least would prove attractive sexually, but a bear's tooth is not without aesthetic allure from the standpoint of colour and lustre. Furthermore, it is an article which is sufficiently difficult of possession to recommend display from the point of view of its rarity. Its association with the bear, a powerful animal and worthy adversary, might imply that some quality, as strength, inherent in the bear, should persist in the tooth—fetishism and magic. If a man owned a great number of these teeth it might be assumed that he possessed one or all of these qualities to a superior degree, thus giving signification to ornament as a mark of caste. By the same token, being powerful, it would be a protector of superior quality (*From Nudity to Raiment;* London, W. & G. Foyle Ltd., 1929).

Clothes and fire presumably were discovered in Paleolithic times, and both were important in extending the range of human habitation. It is possible only to guess at the nature of clothes worn at a time so remote. Some authorities believe that Heidelberg man may have used his powerful jaws for chewing leather as the Eskimo does today, and so have made it pliable enough for use as clothing. Neanderthal man certainly had tools, some of them strongly suggesting the instruments used by tanners; Neanderthal woman stayed at home while the man went hunting, and it is thought that it was at this time that a differentiation arose between male and female dress. In a cave of Cro-Magnon time, at Cavillon in France, a hairpin was found in such a position near a body as to leave no doubt as to its use; other objects resembled toggles or double buttons, and there were also bracelets and leg ornaments. Caverns in the Dordogne have yielded bone pendants and collars of ivory, shells, stags' teeth and fish vertebrae. Mural paintings in the rock shelter at Cogul, Lérida, Spain, show people clothed in what seem to be skin garments somewhat resembling those of the modern Eskimo. Skin garments cannot be made without needles, and specimens of these have been found in large numbers in Magdalenian burials.

Hiler remarks:

> There are strong reasons for believing that the use of fundamental garment forms of a rudimentary perfection dates from the Magdalenian. A simple tunic, the ancestor of a long line of similar pieces, the skirt and kilt (or divided coverings for the legs), the mantle or cape (precursor of the coat) as well as moccasins or boots are among the probabilities.

If this is the case, the fundamental forms of European clothing were established at this remote period and hardly changed in essentials until the middle of the 14th century A.D.

Neolithic man made use of wool and flax fibres for clothing manufacture. Decorated spindle whorls found, for example, in the Grotte du Pontal, Hérault, indicate that the vital discovery of thread had been made, and fragments of both plaited and woven cloth have been found at Robenhausen in Switzerland, and elsewhere. Dyes were used, the colours being the primaries—red (obtained from hematite), yellow (from the yellow weed *Reseda luteola*) and blue (from danewort). This raises the question whether primitive people merely preferred these colours or whether they were able, in fact, to distinguish any others. Experiments conducted with surviving primitives and with children indicate that colour sensibility is much less marked among them than among civilized adults. Red is the first colour noticed, then yellow, with blue a long way after; intermediate tints are ignored altogether. Of course the colours used in primitive dyeing were not bright, hence, perhaps, the enormous prestige of the so-called purple (really purplish-red) dye obtained from the murex in later times. Red also is the colour of blood, and "the blood is the life," but the aesthetic effect of red is enough to explain its popularity without any magical or religious hypotheses.

Primitive man not only dyed his few clothes but also painted his body, and body markings, by painting, tattooing or scarification, served to promote vanity, denote prestige, attract the opposite sex, indicate membership of a clan and frighten the enemy and were probably not differentiated in his mind from garments.

4. Skirts and Trousers.—Much ingenuity has been exercised by anthropologists and historians of costume in explaining what seems to us the fundamental difference between skirts and trousers. The difference lay, originally, merely in the way in which a piece of cloth was draped round the body. If it was allowed to hang free from the hips it was the ancestor of the skirt; if any portion of it was passed between the legs it was the ancestor of trousers. C. H. Stratz proposed a distinction between arctic clothes (trousers) and tropical clothes (skirts). This certainly holds good in historical times, people of both sexes in northern latitudes wearing trousers, people in southern latitudes wearing skirts, while in the regions between, trousers (or other bifurcated garments) are worn by men and skirts by women. The ancient Greeks wore skirts and regarded trousers as the mark of the barbarian. The Romans had the same opinion of the trousered Germanic tribes; nonetheless, the Roman troops came back from service in Germany wearing tight breeches under the Roman kilt.

Trousers are, in general, warmer and more practical for active pursuits than skirts, and the persistence of skirts for women has been thought to be due to the less active and exposed life they have generally been called upon to live. On the other hand, Turkish women, whose lives were extremely sheltered and inactive, generally wore trousers, and skirts (or kilts) have been worn by hardy mountain people like the Scots and the Greeks. Climate indeed has never been the dominating factor, as can be seen in the ample clothes of the Arabs, who live in a hot climate, and the scanty coverings of the Fuegians of the bitterly cold region near Cape Horn. Clothes in short, in primitive as in modern times, are not merely the covering of the body, but the vesture of the soul. (J. Lr.)

II. MEDITERRANEAN WORLD

A. Near East

1. Ancient Egypt.—Modern knowledge of ancient Egyptian

dress derives for the most part from ancient paintings and sculptures, since very few garments have been preserved. It is necessary, therefore, to remember that artists were very much bound by tradition and, further, that modes of representation lagged behind actual changes of fashion. As is usually the case, new fashions originated among the rich; the general tendency was toward greater and greater elaboration in both costume and accessories. Practically the only fabric that has been preserved is linen, found in graves of the Neolithic period, long before the dynastic age. The Egyptians themselves realized that flax culture was very old and believed that the gods were clothed in linen before they made their first appearance on earth. Wool seems scarcely ever to have been used, and silk and cotton were unknown. The first clothing worn by men was a narrow band around the waist to which pendants were attached, the whole arrangement being both amuletic and decorative. The loincloth and kilt were later developments of this. The earliest representations of women show them either nude or clad in tightly fitting white linen skirts down to the ankles.

Men.—The characteristic masculine garment throughout the dynastic period was the white linen kilt, a rectangular piece of cloth wrapped around the body and tied in front. The length, fullness and method of adjustment varied with the date and the social position of the wearer. In the earlier Old Kingdom the kilt was usually short and draped smoothly around the hips. Often one or both of its lower corners were rounded; sometimes it was pleated or partially pleated, and later it might be stiffened to project in front. In the Middle Kingdom there was a fashion for long kilts, sometimes reaching from waist to ankles, sometimes hanging from the armpits, with no belt or other interruption at the waist. In the late 18th dynasty the double kilt appeared, long and full, with the upper one doubled and gathered in front. Fullness was always concentrated in front, and all garments—both men's and women's—were adjusted so as to fit the figure smoothly behind. A triangular loincloth sometimes, perhaps usually, was worn under the kilt.

Shirts, though worn at all periods, are first represented in the 18th dynasty; the upper part of the body, however, was often left bare or covered with a shawl. The shirt, like the kilt, was made of a rectangular piece of linen, the material being folded and sewn up the sides, openings being left for the arms and a hole cut at the fold for the head. Several shirts have been preserved with long, tight sleeves sewn into the armholes. The richly furnished intact tomb of the architect Kha of the 18th dynasty, the contents of which are in Turin, contained a pile of about 50 loincloths, many kilts 20 to 23 in. wide and about 67 in. long, seven sets of loincloths and kilts tied up together and a pile of shirts of both light and heavy, winter weight.

Women.—The characteristic woman's garment in the Old Kingdom was a long, tight slip held up by suspenders over the shoulders. During the Middle Kingdom and early 18th dynasty artists copied the Old Kingdom representations closely, and it is not possible to ascertain when the draped robe, which first appears in pictures after the first half of the 18th dynasty, actually came into fashion. These robes were unshaped, each consisting of a length of material wound around the body, brought up over one or both shoulders and tied at the breast. There were numerous ways of arranging the drapery; most commonly the right arm was left free. Some pictorial representations seem to indicate a tight garment under the robe, but probably the artist was only trying to represent the first twist of the cloth, strained over the body so that folds or pleats were smoothed out. Men are also represented wearing the draped robe in the later New Kingdom.

Women, like men, wore heavy mantles for warmth. Examples survive of materials with a self-pattern on the right side which appears on the reverse as a thick, warm tufting. In the privacy of their homes most women may have gone about without clothing, as did their maids, who are often so represented.

Children.—Children are invariably shown naked, their heads shaven except for the "lock of youth" that hangs down one side. However, a few children's shirts and sandals—smaller models of their parents'—have been preserved.

Fabrics and Ornament.—The Egyptians had not learned to use the mordants required to dye linen successfully, and as their clothing was frequently washed only white was really practical. Nonetheless, yellow, blue, green and red garments were worn on occasion. Costumes made of materials with coloured patterns are represented, but whether the material was linen, and if so how these patterns were applied and how often such garments actually appeared in real life, is uncertain. Tapestry weaving was known but was extremely rare, tapestries and embroideries apparently occurring only in garments belonging to the king and members of his family and, indeed, being treated as heirlooms. To make up for the lack of colour the material of the dress might be elaborately pleated or arranged in a mass of fine folds, bright ribbons might be tied around the waist and hair, and those who could afford to do so wore brilliantly coloured jewelry, often combined with garlands and wreaths of flowers.

Heavy wigs or a padding of false hair, worn by both men and women, are known from an early period. They served not only as an adornment but also to protect the wearer's head from the burning rays of the sun, thus in a way acting as hats. Semicircular kerchiefs, tied by the corners at the nape of the neck under the hair, were sometimes worn to protect the wig on a dusty day. Wigs were dressed in many different ways, each characteristic of a given period; generally speaking the hair became longer and the arrangement of curls and braids—set with beeswax—more complicated as time went on.

Cosmetics, like wigs, served a practical as well as an ornamental purpose. Even during the predynastic period men as well as women applied a line of green paint around the eyes, which helped to absorb some of the sun's glare. In dynastic times the paint used was a dark gray. Red ochre seems to have been used to colour the cheeks, and henna the palms, nails and, in the late period at least, the hair.

Sandals of woven rushes or of leather were worn on occasion by men, women and children (artists represented them as being worn only by men and members of the royal family), but the Egyptians probably usually went barefoot, as, indeed, they still do in rural districts.

The clothing described above was for the most part that of the official class. The king himself is shown either in the severely simple short kilt of the Old Kingdom or in contemporary costume, with decorations peculiar to himself—an elaborately worked jacket, a jeweled belt and apron, and a variety of crowns or royal headdresses. At the other end of the social scale were the labourers and workers in the fields, who went nude or perhaps wore a belt or loincloth of linen or leather. (*See* also EGYPT: *History: Ancient Civilization and Culture.*) (N. E. Sc.)

2. Ancient Mesopotamia.—Simplicity characterized Mesopotamian clothing in the periods of that civilization's greatest flowering. Garments typically consisted of a rectangular piece of loosely woven wool, bleached or dyed red or blue. Linen was employed to a lesser extent, its use increasing in the 1st millennium B.C. The warp formed a straight fringe along the short sides, sometimes knotted into tassels. The weft could be made to stick out in loops, forming a wavy fringe on the long sides. Red and blue garments had white fringes and white garments often had coloured fringes. As Mesopotamian art suppresses most folds, the rendering of the borders is the best clue to the draping of the garment. Men normally draped their clothes counterclockwise, women clockwise. Since manual labour and warfare require freedom of movement, the wearing of long garments denotes leisure and peaceful pursuits. In the earliest periods, clothes were discarded during the performance of feats of strength or service in the temple.

Protoliterate Period.—During this period (*c.* 3500–3000 B.C.) men of rank wore an ankle-length skirt, the rectangular cloth being wrapped so that the visible short side was in front.

Early Dynastic Period.—During the Early Dynastic period (*c.* 3000–2340 B.C.) the cloth was wrapped as before, but the short side was behind the left hip, where the ends of the belt or the cloth itself were knotted. A fringe of long weft loops encircled the skirt below. In the later part of the period, a luxury version had rows of loops all over. This fabric represents the origin of the divine garments of later periods.

ANCIENT EGYPTIAN DRESS

King Senusret I, Middle Kingdom, 12th dynasty, wearing short kilt and white crown of upper Egypt. In the Cairo museum

An official of the New Kingdom and his wife, 19th dynasty. The official wears a pleated kilt; his wife a pleated robe draped around her body with the right arm free. In the Metropolitan Museum of Art

Girl of the Middle Kingdom, 11th dynasty, wearing long, tight slip held up by shoulder suspenders. In the Metropolitan Museum of Art

Chief priest Ranofer, Old Kingdom, 5th dynasty, wearing full, short kilt, stiffened to project in front. In the Cairo museum

Sebek-em-sauef, herald of Thebes, Late Middle Kingdom, 13th dynasty, wearing long, unbelted kilt. In the Kunsthistorisches museum, Vienna

Prince Ra-hotep and Lady Nefret, Old Kingdom, 4th dynasty. The prince is wearing a short kilt draped smoothly around the hips; his wife is wearing a mantle. In the Cairo museum

BY COURTESY OF (ALL EXCEPT BOTTOM CENTRE) THE METROPOLITAN MUSEUM OF ART. (TOP LEFT) EXCAVATIONS OF THE METROPOLITAN MUSEUM OF ART, 1913–14, CONTRIBUTION OF EDWARD S. HARKNESS. (TOP CENTRE) ROGERS FUND, 1907. (TOP RIGHT) EXCAVATIONS OF THE METROPOLITAN MUSEUM OF ART, 1919–20, ROGERS FUND, SUPPLEMENTED BY CONTRIBUTIONS OF EDWARD S. HARKNESS, (BOTTOM CENTRE) KUNSTHISTORISCHES MUSEUM

DRESS

Official from Mari in long, looped skirt. Early Dynastic period, *c.* 2600 B.C. In the Louvre

Female worshipper wearing long cloth draped over left shoulder. Early Dynastic period, *c.* 2600 B.C. From Tutub (Khafajah). In the Iraq museum, Baghdad

Gudea, ruler of Lagash, in full-size cloth worn over left shoulder. About 2150 B.C. In the Louvre

Lady, possibly Gudea's wife, in draped garment covering both shoulders. *C.* 2150 B.C. From Lagash (Telloh). In the Louvre

Ashurnasirpal II, Assyrian king (884–859 B.C.), and butler in rectangular tunics trimmed with tassels. Relief in the British museum

Marduk-zakir-shumi, king of Babylonia, and scribe in sleeved and belted tunics. About 825 B.C. Relief on boundary stone. In the Louvre

Mede, dressed in trousers and jacket, and Persian, dressed in loose tunic, members of the royal guard. About 500 B.C. Relief from the palace of Persepolis

ANCIENT MESOPOTAMIAN AND PERSIAN DRESS

BY COURTESY OF (TOP CENTRE, BOTTOM RIGHT) THE ORIENTAL INSTITUTE, UNIVERSITY OF CHICAGO, (TOP RIGHT, BOTTOM CENTRE) MUSÉES NATIONAUX, (BOTTOM LEFT) THE TRUSTEES OF THE BRITISH MUSEUM; PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) ARCHIVES PHOTOGRAPHIQUES

Egyptian queen; reign of Rameses II, 19th dynasty

Assyrian king in religious attire; 8th century B.C.

Persian royal guard in Median costume, court of Darius; 5th century B.C.

Cretan lyre player in mainland tunic; c. 1400 B.C.

Greek woman in Ionic chiton and himation; 5th century B.C.

Greek youth in short Ionic chiton and chlamys; 5th century B.C.

Roman woman in *tunica*, stola and palla; Flavian period

Roman patrician in toga of Imperial Rome; 1st century B.C.

DRESS OF THE ANCIENT MEDITERRANEAN WORLD

PAINTED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA, INC., BY HERBERT KANE

DRESS

Bedouin woman from Lebanon in biblical-style dress; 19th century

Bedouin man from Lebanon wearing haik headdress; 19th century

Chinese emperor in 12-symbol "auspicious" robe (*chi-fu*); reign of K'ang-hsi, 1661–1722

Chinese princess or imperial consort in ceremonial robe (*ch'ao-fu*); reign of K'ang-hsi, 1661–1722

Chinese noblewoman in informal costume; late 19th century

Japanese lady in formal ceremonial robe (*juni-hitoe*); dating from the 11th and 12th centuries to present day

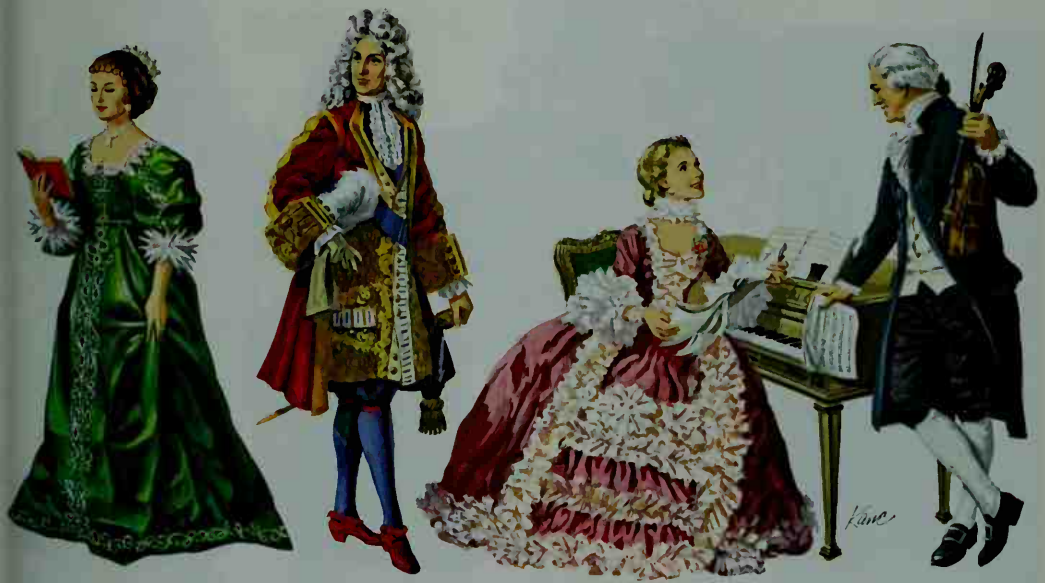
Indian woman in sari; style dating from antiquity to present day; 18th century

Upper-class Korean woman in everyday dress; dating from the Yi dynasty (1392–1910) to present day

DRESS OF THE NEAR AND FAR EAST

PAINTED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA INC., BY HERBERT KANE; PAINTINGS (TOP, CENTRE RIGHT AND RIGHT; BOTTOM, LEFT AND CENTRE RIGHT) FROM ORIGINAL COSTUMES IN THE COLLECTION OF THE METROPOLITAN MUSEUM OF ART

Flemish-French; c. 1500 | Flemish; 16th century | English; 16th century | English; 17th century



French; 17th century | French; early 18th century | French; early 18th century | English; 18th century

EUROPEAN DRESS FROM THE 16TH TO THE 18TH CENTURY

PAINTED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA, INC., BY HERBERT KANE

DRESS

American Puritan; 17th century

American colonial; 18th century

French Empire; early 19th century

English Victorian; mid-19th century

English and American; 19th century

French; early 20th century

U.S. AND EUROPEAN DRESS FROM THE 17TH TO THE 20TH CENTURY

PAINTED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA, INC., BY HERBERT KANE

Cretan woman in wide-skirted dress and high turbanlike cap, late third millennium B.C. Terra-cotta statuette from Petsofa, Crete

Cretan youth in loincloth, c. 16th century B.C. Detail from "The Cup-bearer" fresco, Palace of Minos, Knossos, Crete

Greek girl in open peplos, 438–431 B.C. Statue of Hebe from east pediment of the Parthenon. In the British museum

Nereid in thin chiton and mantle, c. 400 B.C. Found at Xanthus in Lycia. In the British museum

Greek woman in chiton and mantle with roll of folds, 4th century B.C. In the Detroit Institute of Arts

Greek boy wearing chlamys fastened on right shoulder, 4th century B.C. Terra-cotta figurine from Tanagra. In the British museum

Greek man wearing large himation draped over both shoulders, late 4th century B.C. Statue of Aeschines. In the Museo Nazionale, Naples, Italy

ANCIENT DRESS OF THE AEGEAN AND GREECE

BY COURTESY OF (TOP LEFT) FINE ARTS DEPARTMENT, COLUMBIA UNIVERSITY, (TOP CENTRE, TOP RIGHT, BOTTOM CENTRE LEFT, BOTTOM CENTRE RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM, (BOTTOM LEFT) THE DETROIT INSTITUTE OF ARTS; PHOTOGRAPHS, (BOTTOM CENTRE LEFT) JOHN R. FREEMAN AND CO. LTD., (BOTTOM RIGHT) ALINARI

DRESS

Lady wearing Hellenistic, high girt tunic and freely draped palla, 2nd century B.C. In the Palazzo del Conservatori, Rome

The magistrate, Aules Metilis (the Arringatore), in round mantle, c. 100 B.C. In the Museo Archeologico, Florence, Italy

The emperor Augustus in tunic, corselet with relief decoration and paludamentum, after 20 B.C. In the Vatican museum, Rome

Altar boy (Camillus) in wide tunic with large sleeves and broad stripes, probably from the Augustan period. In the Capitoline museum, Rome

Three priests of Mars wearing tunics with narrow stripes, Etruscan headdresses and sandals, Roman Imperial period. Mosaic in the Borghese gallary, Rome

Head of Emperor Septimius Severus (A.D. 193–211) inserted in toga statue of the Claudian period, A.D. 41–54. In the museum at Kassel, Germany

ANCIENT ROMAN DRESS

PHOTOGRAPHS, (TOP LEFT, TOP CENTRE, BOTTOM CENTRE) ALINARI, (TOP RIGHT, BOTTOM LEFT) ANDERSON, (BOTTOM RIGHT) MARGARETE BIEBER

Persian prince wearing court dress; early 16th century. From a Persian painting of the early Safawi school

Turkish woman's dress; late 15th century. Drawing by Gentile Bellini

Woman in embroidered super tunic caught by girdle, showing kirtle, and draped mantle; 10th–11th century. From the *Augsburg Missal*

Flemish woman in belted gown, wearing "butterfly headdress"; 2nd half of 15th century. Statuette of Anna of Burgundy by Jacques de Gerines

Swiss woman in full-skirted dress with *bouffant* sleeves and short shoulder cape or tippet; *c.* 1520. Drawing by Hans Holbein

English man wearing unbelted houppelande, hood turban, soft shoes and hose; late 14th century. From a painting of Chaucer copied from Occleve's manuscript

NEAR EASTERN AND EUROPEAN DRESS: 10TH TO 16TH CENTURIES

BY COURTESY OF (TOP CENTRE AND RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM, (BOTTOM LEFT) RIJKSMUSEUM, AMSTERDAM, (BOTTOM RIGHT) NATIONAL PORTRAIT GALLERY, LONDON; PHOTOGRAPHS, (TOP LEFT) IRIS VERLAG, BERNE (BOTTOM CENTRE) KUPFERSTICHKABINETT, BASEL

DRESS

Cavalier in full breeches, jerkin with falling lace collar, bucket-top boots and large-brimmed hat with feathers; c. 1630. Etching by Abraham Bosse

Gov. John Winthrop of Massachusetts wearing the starched ruff of the early 17th century. Detail of an engraving by J. C. Kellogg from a painting by Sir Anthony Van Dyke

Duchess of Richmond and Lennox in a low-cut dress with tight sleeves encased in hanging sleeves, standing lace ruff and matching cuffs of lace; 1623. Detail of an engraving by William van de Passe

Early American portrait of Elizabeth Paddy Wensley showing the French hood; 17th century

Puritan costume of the early 17th century worn in England and America

Pocahontas wearing a steeple hat made of beaver; early American, 1616. Detail from an English painting

Detail of "The Bradshaw Family" by John Zoffany (c. 1785), showing adults in 18th-century dress and children in clothing that anticipates 19th-century styles

English gentleman in coat, waistcoat and knee breeches, carrying three-cornered hat. The lady wears jacket-and-petticoat dress over domed hoop; c. 1718. Detail from "Viscount Irwin and his Wife" by J. Richardson

AMERICAN AND EUROPEAN DRESS: 17TH TO 18TH CENTURIES

BY COURTESY OF (TOP LEFT, TOP RIGHT) VICTORIA AND ALBERT MUSEUM, CROWN COPYRIGHT, (TOP CENTRE) SMITHSONIAN INSTITUTION, (SECOND ROW LEFT) PILGRIM HALL, PLYMOUTH, MASS., (CENTRE) LIBRARY OF CONGRESS, (SECOND ROW RIGHT) NATIONAL GALLERY OF ART, WASHINGTON, D.C., (BOTTOM LEFT) THE TRUSTEES OF THE TATE GALLERY, (BOTTOM RIGHT) LEEDS CITY ART GALLERY AND TEMPLE NEWSAM HOUSE, LEEDS

Regency dress of 1807. Man wearing morning coat with high stock, breeches and top boots. Lady in high-waisted pelisse with fur trim, carrying a loop-handled reticule

Fashion plate of 1837. Left, man in evening dress with frilled shirt and tight pantaloons; centre, lady in walking dress with large oversleeves and tight, shaped cuffs and fichu shoulder line; right, man in surtout (short frock coat) with frogging and strapped trousers

Woman wearing crinoline and feathered hat tilted over the forehead; 1850–60

Woman wearing ribbon-trimmed dress with shelflike bustle in the back; *c.* 1885

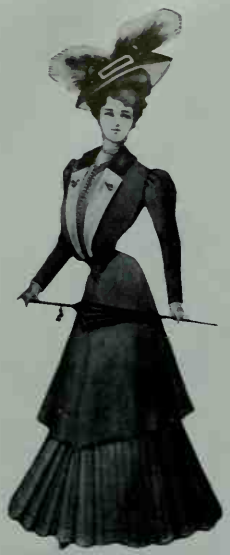
Woman wearing balloon-sleeved velours jacket over winter dress with braided edge; 1894

Summer walking costumes of 1884. The man wears a bowler hat and suit with high-buttoned coat and uncreased trousers. The woman wears a draped-skirt dress and closely fitting jacket

AMERICAN AND EUROPEAN DRESS: 19TH CENTURY

BY COURTESY OF (BOTTOM CENTRE AND RIGHT) "THE TAILOR AND CUTTER"; PHOTOGRAPHS, (TOP LEFT AND CENTRE) JAMES LAVER, (CENTRE RIGHT) BROWN BROTHERS, (BOTTOM LEFT) THE BETTMANN ARCHIVE

DRESS



Walking costume in the S-shaped style worn with hat tilted forward to balance the swing of the skirt; 1907

Straight-line embroidered dress with tunic top and hobble skirt; c. 1910

Fashions of 1919. The lady wears a fur-trimmed coat in a modified lampshade style and high-buttoned boots. The man wears a lounge suit with stiff "butterfly" collar, Homburg hat and spats

Daytime suit with very short skirt and no waistline, worn with flesh-coloured silk stockings and strapped shoes; 1927

Dress in the "new look" style, designed by Christian Dior; 1947

Casual suit in the classic style set by "Coco" Chanel, by Jaeger; early 1960s

AMERICAN AND EUROPEAN DRESS: 20TH CENTURY

BY COURTESY OF (TOP LEFT, TOP CENTRE RIGHT, TOP RIGHT) 'THE TAILOR AND CUTTER'; PHOTOGRAPHS, (TOP CENTRE LEFT) CULVER PICTURES, INC., (BOTTOM LEFT) RADIO TIMES HULTON PICTURE LIBRARY, (BOTTOM CENTRE) WIDE WORLD, (BOTTOM RIGHT) © CONDE NAST PUBLICATIONS LTD., VOGUE PHOTOGRAPH. BY DUFFY

Women wore a similar but larger cloth. With one short side it was placed over the left shoulder, then it was passed under the right armpit and again over the left shoulder, from where the other side hung down to the ankles, covering the left arm except for the hand. A hidden pin or stitching may have held the two layers of material together on the left breast.

Akkad, Neo-Sumerian and Old Babylonian Periods.—Men of rank now also wore a full-size cloth (at least 3 by 1½ yd.), placed with the centre of one short side on the left lower arm (which had to be kept horizontal), wrapped around the back, under the right armpit and over the left arm and shoulder, thus giving freedom of movement to the legs and right arm. The other short side curved up the back. One corner was either tucked under the right armpit or brought forward over the right shoulder. When the cloth grew even longer, it was wrapped around twice, ending over the left arm. Exceptionally, the cloth might be wound clockwise, the first turn forming a skirt and the second brought over the left shoulder with the same result of disengaging the right arm while enveloping the left.

The beret, worn by rulers in the north in the Early Dynastic period, was current in the Akkad period. Thereafter a turban, sometimes covered with curls as if made of fur, was the royal headgear.

For women an arrangement covering both shoulders, not unknown before, now became common. The centre of one long side was placed across the bosom. Both short sides were passed under the armpits, crossed in the back and brought forward over the shoulders and upper arms, so that two points hung down in front. The hair might be enveloped in a cloth held in place by a headband.

Kassite Period.—The mountaineers from the border of Iran who ruled Babylonia during this time (*c.* 1600–1100 B.C.) introduced heavy, richly decorated clothes and soft shoes.

1st Millennium B.C.—The basic garment of the Assyrians was the rectangular tunic. The slits for neck and arms often had embroidered borders and tassels sometimes appeared around the bottom. Depending on the freedom of movement desired, tunics were ankle length or knee length, girt with a cummerbund over which a narrow belt might be worn. Sandals were the common footgear.

Over the tunic the king threw a long shawl, draped like the traditional garment, but, being narrower than the latter, covering the right side only from the waist down. For the lesser members of the court the width of the shawl decreased, becoming a mere sash. The king also wore a headband with rosettes, either separately or over a pointed cap similar to a fez.

Assyrian women wore a sleeved tunic and a large shawl, wrapped so as to cover both shoulders.

The Babylonians also wore sleeved and belted tunics, drawn smooth in front so that the folds were concentrated in the back. Diagonal shoulder bands may denote rank. The royal headdress (generalized in Persian times) took the shape of a pointed cap with a streamer. (M. v. L.)

3. Persian, Arab and Ottoman Empires (to Modern Times).—The primitive costume of the Persians was made of animal skins, wool being little known before the time of Cyrus and cotton and silk not known at all. The costume was in the form of a coat and breeches, and this, with minor modifications, has lasted until modern times. With growing prosperity the Persians began to make both coat and trousers of coloured cloth. They wore at first a conical leather hat, which was exchanged for a time for the Phrygian cornet. The conical cap was sometimes circled by bands of cloth, in which perhaps may be seen one of the origins of the turban. A relief found in the ruins of the palace of Persepolis shows various figures bringing presents and clad in a mixture of Persian and Hebrew modes (the Hebrew dress was longer than the Persian and, in the Semitic tradition, without trousers). There is hardly any trace in ancient Persian monuments of the dress of women.

Scythians and Parthians wore trousers with coats open at the front and crossed with a belt to keep them in place. The coats of the women were longer but otherwise similar, except that the belt was sometimes replaced by a long piece of cloth wound round the hips and knotted in front.

The Arab conquest in the 7th century A.D. brought modifications. Arab costume itself has been singularly unchanging, as can be seen from occasional representations in the monuments of ancient Assyria and Egypt. The Arabs' earliest garments seem to have been a piece of cloth wrapped round the body below the armpits and a long, full shirt with or without sleeves. The descendant of this latter garment is the garb of many modern Egyptians. The Arabs wore over it a mantle of coarse wool or camel hair in the shape of a sack open at the bottom and with holes for arms and head. This is the aba mentioned in the Bible as the costume of prophets. It was usually cream coloured with wide vertical stripes of black, white, brown and blue. The headdress was a small piece of cloth wound round the head or folded in a triangle and kept in place by a ribbon tied in a knot at the front or a cord, plain or ornamented, encircling the crown. This is the haik, the characteristic Arab headdress even of the 20th century. Under it is worn a felt cap (or several felt caps one over the other) coloured red, white or brown.

No representation is known of the early dress of Arab women, but it probably resembled closely the dress of men, and has continued to do so. The shirt, or chemise, reaching to the ground and very wide, was open over the chest but buttoned at the neck. A scarf was worn round the waist. The mantle consisted of a large rectangle of woolen cloth, black or blue with yellow or red stripes. It was sometimes worn over the head on top of the small fichu wound round the crown. The usual veil is a band of black crepe or white muslin, sometimes long enough to reach the feet, kept in place by two ribbons attached to a circlet round the head and often ornamented with pearls or coins.

The great Turkish migration of the 11th century brought some changes to both Arab and Persian costume. The Persian costume at this time consisted of a shirt, a caftan (a Turkish word describing a kind of long coat open at the front, with short sleeves, and sometimes edged with fur) and a cloak. The cap of lambskin in the form of a truncated cone, introduced by the Turks, is still worn in Persia. A cap of similar form but red in colour and made of felt, the fez, became the characteristic headgear of Turks until abolished by Kemal Ataturk in 1925.

Characteristically the Persian trousers were baggy and gathered in at the ankles. Slippers were made of leather with turned-up points. Kurds, Afghans, Georgians and Armenians long preserved these modes, which are by no means extinct.

Documentation increases during the 16th century when Europe became conscious of the Turkish threat, and there was a growing interest in exotic dress. The costume worn by Persian women—and still surviving—consisted of a white cotton chemise with long sleeves, long woolen stockings, woolen embroidered slippers, wide trousers of dyed cotton, tied round the ankles and hanging in folds, an underwaistcoat with long sleeves open to the elbow and a short-sleeved overwaistcoat, a small cap and a shawl tied round the waist. A veil of white muslin was either wound round the head or suspended just below the eyes. Out of doors women threw over their shoulders a piece of cloth that covered them completely.

Men's dress at this period, at least among the upper classes, consisted of trousers at first extremely ample (still worn among the Kurds) but gradually growing tighter. The camise, or shirt, often striped and patterned, worn outside the trousers and falling sometimes to the knees and sometimes to half-calf, was provided with long sleeves. The caftan was buttoned across the chest and closed by means of a scarf. Its long skirts were sometimes turned back and attached to the belt. An outer garment as long as the caftan and always more ample was of a different colour. In the 20th century the overmantle was provided with long wide sleeves, sometimes slit. A very ancient garment, long retained, was the abayah, a kind of long cloak, originally made of camel hide, thrown over the shoulders. Sometimes it had a single wide sleeve, a peculiarity preserved by the modern Kurds.

The waistcoat, dating from the end of the 16th century, was generally of red or blue cloth with braid of a contrasting colour and adorned with small buttons sewn very close together. Over this was sometimes worn a short coat, rather like an Eton jacket, similarly ornamented. Red leather slippers were worn except by

clergy and magistrates, who wore blue.

The original headgear of the Turks was probably the round Tatar cap edged with fur, but after the capture of Constantinople the sultan imitated the Prophet Mohammed by surrounding his cap with a large amount of white muslin wound round and round. It was at this period that the turban became usual among the Turks. Functionaries were compelled to wear it in a form determined by their rank. The costume of the lower classes consisted simply of trousers and a cloak of hide or cloth.

Women's costume was hardly to be distinguished from that of men except that the trousers continued to be more ample. The chemise, made of white muslin and falling to mid-thigh, was décolleté and had no sleeves or very short ones. The dress was open in front and reached the ground. Veils of black horsehair or white muslin were attached to the headdress, a small cap often ornamented with precious stones. The hair was worn either loose and flowing or in plaits encased in a kind of cloth tube.

In the second half of the 20th century the visitor to near eastern countries finds little enough of the traditional costumes described. After the foundation of the Turkish republic there was a progressive invasion of European influences, particularly in Turkey itself. Men largely adopted some form of European dress, the women less so, except in Egypt. Wealthy Egyptian women obtain their clothes from the best *couture* houses of Paris and even peasant women, if they have not abandoned the veil, wear one of net which hardly conceals the features. On the other hand, the black horsehair veil still worn by the women of Damascus and Baghdad makes it difficult for an observer to decide whether the wearer is coming or going.

The typical Turkish fez is still worn by men in Egypt, the rest of the costume being altogether European. This was the rule among the Turks in the days of the last sultans, who themselves wore frock coats with Turkish headgear. Indeed the process of europeanizing had begun in the middle of the 19th century. In 1873 the Imperial Ottoman Commission for the Universal Exhibition of Vienna sponsored an elaborate work containing photographs of men and women in all parts of the Turkish empire, and the pages of this volume reveal clearly not only the variety of costume in the different regions but also the layers of influence out of which they had been built up. In what was then the *vilayet* of Baghdad men are shown dressed in the pure Arab mode while the woman wears a recognizably Persian costume. The peasant of the neighbourhood of Jerusalem wears a long white cotton shirt with a broad leather belt, and over it a garment resembling a western academic gown, with broad black and white stripes; his fez is wound round with white muslin. A Christian artisan in the region east of the Jordan river wears over his long open shirt the jubbah, a long, sleeved garment resembling a western mackintosh. A peasant woman of Damascus is seen covered with jewelry "like an Assyrian idol of which her costume conserves the archaic form." A peasant woman of Lebanon, on the other hand, wears garments of biblical simplicity. The clothes of a Christian woman of Beirut are plainly *à la française* but about ten years behind the western mode. A Kurdish soldier has a turban like that of the Afghans. In Istanbul the same bewildering variety is apparent. The old-fashioned bourgeois was still clad in the costume of his ancestors; the young government employee wore black trousers and a frock coat—there was nothing oriental about his garb except the fez. Between these two extremes could be found every combination and permutation possible. Especially after World War II the process of europeanization was greatly speeded up. (J. Lr.)

B. The Aegean

Clothing worn by the Cretans in the 3rd and 2nd millenniums B.C., and that of the Mycenaeans in the second half of the 2nd millennium, was very different from oriental as well as from later Greek costume. Early in the 3rd millennium in Crete men wore a short loincloth attached to a tight, broad belt. A relief vase from the early 2nd millennium shows a prince wearing long hair, uncovered, and an officer wearing a helmet. From late Minoan times a life-size stucco relief showing a king and a wall painting showing young men carrying precious gifts indicate that elaborate loincloths, with woven patterns and embroidered borders and adorned in front with tassels, were worn. Similar are the costumes of envoys from Crete pictured in Egyptian tombs.

On the mainland, in Mycenae, Tiryns and Sparta, where the Cretan civilization was accepted and imitated in the second half of the 2nd millennium, men wore short tunics with long sleeves for war and the hunt, a helmet with boars' teeth; high sandals; and leggings. A musician on the sarcophagus of Ayia Triada in Crete (*c.* 1400 B.C.) shows that this tunic was adopted there from the Mycenaeans; the lyre player wears a long tunic without sleeves and with a decorative border and a stripe around the shoulders and continuing down to the border. The priests who bring offerings wear fur skirts.

The costume of Cretan noblewomen is much more complicated, reflecting the luxurious living and gay spirit of court life. A lady of the 3rd millennium wore a bell-skirted dress, the sleeveless bodice of which exposed the breasts and stood away from the nape of the neck. Her cap was high and turbanlike. In the middle and late Minoan periods this dress became a tailored, well-fitted, elegant robe. The temple repository in Knossos shows priestesses with bell-shaped skirts made of small strips sewn horizontally together or of different-coloured flounces falling one over another. An apron, similar to the loincloth of the men, hangs from a broad, tight belt. The jacket is open in front, but the breasts are covered by a diaphanous vest. Narrow sleeves cover the upper arms. The headdress is a high turban or a crown.

When Cretan civilization was taken over by the mainland, women accepted this rich dress and made it even richer. The best example is provided by the figures of women from a fresco at Tiryns; their dress exhibits flounces, some smooth, others with scale and half-moon patterns in different colours; the jacket has borders of flower petals. The hair is elaborately bound up with ribbons and rings, with rows of small curls before and behind the headband, a chignon on the crown of the head from which a pony tail falls, and four long strands falling down the back. When women went to the hunt, as shown in another fresco from Tiryns, they wore a simple tunic like that of the men, with short sleeves but no belt. In the bull games women wore the apronlike loincloth and high shoes of the men. On the late Minoan sarcophagus of Ayia Triada, the priestess, like the priest, wears a skirt made of fur.

In the shaft tombs of Mycenae many golden diadems, breastplates and buttons have been found, the last used perhaps as jewelry or sewn on dresses as ornaments.

C. Greece

The clothing of the Greeks, like their civilization, changed with the three periods of their history: the Archaic (*c.* 1000–500 B.C.), the Classical (*c.* 500–330 B.C.) and the Hellenistic (*c.* 330–30 B.C.). In the Archaic period the dress was influenced by the orient; in the Classical period it was original and harmonious; in the Hellenistic period it was luxurious.

1. Chiton.—The main dress of Greek men and women in all periods was a linen (later sometimes woolen) shirt, the chiton. Homer mentions the garment often, terming it radiant white and long. Ionian men wore it with a train, and a long chiton was worn by all men in the Archaic period, later only by elderly men, priests and charioteers. After the Persian war young men wore a short, narrow version. In its simplest form, the chiton was made of two panels of linen cloth seamed up the sides and across the top, with openings left for the head and arms. Actors and priests (for example, the priest of Athena on the central slab of the east frieze of the Parthenon) wore sleeved chitons.

The chiton worn by women was much wider than that of men (sometimes as wide as the woman's measurement from finger tip to finger tip, with the arms outstretched). Hence the openings for the arms were left at the top, rather than on the sides; in adjusting the garment the wearer brought the two edges together at the shoulder and fastened them with a brooch or brooches along the upper arms. The waist was gathered in with a girdle, the extra length (the garment was about a foot longer than the wearer was tall) making a *kolpos*, or pouch, well illustrated by the caryatids of the Erechtheum.

Artisans, warriors and slaves wore a short chiton, often with the right shoulder left free.

2. Peplos.—The main dress of women in the Early Archaic and later again in the Classical period was the peplos, a large rectangular piece of wool folded vertically (*i.e.*, just the opposite of the chiton) and worn with an overfold at the top in several different ways. Every four years the young girls of the best families of Athens, under the guidance of the priestess, wove a new peplos for the cult statue of Athena Polias, the city goddess.

Athletic Spartan girls, and other young girls, wore the peplos without a belt and with one side left open so that the leg showed. In most cases, however, a belt was worn, either around the waist or, in the Hellenistic period, much higher, just below the bust. If the overfold of material at the top was long, the belt was laid over it, and it is seen thus in many statues of Athena. If the overfold was short, the belt was placed below it and a pouch made of the excess length. For young girls both overfold and pouch were long, so that the dress could easily be lengthened for the growing girl by shortening overfold or pouch or both. When peplos and chiton were worn together the peplos served as the overdress.

The peplos and the chiton became more and more similar in form with the passage of time. Sometimes the peplos was worn without an overfold, sometimes the chiton was worn with one; an example is that worn by the caryatids of the Erechtheum. In the Hellenistic period very costly materials—cotton and silk, in addition to thin linen and wool—were used. A heavy woolen chiton was fixed on the shoulders with clasps (*perone*), and named from them a *peronatris*.

3. Himation and Chlamys.—The peplos, being merely a rectangular piece of material, could also be used as a mantle (himation). As such, in the Archaic period, it was laid symmetrically over both shoulders and the ends were allowed to hang down in front. In the Classical period it was commonly draped in such a way that a long end hung down from the left shoulder in front; the himation then was carried back over the left shoulder, across the back, across the right shoulder or hip to the front, across the body and again thrown back over the left shoulder, arm or hip. Women draped the himation over their heads when walking outside the house, as did both men and women in mourning. The many possibilities for style of draping were used by sculptors to reflect the character of the wearer of the himation.

A smaller mantle, the chlamys, worn by men only, was draped around the upper body and fastened with a brooch on the right shoulder, leaving the right arm free. The four corners hung freely on the right side. The two lower ones were rounded during the Hellenistic period.

4. Patterns and Colours.—In the Archaic period over-all patterns, as well as figured representations, ornamented fabrics. In the Classical period patterns were restricted to borders and central stripes. Priestesses wore only white, but other women used many different colours. In the Hellenistic period these became more brilliant, and many mixed colours, particularly violet, were used. Servants and artisans wore dark dresses.

5. Hair.—In the Archaic period men wore beards and long hair, but after the Persian wars they cut their hair short and in the Hellenistic period shaved their beards. Women often wore their hair parted in the centre and bound up in various ways with ribbons, diadems and scarves; chignons and loose back hair were common. Little girls wore braids and twisted locks. In the Hellenistic period the so-called melon coiffure, with many partings like the rind of a melon, was preferred by women and children.

6. Shoes.—Men and women generally wore sandals. The soles were fastened by leather thongs crossed in various ways and bound above the ankle. Men also on occasion wore high leather boots. Women sometimes wore soft closed shoes. Women's shoes became very luxurious in the Hellenistic period. White and red were preferred colours.

D. Rome

After the Tarquinii were driven out and the Etruscans defeated and brought under the supremacy of Rome in the 4th century B.C., the Romans kept the Etruscan dress, at least for their priests. After the conquest of Magna Graecia, however, in the 3rd century, Roman women adopted the chiton (Latin *tunica*) with a high belt and the himation (palla). Men also began to wear the himation (pallium). Nevertheless the Romans had a number of original forms of dress. The most characteristic feature of Roman dress is its sharp differentiation by social and professional classes.

1. Tunic.—The tunic, a shirt corresponding to the Greek chiton, was introduced to Italy by the Etruscans. It consisted of two pieces of linen sewn up the side and across the top, with holes left for the head and arms. Plebeians, herdsmen and slaves wore narrow tunics of coarse linen in dark colours; patricians wore fine white wool. For children the tunic was made wide, with large sleeves. The *tunica angusticlavia*, the tunic with narrow stripes, was worn by children of patricians until their 16th year, when they received the pure white tunic (*tunica pura*). Magistrates and knights wore the *tunica angusticlavia*, senators and other high officers the *tunica laticlavia* (with broad stripes). Women's tunics had a broad central stripe down the front. At funerals and other rites, and by brides, the tunic was worn ungirt (*tunica recta*).

In later times the sleeves were woven in one piece with the body of the tunic, and the decoration became variegated, particularly for children. In the 2nd century B.C. the sleeves became very wide, the stripes often being repeated on them; this garment was the *dalmatica*, fabricated of white Dalmatian wool. It was later taken over as a Christian liturgical vestment (*see* Vestments, Ecclesiastical: *The Dalmatic*).

2. Toga.—The distinctive Roman mantle, the toga, originally Etruscan, was worn during the early period by both men and women of all classes. Gradually it was abandoned by women, then by labouring people, then by the main body of the patricians. Throughout the history of the empire, however, it remained the state dress, the garment of the emperor and high officials of the state. Colour and purple border were rigidly prescribed for most wearers, and the style of draping became extremely complicated—so complicated that rich men had special slaves whose chief duty was handling the toga. For triumphs and, in the later period, for consuls the toga was heavily embroidered (*toga picta*). Candidates for office wore the all-white *toga candida*.

3. Hair.—In the 1st centuries B.C. and A.D. men were clean-shaven; before and after that period they wore beards. The hairdress of Roman women changed with each generation. Particularly high coiffures, often made with false hair, were worn in the periods of the Flavians, down to the Antonines.

4. Shoes.—Footwear was differentiated according to classes. Women wore closed shoes in white, red, green or yellow. Men wore sandals, those of the patricians being red with a moon-shaped ornament on the back. Senators wore brown shoes with four black leather straps wound around the leg up to the middle of the calf and tied in two knots. Consuls wore white shoes. Soldiers wore heavy boots with toes free. (Me. Br.)

III. FAR EAST

Western-style clothes, which many persons prefer to wear during business hours, are now a common sight in all the large cities of the far east, but they do not dominate the scene and are usually exchanged for traditional dress when the day's work is done. In Japan and Korea (more especially in Japan) traditional styles of dress reflect marked Chinese influence, though both countries developed characteristic styles of their own. In like manner, modes of dress in India have been a source of inspiration to some of the countries of southeast Asia and of the East Indian archipelago.

A. China

More than 2,000 years before the beginning of the Christian era the Chinese discovered the marvelous properties of silk and shortly thereafter invented looms equipped with devices that enabled them to weave patterned silks rapidly enough to satisfy the demand for them by luxury-loving Chinese society. Thus centuries before Chinese silks began to be shipped westward and still more centuries before the west learned the secret of sericulture, the people of China had already established ultrarefined standards of elegance in matters of dress.

The earliest period of Chinese history for which reliable visual evidence of clothing styles is obtainable is the Han dynasty (202 B.C.–A.D. 221). Han bas-reliefs and scenes painted in colour on tiles and lacquers show men and women dressed in wide-sleeved kimono-style garments which, girdled at the waist, fall in voluminous folds around their feet. This *p'ao*-style robe continued to be worn in China until the end of the Ming dynasty (1644). The graceful dignity of post-Han *p'ao* is revealed in Chinese figural paintings of the 8th to 12th centuries and also in the modern kimono of Japanese women, for this Chinese style, introduced into Japan in the 8th century, has been little changed in the country of its adoption during the intervening centuries.

Chinese records indicate that at least as early as the T'ang period (618–906) certain designs, colours and accessories were used to distinguish the ranks of imperial, noble and official families, but the earliest visual evidence of these emblematic distinctions in dress is to be found in Ming portraits. In some of these, emperors are portrayed in voluminous dark-coloured *p'ao* on which the 12 imperial symbols, which from time immemorial had been designated as imperial insignia, are displayed. Other Ming portraits show officials clothed in red *p'ao* that have large bird or animal squares (the so-called "mandarin squares" or *p'u-fang*) on the breast, specific bird and animal emblems to designate each of the nine ranks of civil and military officials having been adopted by the Ming in 1391.

When the Manchus overthrew the Ming in 1644 and established the Ch'ing dynasty, it was decreed that new styles of dress should replace the voluminous *p'ao* costume. The most formal of the robes introduced by the Manchus was the *ch'ao-fu*, designed to be worn only at great state sacrifices and at the most important court functions. Men's *ch'ao-fu* had a kimono-style upper body with long close-fitting sleeves that terminated in the "horse hoof" cuff introduced by the Manchus and a closely fitted neckband over which was worn a detached collar distinguished by winglike tips that extended over the shoulders. Below, attached to a set-in waistband, was a full pleated or gathered skirt. Precisely stipulated colours and pattern arrangements of five-clawed dragons and of clouds, waves and mountains were specified for the *ch'ao-fu* of emperors, princes, nobles and officials; the bright yellow of the emperor's robe and the 12 imperial symbols emblazoned on it clearly establishing his lofty rank. All other ranks wore "stone blue" *ch'ao-fu* decorated in accordance with prescribed rules about the number, type and arrangement of the dragon motifs.

Among women, only those of very high rank were permitted to wear *ch'ao-fu*. Women's robes were less commodious than the men's and were cut in long straight lines with no break at the waist. The narrow sleeves with "horse hoof" cuffs of these *ch'ao-fu* robes and the arrangement of their dragon, cloud, mountain and wave patterns were essentially the same as those of the so-called dragon robes discussed below. They were clearly differentiated from the dragon robes, however, by their capelike collars and by flaring set-on epaulets which, gradually narrowed, were carried down under the arms. Stolelike vests, always worn over women's *ch'ao-fu*, were also a distinguishing feature of this costume. The colour of the empress's *ch'ao-fu* was bright yellow, related shades being worn by princesses and wives of princes.

Chi-fu, or "dragon robes" (*lung-p'ao*) as they were usually called, were designed for regular court wear by men and women of imperial, noble and official rank. The *chi-fu* was a straight kimono-sleeved robe with a closely fitted neckband that continued across the breast and down to the underarm closing on the right side, the long tubular sleeves terminating in "horse hoof" cuffs. The skirt of the *chi-fu* cleared the ground to permit easy walking and in men's garments was slit front and back as well as at the sides to facilitate riding, these extra slits being the only feature which distinguished the *chi-fu* of men below the rank of emperor from those of their wives. All *chi-fu* were elaborately patterned with specified arrangements of dragons, clouds, mountains and waves, to which were added auspicious and Buddhist or Taoist motifs. Distinctions in rank were indicated by the colours of the robes and by slight variations in the basic patterns, but because of the large number of personages who wore *chi-fu* these distinctions were not always easily recognizable. Emperors' *chi-fu*, either yellow or blue, were always distinguished by the 12 imperial symbols, but these have also been found on a number of empresses' robes (which have identifying dragon sleeve bands), even though the Ch'ing regulations did not prescribe them for wear by the empress. A large number of *chi-fu*, including those worn by emperors and empresses, were acquired by western museums after 1912 when the overthrow of the Manchu regime and the establishment of the Chinese republic did away with the official hierarchies of imperial China; these provide a rich but complicated field of study.

The *p'u-fu*, a three-quarter-length coat worn by men and women over their *ch'ao-fu* and *chi-fu*, became an important adjunct of Ch'ing dynasty dress because it proclaimed the wearer's exact rank at a glance, being made of plain purplish-black silk on which his insigne was emblazoned in bright colours and gold. The specially designated *kun-fu* of the emperor and the *p'u-fu* of his family were distinguished by specific numbers and arrangement of five-clawed dragon medallions; the *p'u-fu* of nobles had squares enclosing four-clawed dragons or other mythical beasts; and the *p'u-fu* of civil and military officials each had their appropriate *p'u-fang* or mandarin squares.

The informal Manchu *ch'ang-fu*, a plain long robe, was worn by all classes from the emperor down, although Chinese women also continued to wear their Ming-style costumes consisting of a three-quarter-length jacket and pleated skirt. Men's *ch'ang-fu*, cut in the style of the *chi-fu*, usually were made of monochrome patterned damask or gauze; women's *ch'ang-fu* had wide loose sleeves finished off with specially designed sleevebands and gay woven or embroidered patterns. Modern Chinese dress developed directly out of these *ch'ang-fu* styles. Men's robes underwent very little change. Women first narrowed the *ch'ang-fu*, then cut the sleeves off at the shoulders, and finally shortened the skirt and slit it up the sides to form the present sheath style.

B. Japan

The earliest representations of dress styles in Japan are to be found in 3rd- to 5th-century clay grave figures (*haniwa*), a few of which show men and women wearing meticulously detailed two-piece costumes consisting of crossed-front jackets that flare out over the hips, the men's worn over full trousers, which, banded above the knees, hang straight and loose beneath; women's jackets were worn over pleated skirts.

Two-piece costumes appear to have been worn regularly during the 7th and 8th centuries, the jackets of this period being called *kinu*, the men's trousers *hakama* and the women's skirts *mo*. It is known, however, that during the Nara period (710–784) Japanese court circles adopted Chinese court dress, the most characteristic feature of which was the long kimono-style *p'ao* garment, so it must be supposed that the *kinu*, *hakama* and *mo* were the accoutrements of middle- and lower-class society, though these garments may also have been adapted for wear under the *p'ao*. Very little specific information about Chinese court dress of this period seems to have been recorded in either China or Japan, but it is clear that emblematic colours and patterns as well as the *p'ao* style were borrowed from China because modern court dress in Japan, which has been little changed since the 12th century, has many purely Chinese characteristics.

The most important court costumes of Japan are the *sokutai* of the emperor and the *junihitoe* of the empress, which are worn only at coronations and at very important ceremonial functions. (Similar costumes are worn by the crown prince, by princes and princesses of the blood, by high officials and by ladies in waiting.) The most interesting features of the emperor's *sokutai* may be summed up as follows: the voluminous outer robe (*ho*) is cut in the style of the Chinese *p'ao* but is given a distinctively Japanese look by being tucked up at the waist so that the skirt ends midway between the knees and the floor. This *ho* robe is yellow (the colour worn only by emperors and their families in China), and it is patterned with *ho-o* birds and *kilin* (japanized versions of the mythical Chinese *feng-huang* and *ch'i-lin*). The outer and most important of three kimonos worn under the *ho* is the *shitagasane*, which has an elongated back panel that forms a 12-ft. train. The

shitagasane is made of white damask, as are the baggy white trousers (*ueno-hakama*) that are a characteristic feature of the *sokutai* costume. Both these garments and the cap-shaped headdress (*kammuri*) of black lacquered silk with its upright pennon decorated with the imperial chrysanthemum crest are purely Japanese in style, but the ivory tablet (*shaku*) carried by the emperor when wearing the *sokutai* was undoubtedly inspired by the tablets of jade which Chinese emperors carried as symbols of their imperial power.

The outermost garment of the empress's *junihitoe* costume is a wide-sleeved jacket (*karaginu*) which reaches only to the waist. This has a pattern of *ho-o* bird medallions brocaded in colours of the empress's choice. Attached to the waist at the back of the *karaginu* is a long pleated train (*mo*) of sheer white silk decorated with a painted design. The outer kimono (*uwagi*) is very large to accommodate the many layers of kimono worn under it, the abnormally long skirt swirling out fanwise around the wearer's feet. This too is made of rich brocade, its design and colours being a matter of personal taste. Under the *uwagi* the empress wears a plain purple kimono, and under that the robe known as *itsutsuginu*, which has multiple bands of coloured silks (usually five) attached at the edges of the sleeves, at the neckline and at the hem, giving the appearance of several robes worn one over another. No special interest attaches to the *hitoe* kimono worn under the *itsutsuginu* or to the *kosode* worn next to the body, but the divided skirt (*naga-bakama*) which completes the costume is an extremely picturesque garment. Made of stiff red cloth and fastened high up under the breasts, the *naga-bakama* covers the feet in front and is carried out in a train in back. An elaborate coiffure known as *suberakashi* and special hair ornaments affixed directly over the forehead are worn with the *junihitoe*, the empress's ornaments being a lacquered, gold-sprinkled comb surmounted by a gold lacquered chrysanthemum crest.

Other types of dress formalized in the 12th century were the *noshi* (courtiers' everyday costumes) and the *kariginu*, worn for hunting. Both these garments were voluminous hip-length jackets worn with baggy trousers tied at the ankles. At this time also it became necessary to devise special costumes for the newly formed samurai caste. The *hitatare*, the formal court robe of samurai, and the *suo*, a crested linen robe designed for everyday wear, though more closely related in style to the Chinese *p'ao* than the *noshi* and *kariginu*, were characterized by V-shaped necklines accentuated by inner-robe neckbands of white. Several centuries later the samurai adopted the *kamishimo*, a striking jumperlike garment with extended shoulders and pleated skirt-trousers that was worn over the *hitatare*. This costume probably inspired the later fashion of wearing skirt-trousers (*hakama*) over a full-length black kimono which, together with the short black *haori* coat, is today the approved formal attire for Japanese men.

The basic kimono style that was adopted by Japanese women during the Nara period has remained amazingly close to that of the *p'ao* robes worn by the women of T'ang China. The kimono is usually thought of as a Japanese invention, and it was in fact the master designers and dyers of Japan who, in the 17th and 18th centuries, evolved styles of decoration that have made it the most beautiful garment in the world. The practice of wearing short-sleeved kimono (*kosode*) as outer garments and belting them in with narrow sashes (*obi*) originated during the Muromachi period (Ashikaga shōgunate; 1392–1573) when samurai women began to wear a voluminous outer kimono (*uchikake*) as a kind of mantle. Eventually, the *kosode* came to be worn only by married women, the long-sleeved *furisode* being reserved for young unmarried girls. The wide obi, which is today the most elegant feature of the Japanese costume, was not adopted until the early 18th century, and it was at this time also that women first began to wear the short *haori* coat which has come to be an important feature of Japanese women's dress.

Yukata, which are worn by both men and women, are cotton kimono with stencil-dyed patterns (usually done in shades of indigo) that were originally designed for wear in the home after a bath. Because it has become accepted practice to wear *yukata* on the street on warm summer evenings, the cottons designed for them have become increasingly handsome.

C. Korea

Some of the basic elements of modern dress in Korea, the *chogori* (jacket), *paji* (trousers) and *turumagi* (overcoat), were probably worn at a very early date, but the characteristic two-piece costume of today did not begin to evolve until the period of the Three Kingdoms (57 B.C.–A.D. 688). During the early part of this period both men and women wore tight waist-length jackets and short tight trousers, and it is believed that the Koreans' traditional fondness for white clothing dates from this period.

Korean records state that special costumes for court wear modeled after those of T'ang China were adopted during the reign of Kim Ch'unch'u (654–660), but Chinese influence on Korean dress at this period is verifiable only in changes that occurred in the everyday costumes of the nobility. Noblewomen formerly had worn tight trousers and jackets (which continued to be worn by the poorer classes); now they began to appear in wide-sleeved hip-length jackets belted at the waist and in full-length skirt-trousers. The corresponding dress for noblemen was a narrower tunic-style jacket, cuffed at the wrists, belted and worn with roomy trousers bound in at the ankles. The most striking evidence of Chinese influence at this time is to be seen in the style of the *turumagi* overcoat worn by noblemen, pictured in fresco paintings as a voluminous full-length garment made almost exactly like the *p'ao* robe of T'ang China. One-piece robes were never worn in Korea until the late 13th century when the court was forced to adopt Mongol dress; after Mongol domination ended in 1364, Koreans wore the one-piece robe only at wedding ceremonies.

In the 15th century Korean women began to wear pleated skirts (*ch'ima*) and longer *chogori*, a style undoubtedly introduced from China. Noblewomen wore full-length *ch'ima* to indicate their social standing, and began gradually to shorten the *chogori* until eventually it attained its present length, just covering the breast. This style made it necessary to reduce the fullness of the skirt somewhat in order to make it possible to wear it raised up almost to the armpits, which remains the fashion.

The adoption of Chinese-style *p'u-fang* (mandarin squares) as emblems of rank for civil and military officials (who wore them on their *turumagi*) appears to have been the only notable example of Chinese influence on men's dress at this period. Otherwise few changes were made until 1894, when class distinctions were relaxed by government decree. It was at this time that the *turumagi* was shortened and narrowed to its present form.

The most picturesque costume of modern Korea is that of men of leisure, *yangban*, who are past 60 years of age. The *yangban* wear white almost exclusively, their costumes consisting of full trousers tied at the ankles with ribbons, over which is worn a short *chogori* and a fitted vest and, over all, the loose *turumagi*, which falls just below the knees and is tied at the breast. The patriarchal appearance of the *yangban* (who is usually bearded) is accentuated by the black horsehair hat he affects, its flat brim and high crown giving him somewhat the appearance of one of the Pilgrim Fathers. Younger men wear a similar costume (though not the hat) in gray, light blue or light brown.

Women's costumes feature the bolero-style white *chogori* finished off at the neck by a figured band or ribbon that ties from left to right, and high-waisted *ch'ima* which in formal costumes is a full billowing garment made of beautifully patterned silk.

D. India and Pakistan

The Hindu population of India comprises about 2,000 castes, the members of which wear clothes and ornaments that clearly indicate their caste. The subject of dress in India, therefore, cannot be dealt with satisfactorily in a few paragraphs. Some of the principal features of upper-class Hindu and Muslim dress and the history of their development can, however, be sketched briefly.

The ancient origin of two of the most characteristic garments of modern India, the dhoti worn by men and the sari worn by women, is verifiable in sculptured reliefs dating back as far as the 2nd century B.C. In these and in slightly later reliefs both men and women are pictured wearing a long piece of cloth wrapped around

the hips and drawn between the legs in such a fashion that it forms a series of folds down the front. The upper bodies of both men and women were unclothed, though women wore a narrow cloth girdle. Men are pictured wearing large turbans, women head scarves that fell to the hips. Women also wore a great amount of jewelry—bracelets, anklets, jeweled necklaces and girdles—men's ornaments consisting solely of bracelets.

No major change in costume appears to have been made until the 12th century, when the Muslims conquered north and central India. In this part of the subcontinent radical new dress styles were adopted to conform with Muslim practice, which required that the body be covered as completely as possible. Men's costumes thereafter consisted of the jama, a long-sleeved coat that reached to the knees or below and was belted in with a sash, and wide trousers known as isar. These garments and the *farji*, a long gownlike coat with short sleeves that was worn by priests, scholars and high officials, were made of cotton or wool, silk being forbidden to men by the Koran. Somewhat modified, these traditional styles continue to be worn by upper-class men of Pakistan.

Women's garments dictated by the Muslim conquerors consisted of wide-topped trousers snugly fitted around the calves of the legs, a long shirtlike garment and a short fitted outer jacket. Silk was not forbidden to women, and highborn women, forced to spend their lives in seclusion, devoted a great deal of time and money to their costumes. The Mogul emperor Akbar's Rajput wives, inspired by the profusion of luxurious fabrics available in India, designed a graceful new style of dress which Muslim women adopted forthwith. This costume consisted of an open-front pleated skirt, (*ghagra*) worn with a long apronlike panel over the front opening, and a short-sleeved breast-length jacket (choli). The *ghagra* and choli continue to be basic elements of Muslim women's dress, the loose front panel having been replaced by the traditional sari, which is worn as an overgarment, one end being draped around the hips, the other carried up over the shoulder or head.

Dress in southern India was little affected by Muslim rule in the north. The dhoti continued to be worn by most Hindu men (it is forbidden to some castes) and the sari by women. Some additions to these traditional costumes have been adopted. On formal and semiformal occasions many Hindu men wear a long, full-skirted white cotton coat, which reaches to the knees and buttons down the front from top to bottom, over jodhpur-style white trousers; and most Hindu women wear a short choli-style jacket under their sari or a loose waist-length bodice. (Pa. S.)

IV. WESTERN WORLD

A. Europe Through the 18th Century

1. Middle Ages.—In the early middle ages the clothes of both men and women in western Europe showed very little change from those of five centuries before, when Gaulish and Germanic costume had been assimilated to that of Rome, toga abandoned and trousers, usually loose and cross-gartered, added. Short tunics, sometimes two at once, often made of undyed woolen cloth, were worn almost universally. Shoes were simple moccasins, often made of untanned leather. An ample cloak completed the outfit. Such a costume remained that of men of the lower classes for many centuries. Women wore a rather long, shapeless dress concealing the lines of the figure. The sleeves were long and wide and beneath them could be seen the tight-fitting sleeves of the underbodice. There was very little decoration, and colours were simple, mainly earth colours and vegetable dyes. The hair was entirely concealed by a veil.

The feudal lords returning from the crusades introduced oriental luxuries such as silks and damasks. Trousers were replaced by close-fitting hose, revealed by a tunic that at first reached to the knees and later to the ankles. The long, full gown had tight, embroidered or bejeweled sleeves, and round the hips was worn a decorated belt from which hung the pouch, sword and dagger. There was also a straight overmantle fastened round the neck by a cord, chain or jeweled clasp. Improvements in weaving and dyeing made possible a wider range of colours, and the garments of both sexes began to be trimmed with fur. The typical male headgear consisted of a hood framing the face and forming part of a short cape over the shoulders. The hood was sometimes lengthened at the back to form a point or even a long tail known as a liripipe.

The shaping of garments to the body, for both men and women, began at the end of the 13th century, and by the middle of the 14th something that can be recognized as "fashion" appeared. Men wore a gipon, a kind of short tunic, tight-fitting and buttoned down the front; the sleeves were very tight and long enough to cover the knuckles, the neck was round and low. When the gipon was worn without the overgarment called a cote-hardie (a close-fitting, long-sleeved tunic long enough to cover the buttocks), it was belted round the hips. The tight hose were revealed, the two legs often of different colours. The upper garments were sometimes similarly of divided colour and adorned with heraldic emblems; at this period both men and women often wore their coats of arms on their own persons. Shoes, long and pointed, were known as *crackowes* after the Polish city of Cracow; it is thought that the marriage of Richard II of England to Anne of Bohemia (Poland at that time being part of the kingdom of Bohemia) was responsible for this fashion. Gloves, at first worn by kings and bishops as a status symbol, were worn universally among the upper classes in the 14th century.

A characteristic overgarment from 1380 to 1450 was the houppelande, later called the gown. It fitted the upper part of the body but fell below the waist in folds. The neck had a high, upright collar the edge of which was often "dagged," or cut in fancy shapes. The hood also was dagged and, between 1390 and 1410, the peculiar mode arose of inserting the head into the face opening, winding the folds round like a turban and binding them in place with the liripipe. The dagged edge thus formed a kind of cockscomb. Hats were also worn with a plume attached by means of a jeweled brooch.

Women continued to wear the kirtle or gown, but, like men's clothes, more closely fitted, and now décolleté. Sleeves were extremely tight with many buttons. The cote-hardie had long sleeves sometimes reaching to the ground. Over it, for more than a century, women wore a sideless surcoat consisting of a front and back descending to below the waist. In headdresses there was increasing elaboration. Older women continued to wear the veil and the wimple, a piece of cloth covering the chin, but the court ladies adopted a kind of circular arch of goffered linen. Another fashion was to frame the face by means of two pillar-shaped structures of net enclosing the side hair.

After 1400 men were clean-shaven; were, indeed, almost compelled to be so because of the introduction of a helmet with a chinpiece instead of the cowl of mail usual in the preceding century. They also cut their hair short, and after 1410 the "bowl crop," which looked as if the hair had been shaved round a bowl, was usual.

About 1420 the gipon, now called a doublet, began to develop a collar. The cote-hardie worn over it was very short at the beginning of the century, but knee-length from about 1410 to 1450. The houppelande or gown showed considerable variation in the shape of the sleeves. The belt was now usually worn at the waist instead of round the hips. Materials were richer, and there was an increasing use of fur trimming. Hose now began to be joined together like modern theatrical tights and were attached to the lower edge of the doublet by "points" or strings. The hood became rare except among the peasantry, the usual form of headgear being the chaperon, a kind of ready-made turban. There was an increasing use of hats, some of them resembling the top hats of a later age. Women's headgear assumed fantastic shapes, and the hennin, or steeple headdress, was fashionable in France and Flanders between 1460 and 1480, though it never became popular in England. There were also a turban for women and the so-called "butterfly headdress" of transparent gauze raised above the head by means of long pins.

In the second half of the 15th century men wore, under the very short doublet, a kind of padded waistcoat, known confusingly as a petticoat. The shoulders of the doublet were puffed and padded. A tall brimless hat, like a Turkish fez, was worn. For women the

sideless surcoat was replaced by the gown, often with a very deep décolletage. Skirts were very long, often with a train.

2. 16th Century.—The characteristic English fashions of the 16th century were beginning to appear at the time of the accession of Henry VII in 1485. For women the butterfly headdress was replaced by a low hood lined with fabric of a contrasting colour and turned back in a broad fold. When this was stiffened in the shape of a flat arch it developed into the "Tudor" headdress. The hair was completely concealed.

Men were still clean-shaven but wore their hair long. Hats were sometimes adorned with large feathers. Long, pointed shoes gave place to extremely broad shoes. Sleeves, sometimes detachable, also became noticeably wider. They were nearly always puffed and slashed, a curious fashion supposed to have been derived from the costume of German mercenaries. The doublet was longer, reaching almost to the knees, but parted in the front to reveal that astonishing item, the codpiece. Under the doublet men wore a waistcoat, over it a jerkin or jacket and over that a sleeveless and heavily furred gown. All prosperous men wore a gold chain, and this, together with the sleeveless furred gown, has survived as the traditional dress of English mayors. The hat was generally small and worn over one ear. After 1530 it was the fashion to cut the hair short and wear a full beard.

Women wore the kirtle, a bodice and skirt sewn together, and over it the gown, tight-fitting to the waist and falling in ample folds to the ground. Toward the end of Henry VIII's reign it was given a curious bell-shaped sleeve, narrow at the shoulder and opening out to an enormous fur cuff. Trains became shorter after 1530 and ten years later disappeared entirely. The neck of the gown was cut low and square, revealing the neck of the kirtle and, below that, the top of the chemise. The English hood, or Tudor arch headdress, was gradually replaced by the French hood, which was smaller and worn farther back on the head, exposing the hair above the forehead.

The German influence that had been dominant in the first half of the century gave place about 1550 to Spanish. The new effect was narrower, tighter and more formal. The doublet had a narrower sleeve and its skirts shrank almost to the waist. Puffed trunk hose, frequently slashed in contrasting colours, covered the hips and thighs. The characteristic cloak was short, reaching only to the hips, and, about 1560, it was the fashion to wear it attached to one shoulder only.

The most striking characteristic of both men's and women's costume in the second half of the 16th century was the ruff, a frill of folded linen, worn round the neck, that gradually grew larger and larger. It was at first supported by wires, but the invention of starching made these unnecessary. Women's ruffs were worn above or divided in front to show the décolletage. With the ruff was sometimes worn the rebato, a wired collar edged with lace and standing up behind the head in the shape of wings. This is the style familiar from portraits of Queen Elizabeth I. Much jewelry was worn by men, chiefly in the form of gems sewn onto the doublet. Women's stomachers were similarly adorned, and women in addition wore necklaces and ropes of pearls.

Women's skirts grew wider and wider and were kept distended by a roll farthingale, a padded roll worn round the hips, or by a wheel farthingale, which made its wearer look as if she were standing in a large drum. The dresses, however, were sometimes sufficiently short to show the clocked and molded stockings made possible by the invention of the stocking frame. In the last quarter of the century, women wore their hair turned back from the forehead over a pad or a wire frame known as a *palisado*. Men generally wore their hair short, and beards were almost universal: pointed, forked or spade shaped, sometimes even dyed crimson. Many men adopted the curious fashion of wearing an earring in one ear. The flat caps that had been worn in the first half of the century were replaced among the fashionable by hats of various kinds. Apprentices and others of low degree were ordered to wear woolen caps, but the law was ineffective and was repealed in 1597. Women wore hats only for riding or traveling.

3. 17th Century.—The modes of the 16th century continued almost unchanged until after the death of Queen Elizabeth I and even during the early years of the reign of James I. The change came about 1610 with the disappearance of trunk hose and the vogue for longer and tighter breeches. Tall hats ornamented with feathers gave place to low-crowned, wide-brimmed hats. Instead of shoes are found wide boots reaching to the knee and turned down, or half-length boots with wide tops. Ruffs were replaced by wide collars falling over the shoulders and edged with lace. This became the characteristic Van Dyck collar of the Cavaliers; in a plainer form it was worn by the Roundheads also. Women's neckwear showed the same transition, although sometimes the ruff and falling collar were worn together. On their heads women began to wear a square piece of material pinned round the back of the head and known as a head roll. The bodice was now short-waisted, with a round instead of a square décolletage, often laced up the front with a ribbon. The sleeves were wide and sometimes puffed and slashed. The skirt, instead of being distended over a farthingale, was now bunched up to reveal a petticoat. Among the men long hair showed Royalist and short hair Puritan sympathies.

The Puritans' costume was similar to that worn by their Dutch contemporaries; the Cavalier costume was essentially French. The Restoration of Charles II was a real victory for French over English fashion. The doublet had become so short that the shirt was revealed between it and the breeches, and its sleeves also were very short, reaching just to the elbow. The breeches, loose at the knee like very wide shorts, were called Rhinegraves. Every item of clothing was lavishly decorated with ribbons. The falling collar had become a kind of bib edged with lace.

Then, in 1666, there was a complete revolution in masculine attire. The diarist Samuel Pepys records: "This day the King begins to put on his vest . . . being a long cassock close to the body of black cloth . . . and a coat over it." The other great diarist of the period, John Evelyn, calls it "a comely dress after the Persian mode." The new costume, which by 1670 was firmly established in both England and France, consisted of a long coat with wide turned-back sleeves and a row of buttons down the front. Some of these were left unbuttoned to reveal a garment almost identical but without sleeves. Neither coat nor waistcoat (as the undergarment begun to be called) was provided with collar or revers, but a cravat of lace or muslin, sometimes with a bow, was worn. Breeches were tight-fitting, and the stockings, gartered below the knee, were pulled up over them. The outfit was completed by the wig and a hat which had already begun to be cocked but had not yet become a tricorn, or three-cornered hat. There was not much change in women's dress during the first 20 years of the reign of Charles II, though women's garments gradually became stiffer and more formal. They aimed at an effect of height, and this tendency culminated in the last decade of the 17th century in the fontange or topknot, a high lace cap supported on a wire frame.

4. 18th Century.—Men's dress remained static for almost the whole of the 18th century, the typical costume consisting of a long square-tailed coat, embroidered waistcoat, tight knee breeches and clump-heeled square-toed shoes. The three-cornered hat was universal. As the century progressed, the waistcoat grew gradually smaller until it assumed something like its 20th-century form. The wig and hat grew smaller also. The fashion of powdering the hair gave a touch of artificiality and served to distinguish the upper from the lower classes. There was no real change in essentials until the eve of the French Revolution.

Women's dress was not so constant. Shortly after the death of Queen Anne the farthingale returned under another name and in a rather different form, known at first as the hoop skirt and later under the French name of *panier*, or pannier. By 1730 it had become a general European fashion. Panniers were structures of osier reeds or whalebone, rather like a country woman's basket, worn on the hips so that the skirt was extended sideways and not all the way round. The extreme width even had an effect on the architecture of the period, and the curved balusters of the staircases, specially constructed to allow for the passage of women's voluminous skirts, may still be seen. The hair, however, was now dressed close to the head, the towering fontange having been completely abandoned.

A charming fashion of the first quarter of the century was the so-called "Watteau gown," a loose gown, worn over a tight bodice, with long, vertical pleats falling from the shoulders to the ground. At first it was a *négligé*, but by the 1730s it had become the accepted *robe à la française*, or French dress. As dresses grew less formal the materials of which they were made became lighter; heavy brocades gave place to flowered taffetas and damasks and even to delicate lawns and dimities. Men's coats, plain and dun coloured at the beginning of the century, began to be embroidered all over or made of patterned velvet. The shirt ended in a frill of lace at wrist and throat. The silk stockings, now usually white, ceased to be rolled over the knees. The three-cornered hat became much smaller, and was sometimes carried under the arm so as not to disturb the wig.

In women's dress, in 1750, there was a striking decrease in the size of hoops. The triangular-shaped bodice, long and with a tight waist, was cut very low in a square décolletage. The bodice was sometimes laced across the front with ribbons, the corset thus not being a separate garment but forming part of the dress. In cold weather small capes and even large cloaks were worn. Muffs were popular with both men and women, some of them large enough to hold a small lap dog.

In the 1770s women's hair began to rise from the head and the general effect was once more of height rather than width. The shape of dresses began to be modified, the side panniers being replaced by a pad worn at the back, giving the appearance of a bustle.

The1790s saw a fundamental change in both men's and women's costume, essentially a change from court modes to country modes. Instead of the tricorn men began to wear a hat which, with its narrow brim and high crown, is the obvious ancestor of the top hat. Embroidery disappeared from men's coats, and the skirts were cut away in front. What resulted was a hunting or riding costume. Boots were substituted for pumps, and swords ceased to be carried. Men began to wear their own hair instead of wigs, and toward the end of the century they gave up the use of powder.

Women's clothes showed a new simplicity based upon what were supposed to be classical modes. About 1795 the waist became extremely high and remained so for a quarter of a century. The materials used were very plain and thin; in France transparent fabrics were occasionally worn. High-heeled shoes were replaced by heelless slippers, and caps were discarded in favour of bandeaux. From 1794 to 1797 there was a fashion for wearing two or three large ostrich plumes in the hair, and this fashion, slightly modified, persisted in court dress into the 20th century. Dresses were so scanty that cashmere shawls and wraps of various kinds came into fashion as well as the spencer, a short tailless coat with tight-fitting sleeves.

These modes, both masculine and feminine, had been anticipated by children's clothes a generation before. It was not until the middle of the 18th century that there were any special clothes for children, who were dressed as replicas of their elders except that boys wore their own hair instead of wigs. Like adults they had full-skirted coats, tricorn hats and lace ruffles; little girls wore long dresses and were tightly laced even from infancy. Jean Jacques Rousseau's theories of education induced many upper-class parents to clothe their children in more sensible garments. By the 1770s boys were wearing soft shirts and comfortable trousers and girls loose white dresses with a hint of the high waist. (J. Lr.)

B. Colonial America

1. Early Period.—The settlers of the new world brought with them habits of and ideas concerning dress that were characteristic of their places of origin. Basically, however, the dress of the American colonists was completely under English influence. Historical events of the 17th century in England had their influence on costume, and plain dress and rich dress became, in effect, the respective symbols of Puritan and Cavalier. Many Virginia colonists leaned toward the Cavaliers; Puritan ideas prevailed in Massachusetts. Virginia dress, though it differed little in design from that of New England, was in general more costly. The Puritans omitted such extravagances as fine brocades, rich laces, ribbons and feathers; the change to simpler dress that had begun before their departure for America continued.

Probably the greatest change in clothing, in America as opposed to Europe, took place in everyday working costume, the Americans wearing heavier and warmer clothing made of stronger and stouter materials. The distinguishing characteristic of all clothes listed in the inventories of the colonization companies is their wearing quality, and the terms "heavy cloth" and "strong durable stuff" are often encountered. Men, boys and workmen wore comfortable, durable jackets and breeches made from deer and buckskin tanned to the consistency of fine chamois with the use of animal brains, a process the colonists learned from the Indians. Courts of both Virginia and New England forbade the use of rich dress and ornaments by persons of small means, although there is no record of fines imposed for this offense in Virginia. The Dutch were not restricted in their dress, which was sometimes more colourful and exhibited more lace.

Men wore breeches full at the waist and knee; the mandilion, a loose cloak, often lined with fabric of a different colour; doublet and jerkin, somewhat similar garments resembling a jacket, often sleeveless when designed to be worn over another garment; the cassock, similar to doublet and jerkin but longer; and the buffcoat, a strong coat of buff leather, with or without sleeves, tied by a wide sash around the waist. The doublet was especially important, worn by both men and women and by children, its high, tight collar often surmounted by a stiff linen collar or band. It was made of two thicknesses of cloth and welted at the armhole, the welt or wing being a piece of cloth set over the armhole where body and sleeves met. The everyday dress of women was a short gown of durable material, with a full skirt over a homespun petticoat, covered by a long apron of white linen. The more stylish dress was longer and made of finer material. It often had the virago sleeve, full at elbow and shoulder and drawn in at intervals by strings of narrow ribbon, which appears in most 17th-century portraits of American women and children.

Slashed clothing was fashionable, as in England; in the openings made by the slashes could be seen rich materials. In 1634, however, the general court of Massachusetts forbade men and women to make or buy clothes with more than one slash in each sleeve and another in the back. The starched ruff of the early 17th century gave way to the falling band, the common form of which was a broad, plain linen collar. Both men and women wore this collar and plain linen turn-back cuffs.

Stockings were either knitted or cut from woven cloth and sewn to fit the leg. They were attached to men's breeches by points, which were also used to secure other garments; later, sashlike garters replaced points. Both men and women wore stout leather shoes with medium heels. Men also wore French falls, a buff leather boot with a high top wide enough to crush down. After 1660 the jack boot, a shiny black leather boot large enough to pull over shoe or slipper, replaced the French falls; oxfords of black leather were worn by school children.

Both men and women wore the steeple hat of felt or the more expensive beaver. Men also wore the *montero* cap, which had a flap that could be turned down, and the Monmouth cap, a kind of stocking cap. Women of all ages wore the French hood, especially in winter, when it was made of heavy cloth or fur-lined; this hood, tied loosely under the chin, is seen in many portraits of the time. Sometimes the steeple hat was worn on top of the hood.

About 1660, as in France and England, the doublet, jerkin and cassock were gradually transformed into the coat, which became the general style of man's attire. The vest, cravat, sash garters, buckled shoes and wigs all came in about the same period. By 1690 breeches were cut to fit the leg.

As colonial wealth increased, so did refinements in clothing. Many portraits of American women in the last half of the 17th century show costume as stylish as that worn in England. The skirt of the woman's gown was gathered to the bodice and hung full to the floor or was open in front to show the petticoat; sometimes the sides were caught together in the back. This increasing back fullness developed into the bustle, which lasted until about 1711 when the hoop came in. Small, elegant aprons became fashionable.

It was in the last quarter of the 17th century, too, that the characteristic men's clothing of the 18th took shape: the periwig, the tricorn hat, the ruffle of lace or sheer linen at throat and wrists, the long waistcoat, the skirted coat with wide, turn-back cuffs, tight breeches, stockings and buckled shoes.

2. 18th Century.—Fashion was a noticeable element in the first half of the 18th century in America. No laws restricted fine dress in this prosperous period, and merchant ships brought to all the seaport towns elegant fabrics as well as other luxuries. Dresses and suits of homespun, stout shoes and durable cloaks were worn as before, but those who could afford to do so had stylish dress. There was no waste of fabric, however. The cherished brocade dress, the fine suit and embroidered waistcoat were often bequeathed by will to the second and even the third generation. There were no fashion plates, but jointed dolls dressed in the latest styles were sent at regular intervals from London to the American colonies.

The most fashionable woman's dress during most of the 18th century was the sacque, or "Watteau gown" (*see* above), whose ample folds displayed to full advantage the costly material of which it was often made. The commonest woman's dress, however, one worn with variations both before and after the sacque, was a dress with a long-waisted, pointed bodice, a full skirt, a rather low, rounded or square neck and a close-fitting sleeve with a ruffle at the elbow. Stays, or corsets, were a necessary article of dress.

The woman's dress shoe was a brocade slipper with a French heel and usually a buckle. Often the patten, or overshoe, worn to shield the slipper, was made of the same material. As in the 17th century, cloaks were worn extensively, called by such names as pompadours, roquelaures, capuchins and cardinals. The cardinal, a hooded scarlet cloak, was worn during the entire century.

Hoods, which previously had been made ordinarily of black silk or heavy cloth, now came in fine fabrics and gay colours. The calash, a great bonnet that resembled the extension top of a *calèche*, or French carriage, was worn with the high, pompadour style of hairdress. This head covering, usually of thin silk, with whalebone or rattan run at two- or three-inch intervals through shirrings, could be pulled over the face or pushed back. The mobcap, a huge white lace or lawn cap with deep-hanging frills, was also worn. Gypsy hats and the skimming-dish hat, or skimmer, both of leghorn straw, were worn after 1750.

From 1770 to 1780 the polonaise gown was popular. The bodice was fitted as before, but the full skirt was curved away from the front and caught up on either side at the back so that it fell in three large loops, showing the elaborately quilted or embroidered petticoat. A long apron of sheer, embroidered linen was worn with the open-front gowns of this period. Gold beads and fans for women and the snuffbox for men were important accessories.

Little had happened to the man's costume described at the close of the 17th century save a shortening of the waistcoat, a decrease in the size of the turn-back cuffs and the wig, and the replacement of the cravat by the stock, which fastened at the back so that the frilled edge of the shirt could be seen at the open front of the waistcoat. After 1760 breeches were fastened at the knee with buttons and a small buckle, and the front of the coat, which was developing a collar, was cut away at the sides. Unpowdered, natural hair became popular for both men and women. (A. W. Mu.)

C. Europe and America, 19th–20th Centuries

1. Early 19th Century.—The dress of the Regency dandy was a smartened version of the country clothes described above. Beau Brummell, whose clothes were copied by the prince regent himself, was so concerned with fit that he had his coat made by one tailor, his waistcoat by another and his breeches by a third. The top hat became almost universal. The neckcloth was so elaborate and voluminous that Brummell's valet sometimes spent a whole morning getting it to sit properly. It was at this period that English modes for men became everywhere accepted as correct, even in Napoleonic France.

France continued, however, to dictate women's fashions, except for an interlude between 1802 and 1814 when communication was difficult and English dresses diverged noticeably from those worn in Paris. However, after the abdication of Napoleon in 1814, English women's clothing immediately reverted to Parisian styles. The French waist was still high but the skirt had become wider at the hem and was rather heavily decorated at the lower edge to make it stand out. The invention of the fashion plate meant that fashions now filtered down the social scale more quickly. The only real change in men's dress after 1814 was that trousers began increasingly to replace breeches; in summer they were usually made of white duck.

In 1820 women's waistlines resumed their normal position, becoming steadily tighter and tighter. Skirts continued to expand, being sometimes weighted at the lower edge with a band of fur. Colour came back again after a long eclipse and there was a vogue for tartans, resulting no doubt from the popularity of the novels of Sir Walter Scott. The little puffed and sometimes slashed sleeve, another product of the romantic movement, began about 1825 to be worn with another transparent sleeve over it. When this was made opaque, the sleeve assumed the leg-of-mutton shape so characteristic of the period. After 1830, while skirts grew shorter, sleeves became enormous. Hats were also extremely large and ornamented with flowers and ribbons.

2. Victorian Age.—With the accession of Queen Victoria in 1837 these romantic modes began to be modified. The wide sleeves disappeared, or rather the bulge was placed farther down the arm. Large hats, indeed hats of any kind except turbans, were abandoned in favour of the poke bonnet. Shawls were universally worn. The general effect was subdued and modest. On the other hand evening dresses developed a wide décolletage that exposed the shoulders; this early Victorian style, which would have been thought extremely improper in the 18th century, was accepted without question.

The increasing amplitude of skirts in the early 1850s caused a revival of the 18th-century hoop in an improved form, the crinoline, a stiff fabric made of horsehair and linen thread. This was soon replaced by a series of flexible steel hoops, sometimes forming a separate structure and sometimes sewn into the petticoat.

Men's clothes at this period had a somewhat sombre look. The top hat had become the shiny silk hat, usually black. The clothes, except for a surviving fancy waistcoat, were also black, although shepherd's plaid trousers were occasionally worn. The cutaway coat was now worn as evening dress only. High neckcloths had been abandoned for collars and ties not very different from those worn in the 20th century.

The crinoline reached its largest dimensions about 1860. After that it began to slip to the back and was indeed no more than a half crinoline. Then, about 1869, it was replaced by the bustle, although hoops were sometimes still employed. Hats replaced bonnets, being worn tilted over the forehead. In men's clothes there was a steady evolution toward less formal modes, a short black coat sometimes replacing the frock coat or morning coat. The bowler hat, invented in the 1850s for country wear, began to be worn in town. The suit, with coat and trousers made of the same material, was worn by younger men.

As the 1870s progressed the bustle gradually slipped down until it was no more than a fullness at the bottom of the skirt. Almost all dresses had long trains, even the street dresses of fashionable women. In 1880 the fullness of the skirt disappeared for a brief period; dresses were not only smooth over the hips but fairly narrow round the hem. The waist was very tight and the general effect was of a corset worn outside the dress. The bodice was high-necked and very closely fitting. However, by 1884 the bustle was back again in a slightly different form, stretching straight out at the back like a shelf. Hats were small, perched squarely on top of the head.

Not all the women of the 1880s, however, wore these fashionable clothes. Followers of the aesthetic movement wore looser garments, though the waists were still tight, with enormous sleeves, supposed to resemble those worn by women in early Florentine paintings. The humorous journals of the period made great play with the contrast between fashionable and aesthetic modes.

For men the 1880s provided a certain relief from formality by the invention of various kinds of sports clothes. Men took to knickerbockers and tweed jackets, straw hats and "deerstalkers" like that immortalized by Sherlock Holmes. Women also wore straw hats and bodices of naval cut to match the double-breasted "reefers" of the men. In the 1890s women began to wear knickerbockers for cycling, a real revolution in female attire. They also thought it necessary for this purpose to adopt men's stiff collars and trilby hats.

In 1890 sleeves rose to a point on the shoulders, and this feature expanded until it produced the characteristic balloon sleeves of the middle of the decade, familiar from the drawings of Aubrey Beardsley and the posters of Toulouse-Lautrec. Muffs, almost universally worn, were so small that they could be carried on one forearm, the other hand being perpetually occupied in lifting the dress. In evening dress, décolletage, which had been modest in the 1870s and 1880s, became more daring.

Children's clothes were less sensible and comfortable than they had been 50 to 60 years before. What had started in the 1820s as rational dress for boys had been formalized into the rigid discomfort of the Eton suit with its stiff white collar. Fortunate boys were dressed in sailor suits and unfortunate ones as "Little Lord Fauntleroy," in velvet suits with lace collars and cuffs and with the hair dressed long in curls. Little girls were dressed in elaborate and easily soiled garments with much lace. Their skirts were shorter than those of adult women, but the waists were nearly as tight.

As the century drew to a close the wide sleeve slipped and became a bulge over the forearm, facilitating the wearing of the short capes then fashionable. A prodigious quantity of lace was worn, at the wrists or in the form of a frilled shirt front attached to the corsage. For informal wear blouses had become popular, these too adorned with frills of lace.

Men's clothes had divided into formal and informal wear. Formal wear consisted of a long frock coat with silk lapels, white or gray waistcoat, striped trousers, an all-the-way-round stiff white collar and a silk (top) hat. Informal wear consisted of a check suit or knickerbockers and a Norfolk jacket, and a straw hat. Cloth caps also were worn. Even with this costume, however, it was usual to wear a stiff collar. Men's evening dress had also divided into the formal tail coat and the informal dinner jacket, a stiff shirt being worn with both.

3. Early 20th Century.—The first decade of the 20th century showed comparatively little change in the essential lines of feminine costume. The mature type of woman was admired: tall, small-waisted, heavy-bosomed and with a peculiar stance, the S-shaped look, resulting from what was strangely known as the "health" corset, a corset boned in such a way as to throw the hips back and the bosom forward. The effect was accentuated by the Russian blouse and cascades of lace descending from the bust. Never since the days of William III had so much lace been worn. Lace collars and collarettes, lace sleeves, lace plastrons, lace overbodices and lace petticoats, only to be glimpsed occasionally, but requiring the finest workmanship—there was hardly any part of women's dress that was not adorned with this expensive form of decoration. Real lace in such quantities being unobtainable and machine-made lace somewhat despised, a compromise was discovered in Irish crochet, for which there was a considerable vogue, especially in 1907. Skirts were long and sweeping, with a curious resemblance to the dominant line of *art nouveau* furniture. The hair was built high on the head and the flat pancake hats projected forward as if to balance the trailing skirts.

A revolution in nightwear took place in the early years of the century. For 300 years or more women had worn in bed a long smock and men a longer version of the day shirt. Pajamas now began to take their place. They are thought to have originated in India (Hindu *pajama*, "drawers") and, once introduced into the west, became steadily more popular not only for men but also for women.

In 1908 a slight modification began to be discernible in women's clothes. The bust was no longer thrust quite so far forward as before; the exaggerated overlap of the blouse was abandoned, and skirts became a little narrower at the hem, although they still trailed on the ground and required to be gathered up in the hand when crossing a wet or muddy street. The change resulted, in part, from the coming of what was called the empire gown, although it did not resemble very closely the high-waisted dress of a century before. Its effect was to straighten the figure, and by 1910 the process was complete. At the same time hats became extremely wide and the wide skirt was replaced by a very narrow one.

The hobble skirt of 1911, one of the strangest garments ever worn by women, shackled the legs so completely that walking was almost impossible. The feminine silhouette, as so often, resembled a triangle, but a triangle standing on its apex. With the enormous hats went very large muffs, and the handbag reappeared, since it was impossible for such narrow skirts to contain pockets. In the draped effect of evening dresses there is a curious orientalism due in part to Paul Poiret, the most fashionable dressmaker of the period, and in part to the immense success of the Russian ballet, particularly in the pieces staged by Léon Bakst. For day wear the tailor-made was very popular. The fashionable trimming consisted of buttons sewn in the most unlikely places all over the costume.

A kind of tunic overskirt made its appearance in 1912, and by early 1914 had become the feature of dress upon which the attention of designers was concentrated and which was to provide the jumping-off stage for the development of the next mode. There was a fundamental change in the neckline, the new fashion being known as the V-neck and considered by many to be dangerous to both health and morals. Men's clothes remained extremely formal.

The outbreak of World War I in 1914 did not bring about any immediate change in women's dress, but about the middle of 1915 the narrow underskirt was abandoned and the lampshade tunic became the whole dress. This skirt reached to mid-calf, revealing high laced boots. Hats were now small, usually trimmed with a vertical feather. The shortish skirts and high boots lasted with little modification until the end of 1918.

4. Post-World War I.—By 1921 the skirt fullness of the war period had disappeared, and waists had disappeared with it. The general effect was tubular, the corset having been completely abandoned. Hair was bobbed, but the close-fitting cloche had not yet appeared and the extremely low waist was indicated only by the lower edge of the now inevitable jumper. Panniers made a brief appearance in 1923 but did not long affect the prevailing trend. It was not until 1925 that the extremely short skirt made its appearance. With it were worn silk stockings in various shades of flesh pink, a startling innovation.

Skirts reached their extreme of shortness in 1927, when it was impossible for a woman to sit down without showing her knees. The short skirt lasted for day wear until 1930, but evening dresses, by careful degrees—tails, trains, sidepieces and transparent hems—became long again. In 1930 day skirts suddenly lengthened to mid-calf or lower and the waistline moved back to its normal position. There was a temporary vogue for large sleeves, not, as in 1830 and 1895, to decrease the apparent size of the waist, but to make the hips look smaller. The emphasis throughout the 1930s was on slim hips and backless dresses, and sometimes the whole outfit looked as if it had been designed to be seen from the rear. The shoulders were heavily padded to make them look square. The long reign of the cloche hat came to an end, to be replaced by a variety of very small hats perched forward over one eye.

Men's clothes showed a steady progress away from formality. The frock coat disappeared altogether and the morning coat and silk hat were worn only on ceremonial occasions. The wide trousers known as Oxford bags came in in 1924 and trousers remained wide until the end of the 1930s. Soft collars replaced the stiff white linen variety, and for golf and other sports men wore the baggy knickerbockers known as knickers or plus fours, often with a gaily coloured sweater. Women's sports clothes became more and more scanty, and it became usual to play tennis

in shorts or very short skirts, without stockings. Swim suits were extremely exiguous.

Two marked general tendencies may be noted: the disappearance of class distinction in women's day clothes, and the marked divergence between day clothes and evening clothes. Many women were now engaged in some kind of work away from home during the day and there was evolved for this purpose a kind of working uniform, consisting of the tailor-made, or suit. Trousers, in the form of slacks, were increasingly worn for sports but not yet for shopping. On the other hand, even girls in the lower-income groups assumed for evening some kind of "glamour" dress, a dress based ultimately on what had been seen in motion pictures. This influence tended to inhibit change over the years, since as much as two years may elapse between the shooting of a film and its general release. The "glamour" toilettes of the 1930s are therefore curiously static and tend to have the appearance of fancy dress. With regard to foundation garments, C. Willett Cunnington notes:

> A technical invention of some importance in this period was the belt [in the United States, girdle], made of elastic material, which gripped the abdomen and buttocks so as to produce flattening of those regions. Some were of woven textile with a two-way stretch, and were put on by being unrolled from below upward; others were of india-rubber composition, and pulled up. The garment furnished with suspenders, was often worn next to the skin, and supplied a sculptured foundation on which the tight-fitting dress appeared moulded (*English Women's Clothing in the Present Century*, 1952).

With this was worn the brassière, now a separate garment rather than a part of the corset or girdle.

5. World War II Period.—Just before World War II there was a definite attempt on the part of dress designers to bring back the boned corset. Fashion commentators spoke of "the figure of eight which the new clothes demand; so get it, by hook, by crook, or by corset." Apart from this trend there was a wild variety of styles, especially in evening dress. There were hooped skirts, hobble skirts and even harem skirts, a kind of throwback to the fashions immediately preceding World War I. But these developments were cut short by the war.

By the summer of 1939 day skirts were almost as short as they had been in the late 1920s. Shoes were very square-toed with low heels. When war came the little hats that had served for a decade were often replaced by head scarves and, in wet weather, by plastic hoods. Housewives as well as factory workers took to slacks, thereby making stockings unnecessary. Even with skirts many women began to go about with bare legs, on which stockings were sometimes painted with a line drawn down the back to simulate the still obligatory seam. Clothes rationing was introduced in Britain in June 1941, and for the rest of the war fashion may be said to have ceased to exist in that country. In the United States, rationing of clothing worked little hardship, but restrictions on uses of fabrics (leading to the virtual disappearance of silk and nylon) affected clothing. The daytime silhouette for women continued to be broad-shouldered and short-skirted. The short dress for evening reappeared. The hair was worn "upswept" in the back, with a high "pompadour" in front, or else hanging loosely to the shoulders or below.

6. After World War II.—When communication with France was restored in 1945, there was a cry that "fashion is going feminine," but in fact there was at first very little change. Day dresses had more rounded shoulders and a slightly smaller waist; evening dresses sought to revive the modes of 1939. Then in the spring of 1947 Christian Dior launched the "new look" from Paris. The shoulders were narrow, there was a new emphasis on the bust and the skirt was much lengthened and had a wide, billowing hem. Hats, after their wartime eclipse, returned to popularity, with much experiment in form and colour. Brims, in general, were large and flaring, or small and turned back against the crown.

A popular development in postwar fashions was the late-afternoon cocktail dress, which by means of a minor adjustment, such as discarding a bolero, could be made to serve as an evening dress also. There was a certain revival of such Victorian modes as the crinoline for formal occasions. It was as if women were unconsciously striving to return to a more settled age. There was a marked emphasis on the bosom, the desired effect being sometimes obtained by means of a padded or inflated brassière. Soon, however, the "new look" gave place to what seemed like a revival of the modes of the 1920s, with the straight lines and displaced waists of typical postcrisis periods. Dior brought out his H-line and then his A-line, and it seemed as if the designers were unable to decide whether to echo the fashions of 1800 or those of 1925. By the early 1960s they appeared to have made up their minds, fashionable dress resembling very closely that of the '20s, with a lowered waist and very high hemline. Shoes were excessively pointed, with stiletto heels. In the servantless postwar world women wore slacks for housework and shopping; in some communities long shorts (Bermudas or Jamaicas) replaced slacks, and culottes, or divided skirts, reappeared.

Men's clothes after the war showed a curious reaction, not to Victorian but to Edwardian modes: tighter trousers, coats buttoned higher and the revived bowler hat. There was a passing craze for fancy waistcoats. Slacks, sport shirt (worn without a tie) and a jacket resembling battle dress, together with a variety of sweaters, became ordinary wear for many young men. In the evening the tail coat almost entirely disappeared but the dinner jacket maintained its popularity. *See* also references under "Dress" in the Index volume. (J. Lr.)

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DRESSER, CHRISTOPHER (1834–1904), British designer, one of the first professional industrial designers of the 19th century, was born in Glasgow on July 4, 1834. After two years' training at the School of Design at Somerset house, he first taught botany, published *Unity in Variety* (1859) and became a fellow of the Linnaean society. In 1862 he published *The Art of Decorative Design* and soon afterward took up his career as a designer. His work was influenced by a scientific outlook which led to overtheorization and elaboration of the principles of design, reducing the aesthetic interest of his work, particularly his flat patterns, which often were heavy and pedantic. But he showed a genuine understanding of the use of materials, especially metals and glass. He was one of the leaders of the Japanese vogue and visited Japan in 1876 as a representative of the British government.

Dresser died at Mulhouse, Alsace, on Nov. 24, 1904.

Dresser's works include *The Development of Ornamental Art in the International Exhibition* (1862) and *Japan, its Architecture, Art and Art Manufactures* (1882). *See* also DESIGN, 19TH-CENTURY: *Idealism and Innovation*.

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(J. J. Lo.)

DRESSLER, MARIE (LEILA KOERBER) (1869–1934), U.S. actress, remembered for her portrayals of robust, humorous old women, was born in Cobourg, Ont., on Nov. 9, 1869. After appearing with a roving light opera troupe she eventually became a featured actress with Weber and Fields, and played the lead in *Tillie's Nightmare* (1910). Her first film was *Tillie's Punctured Romance* (1915), in which Charlie Chaplin also appeared. Following World War I Miss Dressler was almost lost sight of as an actress, but she was re-established in motion pictures in 1927, meeting with great success as Marthy in *Anna Christie* (1930). The character of Marthy typified the roles she generally played thereafter in many pictures, some of which were *Politics* (1931), *Prosperity* (1933), *Dinner at Eight* (1933) and *Tugboat Annie* (1933). The Academy of Motion Picture Arts and Sciences voted her the best actress of 1930–31 for her performance in *Min and Bill*. She died in Santa Barbara, Calif., July 28, 1934. (M. S. By.)

DRESSMAKING: *see* SEWING, HOME.

DREW, the name of a family of U.S. actors.

1. JOHN DREW (1827–62) was born in Dublin, Ire., Sept. 3, 1827. After a brief career as a seaman, he turned to the stage as an actor of Irish and light comedy roles, making his first New York appearance in 1842. In 1843, with William Wheatley, he leased the Arch Street theatre in Philadelphia. In 1859 he toured Australia and England, leaving his wife as manager of the theatre. He died in Philadelphia, May 21, 1862.

2. His wife, LOUISA LANE DREW (1820–97), was the daughter of a British acting couple. She began her career as a child actress in roles such as Little Pickle in *The Spoiled Child*. As was the custom in her time, Louisa played Romeo, Mark Antony and other male parts, and at various times in her career she acted with W. C. Macready and Joseph Jefferson. She married John Drew in 1850, and between 1861 and 1892 managed the Arch Street theatre. Mrs. Drew had four children, John, Louisa, Sidney (adopted) and Georgiana, the last of whom married Maurice Barrymore and became the mother of Lionel, Ethel and John Barrymore, all actors.

3. The eldest son, JOHN DREW (1853–1927), was born Nov. 13, 1853, in Philadelphia. He did not begin acting until 1873, when he appeared under his mother's management in *Cool as a Cucumber*. In 1875 he made his first New York appearance in Augustin Daly's *The Big Bonanza*. Beginning in 1879, he spent 14 years as an actor with Daly's troupe, leaving it to join Charles Frohman's company at Palmer's theatre in 1892. During the next 20 years, under Frohman's personal direction, Drew established his name as one of the greatest actors of the United States in such plays as *A Marriage of Convenience, One Summer Day, Richard Carvel, Much Ado About Nothing, The Will, The Circle, School for Scandal* and *Trelawney of the Wells*.

When Frohman died in the "Lusitania" disaster in 1915, Drew's career began to ebb. He died in San Francisco, July 9, 1927. So esteemed was John Drew by his fellow actors that he was chosen lifetime president of the Players' club, an honour previously shared only by Edwin Booth, founder of the club, and Joseph Jefferson. In 1922 he published a volume of reminiscences, *My Years on the Stage*.

See also BARRYMORE (family). (S. W. H.)

DREW, DANIEL (1797–1879), U.S. steamboat pioneer and railroad financier, was born in Carmel, N.Y., July 29, 1797. He spent his early life on a farm and attended a country school. After achieving success in cattle trading he bought an interest in a New York-to-Peekskill steamboat in 1834. Six years later he established the People's Line, a steamship company, and the Stonington Line in 1847. He became a Wall Street broker in 1844, took an interest in railroads and in 1850 purchased a small road with Cornelius Vanderbilt. He established a stockbroking and banking firm (Drew, Robinson and Co.) that became one of the principal traders in railroad stocks in the United States. He was also a director and large stockholder of the Erie railroad. Drew founded a ladies' seminary and a theological seminary. In later life he suffered financial losses that resulted in his bankruptcy. He died in New York city on Sept. 19, 1879. (H. J. Sc.)

DREXEL, ANTHONY JOSEPH (1826–1893), U.S. banker and philanthropist, was born in Philadelphia, Pa., Sept. 13, 1826. His father, Francis Martin Drexel (1792–1863), had founded the banking house of Drexel and Co. in Philadelphia. When Anthony and his brothers succeeded to the business, they transformed it into an investment banking house. In 1871 they organized Drexel, Morgan and Co. of New York city, and Drexel, Harjes and Co. in Paris. Anthony Drexel participated in flotation of government bonds, organization of railroads, developing mining properties and urban real estate. From 1864 he was co-owner with George W. Childs (*q.v.*) of the *Philadelphia Public Ledger*. He contributed generously to hospitals, churches and charities, and founded Drexel Institute of Technology with an endowment of $3,000,000. He died June 30, 1893, at Carlsbad, Bohemia.

(J. R. Lt.)

DREYER, JOHN LOUIS (or JOHAN LUDWIG) **EMIL** (1852–1926), Danish astronomer whose *New General Catalogue of Nebulae and Clusters of Stars*, published in the *Memoirs* of the Royal Astronomical society in 1888, with supplements in 1895 and 1908, was still a standard work in the late 1950s, was born in Copenhagen on Feb. 13, 1852. In 1874 he was appointed astronomer at the earl of Rosse's observatory at Birr castle, in Ireland. In 1878 he went to Dunsink, near Dublin, to be assistant at the observatory of Trinity college. He became director of the observatory at Armagh in 1882, retiring from this post in 1916. Dreyer's interest in the history of astronomy led him to undertake the preparation of a complete edition of Tycho Brahe's works. The first ten volumes of *Tychonis Brahe Opera Omnia* appeared at Copenhagen during 1913–26, the remaining four being complete in manuscript at the time of his death. He also edited the *Scientific Papers of Sir William Herschel* (1912). He was awarded the gold medal of the Royal Astronomical society in 1916 and served as president of the society in 1923–24. He died at Oxford on Sept. 14, 1926. (O. J. E.)

DREYFUS, ALFRED (1859–1935), French army officer whose trial for treason began a 12-year controversy that deeply marked the political and social history of the third republic, was born at Mulhouse (Mülhausen) in Alsace, on Oct. 19, 1859, the son of a wealthy Jewish textile manufacturer. In 1882 he went to the École Polytechnique and entered on a military career, attaining captain's rank by 1889. In 1890 he married Lucie Hadamard, daughter of a diamond merchant of Paris. They had two children.

Sent in 1893 as a staff learner to the ministry of war, he fell under suspicion of being the author of a letter which reached the statistical section of the ministry on Sept. 26, 1894. This document, known as the *bordereau*, contained evidence of the betrayal of military information to Germany. On Oct. 15 Dreyfus was arrested by the military authorities and accused of high treason.

The court martial which heard the case *in camera* in Dec. 1894 found him guilty, on meagre evidence, and condemned him to degradation and to deportation for life. He was sent to Devil's Island, Guiana, where he was to spend nearly five years. Although he denied his guilt and although his family consistently supported his plea of innocence, public opinion and the French press as a whole, led by its virulently anti-Semitic section, welcomed the verdict and the sentence. French opinion had already been deeply disturbed by the crisis of Boulangism (*see* BOULANGER, GEORGES ERNEST JEAN MARIE) and by the Panamá scandal, with their implications of corruption in high places. It was excited and belligerent and in no mood to commiserate with convicted traitors.

Doubts, however, began to grow, first in the minds of Gen. R. F. C. Le Mouton de Boisdeffre, chief of staff, and Lieut. Col. Georges Picquart, now head of the statistical section. Picquart found evidence that Maj. C. F. (Walsin-)Esterhazy, formerly of his section, was engaged in espionage, and that his handwriting was that of the *bordereau*. When Picquart was removed from his post, it was believed that his discovery was too inconvenient for his superiors. Meanwhile Dreyfus' family and friends agitated for reconsideration of the case, and some papers aired doubts of the verdict. Bitterly resisted by the anti-Semitic press, this agitation began to attract wider attention. The veteran politician Auguste Scheurer-Kestner, vice-president of the senate, became convinced of Dreyfus' innocence and persuaded Georges Clemenceau (*q.v.*) to denounce the irregularity of the court martial. The "Dreyfus case" began to rank as a major political issue, a development which the weak premier, Félix Jules Méline, tried in vain to prevent.

The affair was made absurdly complicated by the activities of Esterhazy in inventing evidence and spreading rumours, and of Maj. Hubert Joseph Henry, discoverer of the *bordereau*, in forging new documents and suppressing others. When Esterhazy was brought before a court martial he was acquitted, and Picquart was arrested. This precipitated an event that was to crystallize the whole movement for revision of Dreyfus' trial. In Jan. 1898 the novelist Émile Zola (*q.v.*) wrote an open letter to Félix Faure, president of the republic. It was published on Jan. 13, on the front page of *Aurore*, Clemenceau's paper, under the headline "J'Accuse." By the evening of that day 200,000 copies had been sold. Zola accused the first court martial of violating the rights of the defense and the second of acquitting Esterhazy on the orders of the ministry of war. He challenged the authorities to prosecute him.

Amid uproar in parliament, the government, pressed by the nationalists to bring Zola to justice, while the anti-Semites began a series of riots in the provinces, found itself caught between two fires. A petition demanding revision of the Dreyfus trial was signed by some 3,000 persons, including Anatole France, Marcel Proust and a host of intellectuals, men of letters and of art. The trial of Zola, which the government could not now refuse, would focus the whole agitation. It began on Feb. 7 and became a parade of all the many *dramatis personae* now involved, save Dreyfus himself. Zola was found guilty and sentenced to a year's imprisonment and a fine of 3,000 francs, but the revisionist movement had gained its purpose: grave doubts had been cast on the legality of Dreyfus' trial.

Revision would still have been difficult to pursue, however, but for one fortuitous event. Major Henry committed suicide at the end of Aug. 1898, after confessing his forgeries. Boisdeffre resigned as chief of staff. Picquart, now dismissed from the army, was free to join forces with the revisionists. Esterhazy, in panic, fled to Belgium and London. The confession of Henry opened a new phase in the affair, for it ensured that the appeal of the Dreyfus family for a retrial would now be irresistible. A new ministry under Henri Brisson agreed to allow the appeal. In Sept. 1898 the court of criminal appeal decided to proceed with a further investigation of the case. Meanwhile the Brisson ministry, never robust, resigned and was succeeded by a reshuffled ministry led by Charles Alexandre Dupuy (*q.v.*). Already it was four years and five ministries ago since Dreyfus had been condemned; but the Dreyfus affair, already a cause of violent controversy and protracted disorders, was to drag on for eight more years.

By now the issues were regarded as far exceeding the personal matter of the guilt or innocence of Dreyfus. Inflamed by extremist agitation on both sides, in which old issues such as anticlericalism became intertwined, the case of the revisionists had become a cause: the cause of republican civilian authority against a military body claiming to be autonomous within the state, of individual rights against all public authority, of the nation against occult usurping power. On the right, nationalist and authoritarian by tradition, it seemed equally a cause: of national security against international socialism and Jewry, of France against Germany. After Zola's trial, there was formed the League for the Defense of the Rights of Man and the Citizen; after the agreement to hold a retrial, Charles Maurras (*q.v.*) founded the Ligue de la Patrie Française.

Faure died and was succeeded in Feb. 1899 by Émile Loubet, known to favour revision. A new ministry, led by René Waldeck-Rousseau (*q.v.*), took office in June resolved to bring the affair to an end at last. Dreyfus, brought back from Devil's Island for retrial, appeared before a court martial in Rennes (Aug. 7–Sept. 9, 1899). It pronounced him guilty, but in extenuating circumstances, and sentenced him, by five votes against two, to ten years' detention. Loubet, however, remitted the balance of the sentence and canceled the order for degradation. Dreyfus accepted the act of clemency, but reserved the right to do all in his power to establish his innocence.

His efforts, supported by those of his brother Mathieu, continued until, in 1903, he succeeded in adducing enough fresh evidence in his favour to have the verdict of Rennes submitted to the court of criminal appeal. In March 1904 the court decided for full revision. Once again all the witnesses still alive were summoned and examined. In July 1906 the united appeal courts delivered judgment: they annulled the verdict of Rennes. Parliament passed a bill reinstating Dreyfus. On July 22 he was formally reinstated and decorated with the Legion of Honour. After further short service in the army, in which he attained the rank of major, Dreyfus went on to the reserve. He was recalled to active service during World War I and, as a lieutenant colonel, commanded an ammunition column. He died in obscurity in Paris on July 12, 1935.

The Dreyfus case—or *l'Affaire* as it came to be called—was an important landmark in the history of the third republic and indeed of modern France. From the turmoil of which it was the centre emerged a sharper alignment of political and social forces, leading to such drastic anticlerical measures as the separation of church and state in 1905 and to a cleavage between right-wing nationalists and left-wing antimilitarists that haunted French life until 1914 and even later. On each side were mobilized France's most eminent literary men, and the violent controversy destroyed the cohesion of French life for more than a generation after. A conjunction of mistaken loyalties, repeated stupidities, base forgeries and excited extremisms inflamed the situation into a national crisis. At best it evoked a passionate repudiation of anti-Semitism which did France honour; at worst, it revealed and intensified a chronic internal division which was to be a major source of national weakness. *See* also references under "Dreyfus, Alfred" in the Index volume.

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(D. TN.)

DRIESCH, HANS ADOLF EDUARD (1867–1941), German biologist and philosopher, was an exponent of vitalism (*q.v.*; the theory that life cannot be explained as physical or chemical phenomena). He was born on Oct. 28, 1867, at Kreuznach. After studying at Hamburg, Freiburg, Munich and Jena, he traveled in the far east, and from 1891 to 1900 worked in the zoological station of Naples. He then settled in Heidelberg where in 1909 he became *Privatdocent* and in 1911 professor of philosophy. In 1920 he was made professor at Cologne and in 1921 at Leipzig. Driesch began as a disciple of Haeckel but through the influence of G. Wolff and W. Roux came to support a dynamic vitalism.

His doctrine that the functions of protoplasm cannot be ex-

plained mechanically was the outcome of experiments on the blastula of the sea urchin, which showed that any fragment cut at random always gave a complete embryo, and on the restitution of animal parts.

He died in Leipzig in April 1941.

DRILL, a large, short-tailed baboon, *Papio* (*Mandrillus*) *leucophaeus*, from the Cameroons, resembling the mandrill (*q.v.*), but distinguished from it by being smaller and having a black face. The lower lip is bright crimson and the hairs around the face are yellowish-white as is a tuft behind the ears. The rest of the animal is olive brown.

See also BABOON; PRIMATES. (J. E. HL.)

DRILL, MILITARY, is the preparation of soldiers for performance of their duties in peace and war by practice and rehearsal of prescribed movements. In a practical sense, drill consolidates soldiers into battle formations and familiarizes them with their weapons. Psychologically, it develops a sense of teamwork, discipline and self-control; it promotes automatic performance of duties under disturbing circumstances and instinctive response to the control and stimulus of leaders. Modern drill is essentially of two types: close-order and extended-order or combat drill. Close-order drill comprises the formal movements and formations used in marching, parades and ceremonies. Combat drill trains a small unit in the looser, extended formations and movements of battle.

Rudimentary drill appeared in ancient Egypt with the dawn of formal warfare because of the need to move and assemble large numbers of men for battle. Drill in the modern sense was introduced by the Greeks, who engaged in tireless practice in the precise evolutions of the phalanx. Philip II of Macedonia and Alexander the Great further improved the phalanx and its drill. Excellence in military drill contributed to Rome's success in dominating the Mediterranean world for five centuries. After Rome's fall, drill almost disappeared as skill in warfare degenerated during the middle ages. Two notable exceptions were the well-trained Byzantine armies, and Genghis Khan's precisely drilled *toumans*.

Gustavus II Adolphus of Sweden accelerated a gradual revival of skill in European warfare early in the 17th century. His introduction of simplified drill techniques for the use of improved weapons was copied by all Europe. By the end of the 17th century France led in the development of modern standing armies, largely because of a drill system devised by Louis XIV's inspector general of infantry, Jean Martinet, whose name became a synonym for drillmaster. (*See* MARTINET.) To make effective use of inaccurate muskets, concentrated volleys had to be delivered at short range. Troops advanced in rigidly maintained battle lines, all firing simultaneously on command. Through ceaseless drill, the Prussian army of Frederick the Great achieved a mechanical perfection in these tactics. At Valley Forge during the American Revolution, Baron von Steuben (*q.v.*) adapted Prussian techniques into a less rigid drill system fitted to the American character and to conditions of warfare in the new world.

Exact parade ground maneuvers on the battlefield disappeared in the 19th century because of improvements in the range and accuracy of weapons. This trend began during the American Civil War when soldiers had to be trained to spread out, take cover and dig entrenchments. It was hastened later by the introduction of the machine gun and quick-firing artillery. Close-order drill, however, was retained not only because it had value for ceremonies and for moving large bodies of men on foot, but also because it provided a psychological foundation of teamwork and discipline without which combat drill is impossible.

In the U.S. army the details of close-order drill and the basic elements of infantry combat drill are included in a field manual, FM 22–5, "Drill and Ceremonies." Additional manuals deal with evolutions of armoured and other motorized units, and with gun drill for crew-served automatic and artillery weapons. Similar drill manuals exist for the British army.

For purposes of peacetime exhibitions and competition, many military and semimilitary units maintain special drill teams, adept in normal close-order drill movements, and in other fancy and complex evolutions requiring precision and skill in marching and in the handling of weapons. (T. N. D.)

DRILLING MACHINERY. Drilling of holes of various diameters in rock is employed for (1) prospecting for mineral deposits; (2) ascertaining the depth below the surface to a bedrock or other firm or massive substratum, together with the character of the overlying soil, preparatory to mining or other civil-engineering operations; (3) geological, geophysical or other scientific explorations; (4) drainage of gas or water in mining operations; (5) injection of cement into highly fissured or water-bearing rocks prior to excavation; (6) sinking petroleum, natural gas, water or salt wells; and (7) deep blasting in quarries and open-pit mines and blasting in underground workings.

The most successful application of drilling to prospecting is the placing of holes through horizontal or nearly horizontal strata containing seams, for example, of coal, iron, lead or salt. A reasonably accurate map of the location, depth and thickness of such a deposit may subsequently be drawn and the true dip of the strata ascertained from the depths to the deposit of three holes drilled at the corners of a suitable triangle. Deep drilling is often necessary to determine the true depths of deposits whose continuity is disturbed by geological faulting. The data obtained from drilling for prospecting purposes permit cost estimates to be made for the sinking of shafts and the driving of tunnels for exploitation purposes. (For discussion of drilling and drill cores in relation to prospecting and to geologic exploration *see* FOSSIL: *Fossil Study;* SEDIMENTARY ROCKS: *Exploration for Oil and Gas.*)

In sinking petroleum wells, drilling serves both for discovering the oil-bearing strata and for extracting the oil. After about 1918 a number of the deepest borings in the world were made for oil or natural gas; for example, several in the United States were drilled to more than 20,000 ft. Rock-salt deposits are sometimes worked through boreholes by introducing water and pumping out the brine for further treatment (*e.g.*, in Cheshire, Eng.).

There are two principal methods of drilling—percussive and rotary. The former operates by intermittent chipping by impact, whereas the latter is continuous. The rate of penetration of percussive tools depends on the intensity of blow, the number of blows per full revolution of the bit and the frequency of blow. It is necessary, therefore, to adjust these variables to give a satisfactory penetration rate with minimum or acceptable degree of bit wear. Fine-grained hard rocks require high frequency rates, high intensities of blow and the maximum number of blows per revolution. Large-grained heterogeneous rocks are more conducive to the chipping action and fewer blows per revolution are required to effect breakage.

Rotary tools operate by a cutting and sometimes a grinding action. The rotary bit wear problem is more important than in

BY COURTESY OF REED ROLLER BIT CO.

FIG. 1.—SIDE VIEW OF (LEFT) DRAG BIT AND (RIGHT) TRICONE ROLLER ROCK BIT

the percussive system and is dependent on the depth drilled per revolution, the thrust exerted on the tool and the amount of flushing water used.

A modern method of drilling is with a rotary-percussive drill, whose chief application is in shot-hole drilling in mines and on public-works contracts in very hard rocks. It differs from percussive drilling insofar as the rotary action is continuous instead of intermittent. Conversely, it is rotary drilling with a continuously applied percussive action. The chief advantage is that the percussive action need only be introduced when the hardness of the strata results in uneconomic bit wear and slow drilling rates.

Types of Drill Bits.—There are four chief designs of rotary bit: the untipped drag bit, the tipped drag bit, the roller bit and the diamond bit. These bits have very different characteristics, are suitable for different conditions of drilling and so require varying rates of rotation, flushing-water quantities, etc. In general, the rate of penetration with a suitable type of bit is dependent on the compressive strength and shear strength of the rock. Drag bits cut the rock, roller bits operate with a crushing and wedging action and diamond bits grind away the rock.

Drag bits (fig. 1, left) $4\frac{1}{4}$ to 25 in. in diameter are mostly used in soft rocks and may have two, three or four wings. For harder rocks the roller bit (fig. 1, right) gives a satisfactory drilling rate and is preferred to a coring diamond bit when accurate samples are not required. The roller bit shown consists of three rollers mounted on ball bearings and equipped with wedge-shaped teeth. These bits are made in sizes from $3\frac{7}{8}$ to 26 in. in diameter. Modern drag bits are often tipped or dressed with tungsten carbide, and roller bits have tungsten carbide facings to reduce wear and prolong life. Most forms of rotary drilling demand the use of hollow rods of steel to provide circulation of cooling water or other liquid, and these must be robust enough to withstand the heavy feed thrusts necessary to maintain high drilling speeds. Additions of water in quantities of 76 to 350 gal. per hour may be required for rotary drilling in varying strata, dependent on size and depth of hole. For mud flushing, quantities of 1,200 gal. per minute have been used. (See *Hole Maintenance*, below.)

BY COURTESY OF REED ROLLER BIT CO.

FIG. 2.—END VIEW OF DIAMOND BIT FOR CUTTING CORES

Diamond bits may be of the noncoring or coring types. The former, which may be up to $7\frac{3}{8}$ in. in diameter, are used when no accurate sampling is required, in which case the whole section is actually drilled. The coring method makes an annular hole, the core of which furnishes a practically complete cross section of the strata penetrated; the thickness and character of each stratum are revealed, with its depth below the surface. Thus the diamond drill can be used for very accurate prospecting of deposits. The bit, an example of which is shown in fig. 2, is of cast steel, set with a number of diamonds according to the diameter, which may be from $1\frac{9}{16}$ to $3\frac{1}{2}$ in. yielding cores 1 to $2\frac{9}{16}$ in. in diameter. The diamonds require careful setting in the bit and may project but slightly from its surface. Two kinds of diamond are used, "carbons" and borts. The former are a kind of black diamond or amorphous form of pure carbon, are opaque and, as they are tougher than the brilliant and have no cleavage planes, are more suitable for hard rock. Borts are imperfect brilliants and are best used for softer rocks.

Percussive Drilling.—Percussive drilling is the slower of the two methods, but still has many applications, chiefly for shallow holes. The principle consists of applying blows successively to a tool attached to rods or a cable, and rotating the tool between blows so that a new portion of the face of the hole is attacked at each blow. The usual cutting tool or bit is shown in fig. 3(B). The rod is from one to two inches square in long lengths with screw joints. For holes of less than 50 ft. the work may be done by hand, one or two crossbars being clamped to the rod. The men alternately raise and drop the drill while walking round and round to rotate the bit and so keep the hole true. The cuttings are cleaned out by attaching a bailer consisting of a pipe with a foot valve on the rods in place of the bit. However, the trend has been to use compressed-air jackhammers to provide the percussion; mobile drills, capable of drilling down to 200 ft., are known as wagon drills.

A simple form of percussive drilling involves the use of drive pipes. This method is suitable for testing the depth and character of soft material overlying solid rock and as a necessary preliminary to rock boring when some thickness of surface soil must first be passed through. The drive pipe consists basically of one or more lengths of wrought-iron pipe open at both ends and one-half to six inches in diameter. Small-diameter pipes are driven by a heavy hammer; for deep and larger holes a light pile driver is necessary.

The lower end of the pipe has an annular steel shoe; the upper end, a drivehead for receiving hammer blows. Successive lengths are added as required. A bailer, consisting of a cylinder four to six feet long with a valve at the foot, is used for cleaning. Drive pipes are often sunk by the application of weights at the surface and slow rotation by levers. Two pipes are then used, one inside the other. Water is pumped down the inner pipe to loosen the soil and raise the debris. In a variation of this, for tough soil or hardpan, a drill on a hollow rod is raised and dropped inside the pipe. The water passing down the rod and through holes in the bit raises the debris. The "driven well" for water supply is an adaptation of the drive pipe. These methods are rarely used for depths over 120 ft.

For deep boring the rod method is no longer used. Cable (rope)-operated tools known loosely as cable-tool drills (in the U.S.) or churn or "oil-well" drills (in Britain) have been widely used for prospecting and oil-well drilling in the past, but for deeper holes, including those over 6,000 ft., the method has been replaced by rotary drilling. Less than half the oil wells are drilled by cable tools, although many blastholes in quarries are drilled by this method. In its simplest form the "string of tools" suspended from the rope consists of a chisel bit, jars and rope

BY COURTESY OF ACME FISHING TOOL CO.

FIG. 3.—DRILLING TOOLS

(A) Drilling stem; (B) drilling bit; (C) drilling jars; (D) dart-valve bailer; (E) swivel socket for wire rope

socket. The jars (fig. 3[C]) are a pair of sliding links to produce a sharp shock on the upstroke as the jars come together for loosening the bit if it tends to stick fast. A heavy bar (auger stem) is generally inserted between the jars and bit to increase the force of the blow. The weight of another bar (sinker bar) above the jar keeps the rope taut. The length of stroke and the feed are regulated by a "temper screw" or feed screw which allows the rope to be let out four feet or so as boring progresses. The bits are usually three to eight inches in diameter.

BY COURTESY OF GUS PECH MANUFACTURING CO.

FIG. 4.—BUCKET AUGER

This method of drilling is especially suitable for glacial pebble beds and conglomerates, which often damage rotary bits. A great variety of "fishing tools" is used in case of loss of tools. For mobility the drilling machinery may be mounted on a trailer truck or lorry. It is a cheap method of searching for water supplies.

Rotary Drilling.—The simplest form of rotary drilling is the earth auger operated by hand and resembling the wood auger used in carpentry. It is possible to drill soft materials to a depth of 60 ft., but deeper holes can be drilled with the assistance of a small motor or a rotary table. There are two forms of auger, the spiral and the pod types. The auger is attached to rods by socket joint, and successive rods are added as the hole is deepened. Horizontal levers are clamped to the rods and drilling proceeds by rotary action which is stopped from time to time so that the debris can be removed from the tool, or the mud collected by a sludge pump lowered into the hole.

Pod augers are generally from 8 to 20 in. in diameter and are used for drilling sandy soils. A common form consists of two curved plates, one attached to the rod rigidly, the other by hinge and key; a few revolutions fill the pod. For holes of large diameter the auger is handled with the aid of a light derrick.

Rotary drilling, unlike some other methods, may be adapted for holes at any angle and therefore is quite suitable for underground work in coal and metalliferous mines.

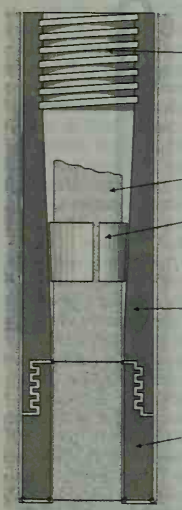

FIG. 5.—CORE LIFTER USED IN DIAMOND DRILL WORK

For diamond drilling from the surface the apparatus consists of a line of hollow rods, coupled by screw joints, and an annular steel bit, set with diamonds, attached to the lower end. By a small engine on the surface the rod is rapidly rotated and fed down automatically as the hole is deepened. The speed of rotation is from 300 to 1,700 r.p.m. depending on the kind of rock and the diameter of the bit. While the boring progresses water is fed down the hollow rods by pump, and returns between the rods and the hole sides. Cuttings are thus conveyed upward leaving the hole bottom clean. Core recovery and inspection of the diamond bit may be carried out every three to eight feet of depth by raising the rods with the aid of a small rope which operates by the driving engine.

Above the bit are the core lifter and core barrel. The core lifter (fig. 5) grips and breaks off the core and raises it to the surface. The barrel, three to ten feet long, fits closely in the hole and may be spirally grooved for the passage of water and debris. It serves partly as a guide, tending to keep the hole straight, and partly for holding and protecting each core. For coring in coal, a double core barrel is mostly used.

In broken fissured rock diamond loss often is so great that such bits are replaced by steel toothed bits. Another core drill is the Davis calyx drill. For hard rock it has an annular bit, accompanied by a quantity of chilled-steel shot (generally known as shot boring). This method is not suitable for holes at an angle to the vertical.

The feed may be hydraulic or differential. With the hydraulic feed, mostly used with the heavier machines for deep work, the rate of feed is independent of the rotation speed of the rod and can be precisely adjusted. There are either one or two feed cylinders supplied with water from a pump. The rod, while rotating freely, is supported by the feed-cylinder piston and caused to move slowly downward by the water's being allowed to pass from the lower to the upper part of the cylinder. Valves regulate the passage of the water, and hence the rate of feed.

The differential feed usually is adopted only on the smaller units intended for shallow-hole drilling. With this system the driving engine has a hollow left-hand threaded screw shaft to which the rod is coupled. This shaft is driven by a spline-and-bevel gearing and is supported by a threaded feed unit in the lower bearing. Geared to the screw shaft is a light countershaft. The number of teeth in the gear wheels is such that the feed unit revolves a little faster than the screw shaft so that the drill rod is fed downward a fraction of an inch for each revolution. To vary the rate of feed for different rocks, there are three pairs of gears with different ratios of teeth. The screwshaft and gearing are carried by a swivel head, which can be rotated in a vertical plane, for drilling holes at any angle.

BY COURTESY OF GEORGE E. FAILING CO.

FIG. 6.—STRAIGHT ROTARY RIG WITH MAST IN WORKING POSITION

Rotary drilling rigs are built in a wide variety to meet the requirements of depth drilled, loads to be handled and the terrain where the wells or holes are to be located. Drives are from gasoline, diesel engines or electric motors, although steam-driven reciprocating engines are sometimes used. Rods are of wrought-iron or steel tubes in five feet or ten feet lengths. Many rigs for shallow depths are truck-and-trailer mounted for economical mobility and rapid assembly. Fig. 6 shows a mobile type of rotary rig suitable for seismic work or prospecting.

For operating in underground workings of mines, small machines are sometimes mounted on columns. They drill holes $1\frac{1}{4}$ to $1\frac{9}{16}$ in. in diameter to depths of 300–400 ft., cores being $\frac{7}{8}$ to 1 in. in diameter.

Rates of advance for core drilling to moderate depths range usually from two to three feet per hour including ordinary delays, though in favourable rock higher speeds are attainable. In deep holes speeds diminish because of the time consumed in raising and lowering the rods. Solid bits produce faster rates as it is necessary only to raise the rod occasionally for examining the condition of the bit.

Hole Maintenance.—Drilling fluids or compressed air can be used for both cooling the bit and transporting cuttings to the surface. The chief disadvantage of air flushing is that no support is offered to the hole sides.

It is essential that a hole be kept open during the drilling process and then until it is no longer required for the extraction of water, oil or gas. The method used in nearly all drilling in fissured ground up to about 1930 was by the use of steel casing. A hole

was started at a diameter much larger than the finishing diameter and lined with coupled steel pipes. Each coupling resulted in a decrease in diameter. However, flush jointed casing can be used to maintain a constant diameter. Steel casing is still used in very friable strata and often to prevent loss of mud or drilling fluids in very pronounced fissures or breaks. Often the casing must be set firmly in position by the use of cement between the casing and sides of the hole. Casing is lowered into the hole in the same way as drill rods, and strings of casing are equipped with a casing shoe or hollow bit to remove loose debris adhering to the side of the hole.

In very strong and homogeneous strata it is often possible to drill many thousands of feet without the use of casing. To achieve this the modern method is to use a drilling fluid containing mud. Any drilling mud must have (1) sufficient weight to support the rock by forming a cake around the sides of the hole; (2) sufficient weight also to control the ingress of gases and fluids into the hole; (3) properties to prevent loss of water or oil into the pores or fissures in the rock; (4) properties of cooling the drilling bit; (5) sufficient viscosity to float the cuttings from the hole; and (6) sufficient viscosity to permit separation of the cuttings from the mud over the shaker screens on the surface. With normal rotary drilling, without the use of coring, samples of cuttings are taken at the separating screens and may be as small as one-sixteenth inch.

Another method of hole maintenance was introduced in the U.S. in the 1950s for putting down large-capacity irrigation wells in unconsolidated strata. Known as reverse-circulation rotary drilling, it employed the static pressure of a heavy drilling mud to prevent caving of the hole walls. The drilling mud flowed from a settling pit directly into the hole, which was kept filled at all times; large centrifugal pumps were used to draw the mud and cuttings up the drill pipe—the reverse of the standard rotary drilling method.

The chemistry of drilling muds is a very complex subject. The acidity or alkalinity of a mud, its pH value, will obviously be a guide to its possible reaction with chemicals in the strata or with any cements used in the hole. It is also essential to know the pH value of the clays and chemicals used and of the mixing water. The desired characteristics of drilling muds are obtained by careful addition of clays such as bentonic clays, weighting materials and chemicals. Other drilling fluids are prepared with oils and are known as oil-base muds.

Power Plant Requirements.—The type of motive power used for drilling depends largely on the availability of electricity, fuel and water. Choice may be made from steam, internal-combustion engines, gasoline or diesel, natural gas, alternating- or direct-current electricity and compressed air. Gasoline motors are usually expensive to operate. Steam power is attractive in areas remote from other power sources, but application depends on the availability of suitable water supplies. It has been used extensively for the deep soft formations of the U.S. Gulf coast and California.

For holes down to 400 ft., 20 h.p. is usually adequate in most formations, while diamond drilling down to 4,000 ft. may require 50 h.p. It is also necessary, of course, to take into account the load to be put on a rotary bit in order to secure efficient penetration. This may vary from 400 lb. on a $1\frac{3}{8}$-in. bit to 10 tons on a 9-in. roller bit.

U.S. experience has shown that, where fuel and water supplies are costly and drilling is simple, straight power rigs are most efficient. Typical examples are the practices adopted in Texas and New Mexico. Special hydraulic couplings and torque converters have been developed to obtain the maximum efficiency from such rigs.

A full rotary drilling layout for very deep drilling may have up to eight prime movers and generators. Motors of 300 h.p. are necessary to drive the generators, which may be of 150 kw. output. It also is necessary to have a motor of up to 800 h.p. for driving the reduction gearing and hoisting the rods. A smaller motor of 200 h.p. may be necessary for rotating the bit and rods, two 500-h.p. motors for driving the mud-circulating pumps and one or two small motors for driving the mud-screening plant. The hydraulic coupling has had widespread use in rotary drilling in many oil fields of the world. It has the advantage of reducing shock in the form of torsional vibrations to the drill and reducing slip due to acceleration. Torque converters are also widely used. They govern the torque on the output side of the prime mover. When the load on the drill increases the torque is automatically increased.

For rapid drilling using very little coring, a drilling machine may be mounted on skids. The height of the derrick is dependent on the type of strata, depth of hole, number of bit changes, etc. High derricks are mostly used when coring, necessitating frequent hoisting, is in use.

Other equipment includes controls for operating the rotary table drill fluid pumps, and also hydraulic and electrical controls. Instruments include weight indicators to show the total load on the derrick and weight on the bit, pressure gauges for slush pumps, both indicating and recording, and torque indicators to show rotation losses on drill pipe. There are also tachometers, temperature, air-pressure and oil-pressure gauges and ammeters.

Drilling for water, resulting in artesian wells, can be performed with either the normal percussive method or, in very hard rocks, with rotary methods. Wells may continue to supply water for many years after being drilled, but occasionally have to be rejuvenated. This is carried out by firing explosives, lowered in canisters, in the hole. The operation results in cracks and fissures being opened up so that water is supplied in larger quantities. An example is a well at Rochester, Kent, which yielded 20,160 gal. of water an hour immediately after rejuvenation.

Diamond drill holes are rarely straight; very deep holes may vary even as much as 60° from their true direction. This is because the rod does not fit closely in the hole and therefore bends. Deviation is likely to occur also in drilling through inclined strata, especially when the layers are of different degrees of hardness.

By using a long and closely fitting core barrel deviation is reduced. Nearly horizontal holes always deflect upward because the sag of the rod tilts up the bit. Diamond-drill holes should therefore always be surveyed. This is done by placing into the hole instruments for observing at a number of successive points the direction and degree of deviation. If accurately surveyed a crooked hole may be as useful as a straight one.

See BLASTING; COAL AND COAL MINING; MINING, METAL; PETROLEUM; WELL; etc.

See also references under "Drilling Machinery" in the Index volume.

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(RT. SD.)

DRINKWATER, JOHN (1882–1937), British poet, playwright and critic, remembered as a typical "Georgian" man of letters, a successful promoter of the repertory theatre in England and as the author of popular chronicle dramas, was born at Leytonstone, Essex, on June 1, 1882. After 12 years as an insurance clerk, Drinkwater devoted himself to theatrical enterprise, and became manager and producer to the Pilgrim Players, who developed into the Birmingham Repertory Theatre company. His first volume of poems appeared in 1906 and his first play, *Cophetua* (in verse), in 1911.

Drinkwater subsequently published several volumes of verse, critical studies, *William Morris* (1912), *Swinburne* (1913) and others, and several historical plays, of which *Abraham Lincoln* (1918) was produced with great success both in London and in the United States. In 1923 his *Collected Poems* (2 vol.) were published, and in 1925 *The Muse in Council,* a collection of essays, his *Collected Plays* (2 vol.), and a prose study of Byron, *The*

Pilgrim of Eternity. His autobiography appeared in two volumes, *Inheritance* (1931) and *Discovery* (1932). He died in London on March 25, 1937. (J. Sp.)

DRIVER, SAMUEL ROLLES (1846–1914), English Semitic languages scholar, co-editor of the Oxford *Hebrew and English Lexicon of the Old Testament* (1906), was born in Southampton on Oct. 2, 1846. Educated at Winchester and New college, Oxford, where he became a fellow (1870) and tutor (1875), in 1883 he succeeded E. B. Pusey as regius professor of Hebrew and canon of Christ Church, Oxford. He was a member of the Old Testament Revision committee (1875–84) for the Revised Version of the Bible. He died in Oxford on Feb. 26, 1914.

Driver devoted his life to the study of the language and text of the Old Testament and to its interpretation. He played a leading part in the communication to British students of the new literary critical approach to the Old Testament which was then current on the continent of Europe, especially in Germany. He also helped to lay secure foundations for research into Hebrew and Semitic philology, which was then entering upon a fresh stage. His *Introduction to the Literature of the Old Testament* (1891; 9th ed., 1913) became a standard work, and exercised great influence on younger scholars. Of his numerous commentaries on books of the Old Testament, at least one, *Notes on the Hebrew Text and the Topography of the Books of Samuel* (2nd ed., 1913), has become a classic. A list of his publications is given in an appendix to his selected sermons, *Ideals of the Prophets* (1915), ed. by G. A. Cooke. His son Godfrey Rolles Driver (1892–), professor of Semitic philology in the University of Oxford, was made chairman of the Old Testament translation committee for the New English Bible.

See the appreciation by A. Cowley in *Proceedings of the British Academy* (1915–16). (D. W. Th.)

DRIVER'S INSURANCE: *see* Motor Vehicle Insurance.

DRIVING AND COACHING. Driving is a word used in a restricted sense for the art, or sport, of controlling and directing draft animals from a coach or other conveyance to which they are harnessed for the purpose of traction. The animal most commonly employed is the horse, but the mule, ass and ox are also much used, while in arctic lands their place is taken by the reindeer and the dog.

The use of horses for driving goes back to remote times. On bas-reliefs of Assyrian and Egyptian origin kings are shown doing battle and hunting in two-wheeled chariots drawn by a pair of horses. Ancient Britons used them for warfare and agriculture, and the Romans and Greeks used them for chariot racing and other sports. Italy and Hungary have been credited with the introduction of the carriage in Renaissance times; about 1550 the first private carriage was in use in England, but for nearly two more centuries the saddle horse remained the usual means of transport. The ponderous, springless stagecoach toiled slowly over the rough and rutted tracks throughout the 18th century, and it was only at the end of that century that the construction of better roads and the invention of springs for carriages made driving at all pleasurable. In Britain the first mail coach was put on the road in 1784, running from Bath to London at the rate of about seven miles per hour, and the stage and mail coaches existed side by side until the advent of the railways. By the beginning of the 19th century the art of coachbuilding had reached a high degree of perfection and driving as a pastime was becoming fashionable. An important revival of coaching was initiated in 1866, and up to World War I there were numerous stagecoaches running daily in and out of London. On July 13, 1888, J. Selby performed his celebrated feat of driving the "Old Times" coach from London to Brighton and back in 7 hr. 50 min., averaging 13.79 miles per hour (with 8 teams and 14 changes). A number of driving clubs came into existence in England in the 19th century. The Benson Driving club lasted from 1807 to 1854; the Richmond club from 1838 to 1845; and Four-in-Hand Driving club from 1856 to 1926. The Coaching club was founded in 1870 and in 1958 the British Driving society was formed to encourage people who wish to drive horse for pleasure. In the United States, the Coaching club, founded in 1875, held its last extended drive, from the club's headquarters at the Knickerbocker club in New York to Belair house, Collington, Md., Oct. 11–14, 1916; the club continued in existence, establishing the Coaching Club American Oaks, a stake race for three-year-old fillies, at Belmont park, first held in 1917.

The amateur will do well to visit such shows as the Richmond and International Horse shows, where he will see the finest harness horses and the most skillful drivers or "whips." He will also see fast U.S. trotters and pacers and note the difference in the style of U.S. and English driving. The number of horses driven is usually one, two or four.

When two horses are used they may either be placed side by side, in double harness, or, less commonly, one following the other, in a tandem. Four horses, or a four-in-hand, are harnessed in two pairs, one following the other, and called respectively the leaders and the wheelers. When three horses are used, two wheelers and a single leader, this is known as a unicorn team. In Russia and Hungary three horses are driven abreast, the centre horse trotting and the outside horses galloping; such a team is known as a troika.

Driving is an accomplishment which can be learned only at the hands of a first-class coachman and requires constant practice. The following are a few principles which are common to all branches of driving, whether of one, two or four horses. The driver should have knowledge of horses. He should become acquainted with every part of the harness he uses and with the purpose which each buckle or strap is intended to serve. The indefinable quality known in horsemanship as "good hands" is partly the result of learning the correct position for the left arm and hand, which hold reins. The hand should be kept at about the level of the lowest button of the driver's waistcoat or at belt level, and near the body though not pressed against it; the upper arm should lie loosely against the side, the forearm horizontal across the front of the body, forming roughly a right angle at the elbow joint, the wrist bent inward, and the back of the hand and knuckles facing outward toward the horse. In this position the three joints of the arm form a kind of automatic spring movement that secures the "give" to the movement of the horse's mouth which, in conjunction with firmness, is a large part of what is meant by "good hands." The reins must also be held with the proper degree of bearing on the bit; this depends greatly on the character of the horse and the severity of the bit, but under no circumstances should the reins be allowed to lie slack. The driver should always just "feel the horse's mouth" as lightly as possible; he then has the animal under control, but does not pull on the mouth and cause chafing and fretting.

The driver will learn early that a horse must be kept well in hand going downhill and given its head on an ascent, and that the hand brake should be used sparingly. He must acquire an eye for pace and distance, and the instinctive realization of the length of the carriage behind him, without which he may collide with other vehicles or allow insufficient room in turning a corner or entering a gateway. Special skills are required to drive a tandem or a four-in-hand, and it needs both strength and an instinctive knowledge of the position of the greater number of reins in the hand. It also requires a knowledge of the proper use of the whip, accuracy with which is essential when driving a four-in-hand.

(G. W.; E. E. Hn.)

DRIZZLE, a steady light rain in which the drops are very minute (diameter less than $\frac{1}{50}$ in., approximately) and numerous. Such small drops seem almost to float in, and thereby to follow, even the slightest motions of the air.

Drizzle is distinguished from sprinkles or ordinary light rain in that it falls from thick low-lying stratus or strato-cumulus clouds, rather than from cumulus or alto-stratus, and always causes poor visibility. In theory the precipitation of drizzle is a consequence of turbulence produced by friction of the air with the ground, whereas other rain requires larger-scale vertical motions reaching higher levels in the atmosphere. Freezing drizzle causes glaze (or glazed frost), a thin, transparent ice crust on the ground and exposed objects; but frozen drizzle (or granular snow) consists of very fine snow or ice grains falling under identical cir-

cumstances as rain drizzle, except at cloud-level temperatures at or below the freezing point.

In the U.S., drizzle is sometimes confused with mist (*q.v.*).

(R. G. Se.)

DROESHOUT, MARTIN (1601–*c.* 1650), English engraver, whose title to fame is his engraved portrait of William Shakespeare, which appeared in the first folio edition of Shakespeare's plays (1623). Born in London, probably in April 1601, the son of Michiel Droeshout, he was probably the pupil of his father and of his elder brother John, both engravers. The Shakespeare engraving was eulogized by Ben Jonson and called true to life. Since the engraver was only 15 years old at the time of Shakespeare's death, the portrait was probably not done from life. Among Droeshout's more successful mature works are several other portraits, book decorations, and allegorical, mythological and satirical subjects. (C. H. C. B.; X.)

DROGHEDA (Droichead Atha, "Bridge of the Ford"), a municipal borough and seaport on the southern border of County Louth, Republic of Ireland, lies on the Boyne river about 4 mi. from its mouth in Drogheda bay and 30 mi. N.W. from Dublin by road. Pop. (1961) 17,085. Drogheda was a stronghold and trading post of the Danes and later of the Anglo-Normans, who replaced the ford by a bridge. In 1157 a synod was convened there. Two towns grew up, one on either side of the river, which received separate incorporation in 1228 but were combined by charter in 1412. In the reign of Edward III it was one of the four staple towns of Ireland with Dublin, Waterford and Kilkenny, and was granted the right of coining money. Several parliaments were held there, the most notable being in 1494 when Poynings' law was enacted (*see* Poynings, Sir Edward). In the 1641 rebellion the town was besieged by Sir Phelim O'Neill and was relieved, but in 1649 it fell to Oliver Cromwell and the inhabitants were massacred; after the battle of the Boyne in 1690 it surrendered without a struggle, though garrisoned by King James's army. It ceased to be a parliamentary borough in 1885 and a county of itself in 1898.

The ancient fortifications of Drogheda have disappeared except for the gateway of St. Lawrence on the north side, which remains almost perfect, and the ruins of the West or Butler gate. From the close of the 12th century to some time after the Reformation the primates of Ireland lived in Drogheda. In the Dominican friary founded in 1224, of which the Magdalen tower remains, Richard II received the submission of the O'Neill, O'Donnell and other chieftains of Ulster and Leinster. Of the establishments of the Franciscans, Carmelites and Knights of St. John nothing is left, but there are a tower and a pointed arch of the Augustinian abbey of St. Mary d'Urso founded in 1206. In St. Peter's church, which was erected to his memory, a shrine contains the head of the archbishop of Armagh, Blessed Oliver Plunket (*q.v.*), who was martyred at Tyburn in 1681. The Bluecoat school was founded in 1727 but the present buildings date from 1870. At Mellifont, 6 mi. W., are ruins of the first Cistercian abbey of Ireland.

There are linen and cotton mills, coachbuilding works, flour and sawmills, a brewery, a large cement works and factories making vegetable oil products, clothing, boots, fertilizer and spark plugs. Drogheda is the headquarters of the valuable Boyne salmon fishing. Agricultural produce and coal are traded by sea.

DROGOBYCH, a town of Lvov *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., and formerly an administrative centre of its own *oblast*. Pop. (1959) 42,145. On May 21, 1959, Drogobych *oblast* was absorbed into Lvov *oblast*. Drogobych lies in the foothills of the Carpathian mountains, about 40 mi. S.S.W. of Lvov. It is an ancient town, known in the 11th and 12th centuries for its salt, which is still mined nearby at Stebnik. Known as Drohobycz, it was in Poland between World Wars I and II, passing to the U.S.S.R. in 1939. It is important as the centre of the Carpathian oil and natural gas field, the principal oil fields being near Drogobych and Borislav. Nearby are potassium and magnesium salt mines and natural gas wells. Ozocerite is also found locally. There are timber and light industries. Drogobych has a pedagogic institute and an oil-electromechanical technical school. (R. A. F.)

DROIT, a right or that to which one has a right; a term used in various legal connections, referring principally to certain rights of a feudal superior, such as *droit du seigneur* (*q.v.*). In English law, the best-known use is in the phrase droits of admiralty, these being rights of the crown to property found upon the sea or stranded upon the shore, including great fish (whales, porpoises, sturgeon, etc.), wrecks, flotsam, jetsam and lagan (*q.v.*), and enemy ships found in English ports. Droits of admiralty are not, as such, recognized in the United States. *See* also Prize Courts and Prize Law. (M. C. Me.)

DROIT DU SEIGNEUR, known also as *jus primae noctis* ("right of first night"), a feudal right said to have existed in medieval Europe giving the superior to whom it belonged the right to sleep the first night with the bride of any one of his vassals. The custom is paralleled in various primitive societies, but the evidence that we have of its existence in Europe is almost exclusively of the redemption dues paid by the vassal to avoid enforcement, not of actual enforcement. The one document which appears to present the right actually in operation (decree of the Seneschal of Guyenne, 1302) has been challenged on several grounds in the course of spirited controversy in France. Remarkable displays of learning have been devoted to the problem, but although it seems possible that such a custom may have existed for a short time at a very early date in parts of France and Italy, it certainly never existed elsewhere. A considerable number of feudal rights related to the vassal's marriage, particularly the lord's right to select a bride for his vassal, but these are almost invariably known only in the form of a money payment, or "avail," for redemption. It seems likely that, in effect, the *droit du seigneur* was only another tax of this sort.

See L. Veuillot, *Le Droit du seigneur au moyen age* (1854); J. Delpit, *Le Droit du seigneur* (1873). (M. C. Me.)

DROITWICH, a market town, spa and municipal borough in the Worcester parliamentary division of Worcestershire, Eng., 7 mi. N.N.E. of Worcester by road. Pop. (1961) 7,976. The old town, which stands on the Salwarpe river, a tributary of the Severn to which it is connected by a canal, contains many half-timbered black-and-white houses among which are Priory house and the Elizabethan manor house of Wyche (now the Raven hotel). In a former manor house on this site St. Richard, the town's patron saint, was born about 1197 and scenes from his life are depicted in mosaics in the Roman Catholic church at Witton (1909), the suburb at the top of the hill upon which the modern Droitwich is built. A statue of St. Richard stands in Vines park. A bronze tablet in St. Peter's church commemorates Edward Winslow (*q.v.*), one of the Pilgrim Fathers and three times governor of the New Plymouth colony, who was born in Droitwich and baptized in the church. The town has long been famous for the salt obtained from the brine springs or *wyches*, to which it probably owes its name and origin. The brine pumped up is about ten times as salty as sea water and is used for the treatment of rheumatic diseases. The health resort superseded the salt-manufacturing town in 1830 after a cholera patient was dipped into a vat of hot brine and recovered. The salt industry was moved to Stoke Prior in 1922. Besides the Royal baths and the St. Andrew's Brine baths with their clinics, there are hospitals and convalescent homes.

A Roman villa has been found at Droitwich and it is probable that the brine springs were then used as a source of salt. They are mentioned in several charters before the Conquest but at the time of the Domesday survey they belonged to the king who received a yearly farm of £65; the manor was then divided between several churches and tenants in chief. King John granted the town its first charter in 1215 in return for a yearly rental of £100 for the springs. Mary I granted the incorporation charter in 1553–54 and James I granted a fuller charter which remained in force until 1835. The many medieval fairs have been discontinued. Besides catering for visitors and patients, Droitwich has light industries making heating appliances, metal and plastic goods and food products.

DRÔME, a *département* of southeastern France, situated east of the Rhône river, was formed in 1790 from parts of Dauphiné and Provence (*qq.v.*). It is bounded on the west by Ardèche

across the Rhône, north and east by Isère, east by Hautes-Alpes and south by Vaucluse. Pop. (1954) 275,280. Area 6,560 sq.km. (2,533 sq.mi.). Drôme is crossed by left-bank tributaries of the Rhône from the Alps, including the Isère, Drôme, Roubion and Aygues. It extends from the outer portion of the north-south ranges of the limestone Préalpes of the Vercors, Diois and the Baronnies to the plains along the east side of the Rhône, which are interrupted by rocky spurs that constrict the valley.

Although winter snow lingers late on the mountains, the lowlands have sunny, warm summers. They are subject, however, to the icy blasts of the notorious north wind, the mistral, funneled by the Rhône valley and emphasized by the constrictions between its basins. Only in sheltered sites in the south of the *département* does the olive appear. On slopes that have a favourable exposure the vine is extensively grown, however, and the vineyards on the schistose hills near Tain-l'Hermitage produce a wine of high quality. The cultivation of fruit, including almonds and walnuts, is widespread, Montélimar being especially well known for its nougat, and the production of market-garden crops was being increased in the 1960s by the extension of irrigation. On the other hand, mulberry cultivation has greatly declined, though textile factories have spread into the *département*, especially in the northern part, nearest Lyons.

Situated along the historic routeway of the Rhône valley, the old settlements are characteristically perched on defensive sites. At the ancient crossing of the Isère, the twin bridge towns of Romans-sur-Isère and Bourg-de-Péage have experienced industrial growth, with leather and footwear as well as textile industries at the former and felt-hat manufacture at the latter. Along the Rhône the left-bank towns in Drôme are usually paired with settlements across the river in Ardèche.

The main railway to Marseilles and Route Nationale 7 traverse the *département* from north to south. After a long period of decline the navigation of the river was revived by major improvement works, including that associated with the multipurpose Donzère-Mondragon project, constructed after World War II. From the rocky defile of Donzère, a deep lateral canal is derived from the Rhône and rejoins the river 18 mi. farther south at Mondragon, after serving the great André Blondel electric power station at Bollène. Besides providing power for the electrification of the railway and for industrial development, including a plutonium factory, the scheme provides water for irrigation and a navigation channel to bypass the most obstructed reach of the Rhône, in the plain below Donzère. By the early 1960s the project had already resulted in the creation of new settlements. Valence (*q.v.*) is the capital of the *département*, which comprises the three *arrondissements* of Valence, Die and Nyons. It forms the bishopric of Valence and comes under the court of appeal and *académie* (educational division) of Grenoble. Roman remains, medieval castles and the traces of town walls are typical of the old towns in the *département*. Among them the little walled town of Grignan, with its Renaissance château, is well known through the writings of Mme de Sévigné, who died there. (AR. E. S.)

DROMEDARY, the Arabian (one-humped) riding camel, a swift, domestic species not found in the wild. Being longer-legged and slimmer than the bactrian (two-humped) camel, it has been known to carry a man 115 mi. in less than 11 hours. *See* CAMEL.

DROMICEIDAE, a family of flightless, terrestrial birds comprising one living form, the emu (*q.v.*; *Dromiceius novaehollandiae*) of Australia.

DROMORE, a market town and urban district of County Down, Northern Ireland, on the upper Lagan, 17 mi. S.W. of Belfast by road. Pop. (1961) 2,125. A bishopric grew out of an abbey of regular canons reputedly founded there by a St. Colman *c.* 600. The town and cathedral were destroyed in the 1641 insurrection and the present structure was built by the Anglican bishop Jeremy Taylor in 1661. Another bishop of Dromore was Thomas Percy (1729–1811), the editor of the *Reliques of Ancient English Poetry;* both bishops are buried in the cathedral.

The diocese was united in 1842 with that of Down and Connor. Dromore is also the name of a Roman Catholic diocese. The 8th- or 9th-century cross of Dromore, formerly in the market place, was restored and re-erected beside the Lagan bridge in 1887. The large mound near the town is a Norman earthwork. The chief industries are hemstitching, bleaching and dyeing.

DRONGO, any of about 30 species of old-world tropical perching birds, also known as king crows or drongo shrikes, forming the family Dicruridae, related to the old world orioles. They are handsome, usually glossy black, fork-tailed birds, 10 to 12 in. long, the prolonged outer tail feathers sometimes doubling that length. They are commonest in southeastern Asia, but also occur in Africa, the Malay archipelago and Australia. The drongo cuckoo of India (*Surniculus lugubris*) resembles or mimics the black drongo (*Dicrurus macrocercus*) and lays its eggs in the drongo's nest. (G. F. Ss.)

DROP FORGING: *see* FORGING.

DROPSY: *see* EDEMA.

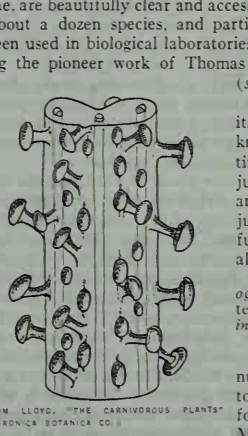
DROSERACEAE, a family of dicotyledonous plants, remarkable in that all its members are carnivorous. There are four genera and about 90 species. *Drosera* is a cosmopolitan genus including about 85 species, known as sundews (*q.v.*). *Dionaea* is Venus's-flytrap (*q.v.*). *Aldrovanda*, widespread in the old world, is a water plant, lacking roots. *Drosophyllum* (*q.v.*), allied to the sundews, is found in the eastern Mediterranean. *See* CARNIVOROUS PLANTS.

FROM D. J. BORROR AND D. M. DELONG, "AN INTRODUCTION TO THE STUDY OF INSECTS," HOLT, RINEHART AND WINSTON, INC., 1959

FRUIT FLY OR POMACE FLY (DROSOPHILA)

DROSOPHILA, a genus of flies (Diptera), commonly known as vinegar, or pomace, flies and also, popularly but misleadingly, as fruit flies (this last name rightly belongs to flies of the family Tephritidae [Trypetidae; *see* FRUIT FLY], to which vinegar flies are not closely related). The number of *Drosophila* species may be conservatively guessed at no less than 1,000.

Some, though not all, species lend themselves admirably for laboratory and field experiments on heredity and evolution. They are cultured easily and cheaply: their life cycles are short (less than two weeks at room temperature, 25° C.), a pair of parents producing hundreds and even thousands of progeny. Their chromosomes, particularly the so-called giant chromosomes in the cells of the salivary glands of mature larvae, are beautifully clear and accessible for study (*see* CYTOLOGY). About a dozen species, and particularly *D. melanogaster*, have been used in biological laboratories throughout the world, following the pioneer work of Thomas Hunt Morgan and his school (*see* GENETICS).



FROM LLOYD, "THE CARNIVOROUS PLANTS" (CHRONICA BOTANICA CO.)

DROSOPHYLLUM SMALL PORTION OF A LEAF SHOWING THE TWO KINDS OF GLANDS, STALKED AND SESSILE

The biology of *Drosophila* in its natural habitats is not well known. Some species live in rotting, injured—but not in uninjured—fruits and are attracted to and live on fermenting plant juices, whereas others develop in fungi or in fleshy flowers. *See* also FLY.

See M. Demerec (ed.), *The Biology of Drosophila* (1950); J. T. Patterson and W. S. Stone, *Evolution in the Genus Drosophila* (1952). (T. DV.)

DROSOPHYLLUM, a genus of carnivorous plants allied to the sundews (*Drosera*) and found in the hills of Portugal and Morocco. It is a low, shrubby plant which, in contrast with other carnivorous plants, inhabits

dry soil. It produces numerous long, linear leaves bearing two kinds of glands: stalked, having the shape of minute toadstools, and sessile, lacking the stalk. The former are coloured red, the latter pale green. The stalked glands secrete a stiff mucilage which serves to catch insects as large as houseflies. In struggling, the prey is bedaubed with the mucilage and is asphyxiated. Coming into contact with the digestive glands, which have been stimulated from the stalked glands, the prey is attacked by a digestive enzyme. It is thought that a mosquito can be digested completely in 24 hours.

The common name for the plant in Portugal is "slobbering pine" or dew of the sun (sundew). *See* also CARNIVOROUS PLANTS.

(F. E. L.; X.)

DROSTE-HÜLSHOFF, ANNETTE ELISABETH, BARONESS VON (1797–1848), the outstanding German woman writer of her time. Her parents belonged to the Catholic nobility of Westphalia and she was born on Jan. 10, 1797, at Hülshoff near Münster. With her brothers she was educated by tutors. She learned to love the landscape of her homeland and to understand its people, even sharing some of their superstitions. The impressive cycle of religious poems *Das geistliche Jahr* (begun 1820, completed 1839, first published 1851) reflects both her piety and her doubts. After the death of her father she moved to nearby Rüschhaus and in 1830 she met the novelist Levin Schücking (1814–83) who was to be her only link with contemporary literature and a spur to poetic ambitions such as she lacked in her family circle. He thought of her as a friend, but her feelings toward him were more intense. In 1841–42 she stayed at the home of her brother-in-law Joseph, Baron von Lassberg (1770–1855) in Meersburg where Schücking was librarian. There she wrote a number of her best poems, often inspired by memories of Westphalia. Her lyrics and ballads, first published under her full name in 1844, are distinguished by shrewd and unsentimental observation of nature, originality of approach and virility of tone. Her only completed prose work, *Die Judenbuche*, a penetrating study of a murderer's upbringing, crime and atonement within the setting of Westphalian village life, appeared in 1842. After a lifetime of indifferent health, she died on May 24, 1848, at Meersburg.

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DROUAIS, JEAN GERMAIN (1763–1788), French historical painter, was born in Paris on Nov. 25, 1763. His father, François Hubert Drouais, and his grandfather, Hubert Drouais, were well-known portrait painters. Jean studied first under his father, then under N. G. Brenet, and finally under J. L. David, whom he accompanied to Rome. There he was influenced by ancient art and by Raphael. Goethe, who was at Rome when Drouais's "Marius at Minturno" was finished, has recorded the deep impression made by the picture. The last picture he completed was "Philoctetes on the Island of Lemnos." He died on July 15, 1788, at the age of 24.

DROUET, JEAN BAPTISTE (1763–1824), French revolutionary, chiefly remembered for his part in the arrest of Louis XVI, was born at Ste. Menehould in Champagne, where his father was postmaster. The carriages conveying Louis XVI and his family on their flight to the frontier stopped at his door on the evening of June 21, 1791; and the passengers were recognized by Drouet, who took steps which led to their arrest on reaching Varennes. For this service he declined a reward. In Sept. 1792 he was elected deputy of the Convention. He voted the death of the king without appeal, showed implacable hostility to the Girondins and proposed the slaughter of all English residents in France. He was captured by the Austrians at the siege of Maubeuge in Hainault (1793) and imprisoned at Spielberg in Austria until the close of 1795. He then became a member of the Council of Five Hundred, and was named secretary. Drouet was implicated in the conspiracy of Babeuf (1796) and was imprisoned; but he escaped to Switzerland and then to Teneriffe. There he took part in the resistance to Nelson's attempt on the island in 1797. He later visited India. The first empire found in him a docile subprefect of Ste. Menehould. After the second Restoration he had to leave France (1816). Returning secretly, he settled at Mâcon under the name of Merger. He died there on April 11, 1824.

DROUET D'ERLON, JEAN BAPTISTE, COMTE (1765–1844), French soldier whose long career raised him from the ranks of Louis XVI's army to be the first governor-general of Algeria and a marshal of France under Louis Philippe, was born at Reims on July 29, 1765. A volunteer in the regiment of Beaujolais from 1782, he had reached the rank of corporal in 1792, before the fall of the monarchy. Elected captain in 1793, he became aide-de-camp to Gen. P. Lefebvre in 1794 and thenceforward enjoyed rapid promotion. General of division in 1803, he was created comte d'Erlon by Napoleon in Jan. 1809. Having been chief-of-staff of the Bavarian army (from March 1809) and subsequently its commander in chief, in Aug. 1810 he was sent to Spain, where he became governor of Extremadura. He was promoted lieutenant general in 1813. Under the first Restoration he was made commander of the 16th military division, but conspired against the regime. Joining Napoleon during the Hundred Days in 1815, he was made a peer of France and given command of an army corps, but in the Waterloo campaign he spent June 16 between Ney at Quatre-Bras and Napoleon at Ligny, failing to support either as required.

On the second Restoration Drouet fled to Bavaria, where, as Baron Schmidt, under King Maximilian I's protection, he set up a brewery near Munich. The death sentence passed on him in France in 1816 was, however, canceled in 1825. Returning to France in 1830, he was reinstated on the active list by the July monarchy. As commander of the 12th military division at Nantes, he was responsible for the arrest of the duchesse de Berry (1832).

In July 1834 Drouet was appointed governor-general of Algeria. Ignorant of the country, he at first let himself be guided by his chief-of-staff, Gen. C. A. Trézel, but on Trézel's being posted to Oran he fell under the influence of the scheming Juda ben Durand, an emissary of Abd-el-Kader (*q.v.*). He disavowed Trézel after the latter's defeat by Abd-el-Kader at La Macta. Weak, lazy and bewildered by intrigues despite his intelligence, he was recalled to France in July 1835. After further years at Nantes, he was made marshal of France in April 1843. He died in Paris on Jan. 25, 1844. His Algerian correspondence is edited by G. Esquer, as volume iii of the *Correspondance générale* in the *Collection des documents inédits sur l'histoire de l'Algérie après 1830* (1926).

(L. G.)

DROUGHT (DROUTH) results from long-continued dry weather and lack or insufficiency of rain which causes exhaustion of soil moisture, suffering of plants from lack of water, depletion of underground water supplies and reduction and eventual cessation of stream flow. Only when the rate of rainfall exceeds the rate of evapotranspiration (evaporation and transpiration combined) is there a surplus of water for soil moisture recharge, ground water recharge and runoff. On the other hand, when the rate of transpiration exceeds the rate of precipitation, moisture in the root zone of the soil will be used up. So long as soil moisture is deficient, water cannot pass through the root zone to replenish ground water, nor does it produce appreciable amounts of surface runoff. Ground water sustains stream flow; but, as long as there is no ground water recharge, the ground water reserves will gradually decline and stream flow will diminish. Thus, the various aspects of drought are interrelated. Absence of rain means utilization and rapid exhaustion of soil moisture with consequent damage to plants and reduction of crop yield; the dry soil prevents addition of water to ground water reserves which are consequently gradually depleted.

Drought is most accurately described as a condition in which the amount of water that is needed for evaporation and transpiration exceeds the amount actually available. Because of the difficulty of determining water needs, however, drought has most often been defined as a period of consecutive days without rainfall. According to a U.S. weather bureau definition a drought exists whenever the rainfall for a period of 21 days or longer is but 30% of the average for the time and place. Tennessee Valley

authority meteorologists defined drought similarly. The British Rainfall organization defined an "absolute" drought as a period of at least 15 consecutive rainless days. Other attempts to define drought restrict the rainfall to a definite percentage of the monthly or annual normal value.

One such definition states that drought occurs when the annual precipitation is 75% of normal or monthly precipitation is 60% of normal; another says that any amount of rainfall less than 85% of normal constitutes drought.

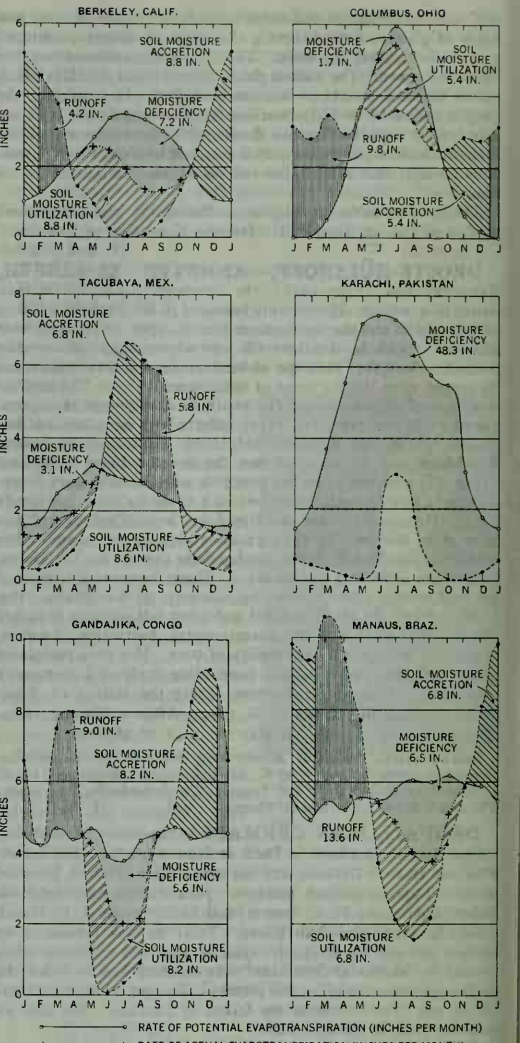
It is evident that drought cannot be defined as a shortage in rainfall alone because such a definition would fail to take into account the amount of water that is needed. Furthermore, the effect of a shortage of rainfall depends on whether the soil is moist or dry at the beginning of the period. Drought begins only when the vegetation can no longer absorb water from the soil rapidly enough to replace that lost to the air by transpiration. It does not necessarily begin on the day that rain ceases but rather only when soil moisture is exhausted.

There are three basic types of drought. The first, called permanent drought, is characteristic of the driest climates. The sparse vegetation is adapted to drought, and agriculture is impossible except by irrigating through the entire crop season. In regions of permanent drought stream flow is absent; there is no runoff except locally when a rare rain occurs. The second, or seasonal drought, is found in the climates that have well-defined rainy and dry seasons. The natural vegetation is made up of plants that produce seeds during the rainy season and then die, and of plants that remain alive but become dormant in the dry season. For successful agriculture, planting dates must be adjusted so that the crop develops during the rainy season. Otherwise, irrigation is necessary. Stream flow is periodic; all but the largest streams may become completely dry during the dry season. The third kind of drought results from the fact that rainfall is irregular and variable everywhere. These are contingent droughts. They are due to the accidental failure of rainfall and are not certain to occur in any definite season, but they are most probable in summer when water needs of plants are greatest. They may occur almost everywhere, even in the areas of seasonal drought, but are most characteristic of subhumid and humid climates. They are usually brief and irregular and may affect a relatively small area. They vary greatly in intensity and time of occurrence and cannot be anticipated.

A fourth type called invisible drought can also be recognized. Even when summer showers are frequent they may not supply enough water to restore that lost by evaporation and transpiration. The result is a borderline water deficiency that cuts crop yields to a small fraction of the potential. When water is supplied to the crops by irrigation to make up the deficiency, crop yields increase twofold and threefold. (*See* IRRIGATION: *Supplemental Irrigation.*)

The amount of water in the root zone of the soil at any time is a result of the interaction of two meteorologic processes—precipitation, which adds water to the soil, and evapotranspiration, which removes it. The meteorologic forces that determine the amount and distribution of precipitation are not the same as those that govern the need for it. The distribution of precipitation in space and time over the inhabited parts of the earth is reasonably well known. On the other hand, almost nothing was known in the second half of the 20th century of the similar characteristics of evapotranspiration. It would be possible to measure actual evapotranspiration as soon as existing methods were perfected. But since potential evapotranspiration does not represent actual transfer of water to the atmosphere but rather the transfer that would be possible under ideal conditions of soil moisture and vegetation, it usually cannot be measured directly but must be determined experimentally.

The many studies that have been made reveal that evapotranspiration depends principally upon four things: (1) climate; (2) soil moisture supply; (3) type of plant cover; and (4) type of land management. Contrary to popular opinion the last two factors are relatively unimportant. The climatic or atmospheric factors determine the rate of transpiration as long as there is no deficiency



(CENTRE RIGHT AND BOTTOM LEFT) FROM "PUBLICATIONS IN CLIMATOLOGY," VOL. VII, NO. 4, 1954, (OTHERS) BY COURTESY OF C. W. THORNTHWAITE

PRECIPITATION COMPARED WITH EVAPOTRANSPIRATION AT SIX SELECTED WEATHER STATIONS. DROUGHT, OR MOISTURE DEFICIENCY, OCCURS WHEN WATER NEED IS NOT FULLY MET BY PRECIPITATION AND SOIL MOISTURE UTILIZATION

of moisture within the transpiring parts of the plant.

The moisture content of the soil determines the supply of water to the absorbing roots and then to the transpiring parts. Thus, as long as soil moisture is not deficient, temperature and sunshine are the chief controlling factors. The relation between temperature and sunshine and evapotranspiration observed at various places in western United States provides a useful basis for determining potential evapotranspiration elsewhere, at least approximately.

Annual potential evapotranspiration varies from less than 20 in. in the north of the United States to more than 50 in. in the south.

In the arctic tundra it is less than 10 in. and in some parts of the tropics it is more than 60 in.

Except in equatorial climates, the potential evapotranspiration varies systematically from month to month throughout the year; it is quite small or negligible in winter and, even in the polar regions, is large in summer.

This periodic variation between winter and summer which is associated with the apparent motion of the sun gradually diminishes in the tropical regions until at the equator it disappears. Potential evapotranspiration may vary from month to month, however, even in full equatorial climates. For example, in Manaus, Braz., within 3° of the equator, the need for water is highest in August, September and October during the dry season and least in February at the height of the rainy season.

Almost everywhere in the world soil moisture is deficient at some time during the year. The magnitude of the deficiency is the most direct measure of drought and represents, of course, the amount by which the precipitation fails at any time to provide an adequate water supply to the vegetation. It is the amount which should be supplied to crops by irrigation to assure maximum yields.

Even in humid climates such as eastern United States or western Europe droughts are frequent and severe. More often, however, the rains are spaced only a little too far apart in time or are too light to supply needed water at the right time. Soil moisture is deficient and drought results although it may not be recognized by any visible signs until after serious damage has been done to the crop. Water is available for supplemental irrigation in most humid regions. The benefits to be secured by adding the right amount of water at the right time are gradually coming to be understood.

Drought is the most serious physical hazard to agriculture in nearly every part of the world. Since both precipitation and the demands for water by crops vary from one year to another, there is a similar great variation in the magnitude of drought. To be able to forecast drought incidence and intensity a season, or even a few weeks, in advance would be of inestimable value to agricultural, industrial and commercial interests. For many years a tremendous amount of effort was expended by official agencies and private individuals all over the world in attempts to develop reliable means of making seasonal drought forecasts. By the second half of the 20th century no method had been found and the possibility of finding one appeared unlikely.

Even more important than the forecasting of drought would be the ability to control it through the artificial production of rainfall. Experiments in cloud seeding with dry ice and silver iodide in the late 1940s were sensationally reported and led to the formation of many firms of rain makers who operated throughout the world. Before the end of the 1950s, it had become clear that the potentialities of rain making were limited and that there was no reason to expect that drought would be controlled or reduced in importance or areal extent.

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DROWNING AND LIFESAVING. Drowning means suffocation by immersion in a liquid, usually water. Water closing over the victim's mouth and nose cuts off the body's supply of oxygen. Deprived of oxygen the victim stops struggling, loses consciousness, gives up the remaining tidal air in his lungs and sinks to the bottom. There the heart may continue to beat feebly for a brief interval, but eventually it ceases and death ensues. Lifesaving is the term used for all the methods devised to aid or rescue drowning persons and to revive the apparently drowned.

The number of lives lost by drowning in the world each year totals many thousands (approximately 7,000 in the United States alone). By far the largest number of these are bathers. The second largest number of drownings occur in small water craft accidents. More than 90% of the drowning accidents among bathers occur within ten yards of the safety of shore, shallow water, pier, float or poolside. Most drownings occur as would be expected among nonswimmers, although the number of novice swimmers who lose their lives in the water runs a close second. Drownings among skilled swimmers are rare.

The commonest causes of drowning among nonswimmers are: (1) stepping off into deep water while wading; (2) being knocked down and swept into deep water by wave action or current; (3) being precipitated into deep water as a result of capsize or sinking of small water craft; (4) falling or being pushed into deep water from an overhanging bank, pier, float or small craft; (5) ill-advised attempts to aid drowning persons. The commonest causes of drowning among novice swimmers are: (1) exhaustion in deep water because of undue expenditure of energy; (2) ineffectiveness of newly acquired strokes; (3) ill-fated attempts to aid drowning persons.

There are three ways in which a nonswimmer can be reasonably safe in, on and near the water. The first is to confine his aquatic activities to supervised shallow-water areas. The second is to wear a life vest or other buoying device when venturing into small water craft. The third is to be accompanied by a person skilled in lifesaving who is capable of making a rescue in case of accident. The novice swimmer also has three ways to ensure his safety. First, by staying in water of standing depth until he can use his newly acquired strokes with some degree of ease. Second, by making his first ventures into deep water only under the supervision of a person skilled in rescue techniques. Third, by being able to swim twice as far in shallow water as he proposes to swim outward from shore; also by being able to float or rest in a floating position before taking his place among swimmers. Reasonable safety in the water for nonswimmer, novice and skilled swimmer alike is to be found only within supervised bathing places. Risk is always involved when bathing or swimming in unknown waters, or when unaccompanied or unsupervised by someone skilled in lifesaving. In the last analysis, however, the safety of a person in, on or about the water under any conditions lies in his ability to take care of himself. The nonswimmer should learn how to swim at the earliest opportunity. He should try to become a skilled swimmer. Then, as a skilled swimmer, he should perfect his skill to the point where he can take care of himself in any but the most perilous situation.

One of the most tragic of water accidents is the double drowning in which a person sacrifices his life, often needlessly, trying to rescue a person in danger of drowning. Contact with a drowning person poses no threat to the trained lifesaver skilled in ways of avoiding or releasing the grip of the victim. For the person unskilled in lifesaving to come within the grasp of a drowning person almost always results in death for both. There are ways, however, in which anyone can give effective aid to the victim whether he is a skilled lifesaver or not, even if he cannot swim at all. Furthermore, there is one form of swimming rescue that may be employed effectively by any reasonably skilled swimmer, with small risk.

So many persons get into difficulty close to safety that the rescuer may aid them without entering the water at all. For those very close to the rescuer, a hand reach is enough. The rescuer must have a firm position or handhold on something to avoid being pulled in himself, and he must grasp the victim, rather than permit the victim to grasp him, for the same reason. To make contact with the victim just beyond hand reach, anything to serve as an extension may be used. An oar, a paddle, a boat hook or even a fishing rod may be held by one end while the other end is thrust into the victim's grasp and he is drawn to safety. A drowning victim beyond reach of extensions may be aided by flinging within his grasp anything that has enough buoyancy to enable him to keep his head above water until he can be brought to safety. Ring buoys, inflated tubes, floating seat cushions or life vests may

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FIG. 1.—REAR APPROACH IN LIFESAVING

be so employed. Ring buoys of the throwing type may be hurled with considerable accuracy to a distance of 50 or 60 ft.

A swimming rescue may be made as a last resort by a person who is a strong swimmer even though he may have had no lifesaving training, provided he is willing to take the risk involved. The rescuer should approach the drowning person from the rear even though it involves circling the victim to come at him (fig. 1). Watching his chance, the rescuer should swim to within arm's reach of the victim and assume an upright position in the water with the legs in stroking position, a little forward of perpendicular. The rescuer should grasp him firmly by the hair, or by the collar if the victim is clothed. Immediately, the rescuer should turn on the side and start swimming strongly with the legs and the free arm. The holding arm should be kept rigid. No attempt should be made to lift the victim's head above water, because the act of swimming away will not only bring the victim's face above the surface so he may breathe, but it will plane the victim's body to the horizontal position and thus make towing easier. If the

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FIG. 2.—HAIR CARRY

victim sinks beneath the surface as the rescuer maneuvers into position, the rescuer should unhesitatingly follow him down, reverse position, seize the hair or collar and pull him to the surface. He may then be towed to safety.

Small craft accidents frequently occur far from shore. Under such circumstances, the only feasible way to aid the victims is to use a rowboat. If the boat is small the safest way to make the rescue is to wind the boat end for end when the victim is reached, and back down upon him in the water. The victim may then grasp the stern and climb or be pulled into the boat with little danger of upsetting or filling the craft. If a small motorboat is employed to make a rescue, the same technique is used but the clutch must be released or the engine stopped before contact is made to avoid injuring the victim with the spinning propeller.

The major methods in modern use for resuscitating the apparently drowned are described in ARTIFICIAL RESPIRATION.

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(C. L. BT.)

DROYLSDEN, an urban district (1894) in the Ashton-under-Lyne parliamentary division of Lancashire, Eng., 3½ mi. E. of Manchester and 2½ mi. W. of Ashton-under-Lyne. Pop. (1961) 25,461. Part of the manor of Manchester, Droylsden was an agricultural area until 1784 when a Moravian settlement was built at the southern end of the township. In 1785 the congregation was "settled," the church opened and the name Fairfield given to the settlement. Fairfield still retains its late Georgian houses and cobbled streets. Coal mining began in about 1790 in the area and a dye works was opened early in the next century. The town is now largely industrial with textile mills and factories, engineering (the making of textile machinery), the manufacture of chemicals and the preserving of fruit.

DROYSEN, JOHANN GUSTAV (1808–1884), German historian and politician, developed, under the stress of political circumstance, a conception of Prussia's historical vocation which had considerable influence. He was born on July 6, 1808, at Treptow, Pomerania, son of an army chaplain. The War of Liberation against Napoleonic rule made a lasting impression on him, laying the foundation of his ardent attachment to Prussia. After studying at Berlin he became a *Gymnasium* teacher and in 1835 professor of classical philology in Berlin. To these years belong Droysen's works on Alexander the Great and on Hellenism (conceived as a distinctive east-west culture). In 1840, however, he accepted an invitation to Kiel as professor of history and there he became interested in the Schleswig-Holstein question, then acute. In 1850, with Carl Samwer, he published *Die Herzogthümer Schleswig-Holstein und das Königreich Dänemark seit dem Jahre 1806* (Eng. trans., 1850), which was formative of German opinion, and he supported the rights of the duchies so prominently that in 1851, after Holstein passed to Denmark, he thought it prudent to accept an invitation to Jena. It was nevertheless during this agitated period that he worked on his admirable life of Yorck von Wartenburg (1851–52).

Meanwhile the movement for German unification drew him. In 1848 he became a member of the Frankfurt parliament and secretary to the committee for the constitution. Droysen believed in Prussia's vocation to lead Germany and after the king refused the imperial crown in 1849 he retired in disappointment. In spite of Droysen's intense Prussian patriotism, his liberal views brought him disfavour in official circles and it was not until the regency of Crown Prince Frederick that he was called back to Berlin (1859). Droysen took no further active part in politics but devoted himself to his great work, the *Geschichte der preussischen Politik,* 14 vol. (1855–86). The history goes up to 1756 and was unfinished at his death in Berlin on June 19, 1884. Droysen's belief in Prussia was no unrestrained nationalism, for human individuality and responsibility were for him basic articles of faith.

DRUG: *see* ANESTHESIA AND ANESTHETICS; ANTIBIOTICS; BARBITURATES; DRUG ADDICTION; NARCOTICS; PHARMACOLOGY; PHARMACOPOEIA; POISON; SULFONAMIDES; TRANQUILIZING DRUGS; *see* also under names of specific drugs such as CHLORTETRACYCLINE; HEROIN; OPIUM; PENICILLIN; etc.

DRUG ADDICTION, from a public health standpoint, refers to the habitual use of chemical agents despite harmful consequences that depend on the pharmacological and toxicological properties of the drug, the personality of the user, the needs and demands of the society in which he lives, and the degree to which he neglects his own and his dependents' health and welfare through indifference or economic drain. This article discusses first the medical aspects and then the sociolegal aspects of drug addiction. For a discussion of the laws pertaining to drug addiction, *see* NARCOTICS, LAWS RELATING TO.

MEDICAL ASPECTS

In a medically restricted sense, drug addiction is synonymous with physical dependence, *i.e.,* a state produced by repeated administration of certain drugs with the result that abrupt withdrawal of them is followed by physiological and psychological disturbances (abstinence syndromes) that are usually transient but may terminate fatally. Associated with the development of physical dependence is the acquisition of tolerance—*i.e.,* a progressive decline in the degree of effect produced by a given dose of the drug; as the effect declines, the user is impelled to increase the dosage progressively, with the attendant hazards of toxic side effects and further intensification of his need for the drug to prevent abstinence distress. This cycle greatly enhances the habituation process.

Drugs That Produce Physical Dependence.—These drugs include opioids, barbiturates, certain nonbarbiturate sedatives and alcoholic liquors.

Opioids.—Opioids are those drugs that, regardless of origin, display morphinelike properties. Opium (*q.v.*) itself (containing 10% morphine and prepared from the sap of the capsule of a poppy, *Papaver somniferum*) is usually smoked or ingested; morphine (*q.v.*) and certain of its derivatives such as codeine (methylmorphine), diacetylmorphine (heroin), dihydromorphinone (Dilaudid), dihydrohydroxycodeinone (Eucodal), as well as a number of synthetic analgesics such as meperidine (Pethidine, Demerol, Dolantin), ketobemidone, methadone (Dolophine, Amidon) and dextromoramide (Palfium), are usually injected but are also taken orally while heroin is often sniffed or smoked. Opium is most widely used in the orient, while heroin is the commonest opioid purveyed illicitly throughout the world. Though the effects of the various opioids differ, depending on the particular opioid used and the mode of utilization, the general features of intoxication and addiction for this class of drugs can be illustrated by the effects of morphine under experimental conditions. Those effects are as follows:

In nontolerant persons, injection of a small amount of morphine commonly produces easily reversible drowsiness and relative indifference to ordinarily painful or otherwise distressing stimuli without significant mental confusion, though performance may be slowed. Contrary to popular notions, lurid fantasies are rare and sexual desire is not increased though potency may be enhanced in the male by delay of orgasm; if injected intravenously, morphine may produce transient orgastic abdominal sensations. Often, this "pleasant" pattern of effects, lasting four to six hours, is offset by itching and flushing of the skin (due to release of histamine), giddiness and vomiting, but habitués come to regard these "unpleasant" effects as harbingers of euphoria after a few repetitions. With more frequent repetitions, however, most of the euphoric as well as dysphoric effects decline in duration and intensity, as do certain other effects such as respiratory depression, slowing of the pulse and lowering of body temperature, while pupillary constriction decreases less rapidly and spasm of smooth muscle not at all, producing severe constipation. In this tolerant state, secretion of adrenocorticotrophic hormone (ACTH) by the pituitary gland is reduced, sexual interest is lost, males become impotent and females cease to menstruate. In attempts to regain euphoria, addicts have been known to increase their daily dose to extremely large amounts with only partial and transitory success. Because of development of physical dependence along with the development of tolerance, morphine abstinence phenomena now appear if the accustomed dose is withheld. Beginning 12–16 hours after the last dose, restlessness, anxiety, frequent yawning, running of the eyes and nose, pupillary dilatation, sweating and gooseflesh are noted first. In addition, muscular aches and twitches, abdominal cramps, vomiting and diarrhea, rapid pulse, elevated blood pressure, insomnia, agitation, weight loss, spontaneous ejaculations in the male and profuse menstrual bleeding in the female supervene later, developing maximally during the next two or three days and then subsiding gradually, though physiological normality may not be achieved for six months or longer. Such abstinence phenomena are specifically alleviated by injection of a small amount of morphine (or an equivalent dose of another opioid); however, the phenomena reappear several hours later. The untreated morphine abstinence syndrome is rarely fatal, except in patients with cardiac disease, active tuberculosis or other debilitating illness.

Persons with character disorders, at least in the United States, seem to be especially prone to drug addictions of all sorts, but the factors disposing them to a preference for opioids are not well understood. Infants born of mothers physically dependent on opioids may exhibit abstinence phenomena within 12 hours after birth. Tolerance to and physical dependence on opioids can be induced experimentally in the chimpanzee, monkey, rat, normal dogs, dogs in which the cerebral neocortex has been removed, in the paralyzed limbs of dogs whose spinal cord has been cut by transection, and reportedly even in unicellular organisms and tissue cultures. The latter suggests that the physiological basis of these phenomena is cellular counteradaptation. It has also been hypothesized that relapse may be due in part to recurrence of abstinence phenomena as a conditioned response, acquired during previous episodes of physical dependence.

The diagnosis of physical dependence on opioids is made by observation of the abstinence syndrome when the drug is withheld or after subcutaneous injection of a specific morphine antagonist such as nalorphine. Treatment requires hospitalization and proceeds in two phases: (1) withdrawal of the opioid by rapid reduction (7–10 days) of the dose, or substitution of methadone for the opioid followed by abrupt withdrawal or very rapid reduction (3–5 days) of this synthetic analgesic, which produces a less severe though more protracted abstinence syndrome; and (2) several months of supervised abstention from all drugs, with psychotherapy and postinstitutional guidance.

Barbiturates.—The so-called short-acting barbiturates, pentobarbital (Nembutal), secobarbital (Seconal), amobarbital (Amytal), etc., are widely abused in Europe and North America. They are usually taken orally (or rarely, by injection) to promote sedation and sleep, but as partial tolerance to these effects develops and the daily dose is increased, mental dulling, inco-ordination, slurred speech and irritability predominate. Abrupt withdrawal of these drugs from medium-size daily dose levels is followed within 24 hours by agitation, insomnia, sweating and tremulousness, and from large doses by convulsions and/or delirium later. Though recovery usually occurs after 2–3 weeks, the delirium may occasionally end fatally. In treatment, withdrawal of barbiturates is accomplished safely only by very gradual reduction of the dose. Postwithdrawal treatment is basically the same as for opioid addiction. (*See* also BARBITURATES.)

Nonbarbiturate Sedatives.—These drugs include paraldehyde, chloral hydrate, meprobamate (Miltown, Equanil) and glutethimide (Doriden). These sedatives, which usually are taken orally, can, except for differences in dose-equivalences, produce syndromes of intoxication and abstinence that are very similar to those described for barbiturates, and the same general treatment principles apply for them.

Alcohol.—Evidence indicates that "rum fits" and delirium tremens may be precipitated in severe chronic alcoholics by abrupt withdrawal of alcoholic liquors. In many other respects, the clinical features of chronic alcoholic intoxication and the alcohol abstinence syndrome resemble closely those produced by barbiturates. (*See* also ALCOHOLISM.)

Other Drugs.—Drugs that do not produce physical dependence but cause serious consequences when abused include cocaine, cannabis products and certain of the "stimulant" amines.

Cocaine.—Cocaine (*q.v.*), the active principle in the leaves of *Erythroxylon coca,* anesthetizes and constricts the blood vessels of the skin and membranes with which it comes in direct contact, thereby causing perforations of the nasal septum if sniffed or abolition of hunger pangs if ingested; it is ingested by large numbers of coca-leaf chewers, or "coqueros," among the Indians in the high Andes of Peru, Bolivia and adjacent territories. The effects on the central nervous system depend on the extent that cocaine is absorbed through the skin and membranes or on the dose if it is injected intravenously (the commoner practice of habitués other than the Andean Indians). The actions of the drug are ascribable to its capacity to mimic adrenalin and to stimulate the central nervous system; as a result it causes pupillary dilatation, rapid pulse, enhanced tendon reflexes, reduction of fatigue, elation, nervousness, insomnia, visual, auditory and tactile hallucinations (*e.g.*, insects crawling under the skin) and paranoid delusions that may render the user dangerous. Death may result from convulsions or from paralysis of the heart muscle.

Cannabis Products.—These (marijuana, hashish, bhang, ganja [or ghanga], charas, kef) are prepared from certain varieties of the hemp plant, *Cannabis sativa,* and are widely smoked, chewed or ingested in north Africa, Asia and to a lesser extent in the Americas. Because of the tetrahydrocannabinol content of their resins, these products cause congestion of the ocular conjunctiva, pupillary dilatation, rapid pulse, dreamy states with impairment

of time sense, loquacity, silly behaviour with outbursts of inappropriate laughter and, in some persons, psychotic reactions. The latter are said to be especially common among inveterate users of hashish. (*See* also HEMP: *Hemp as a Drug Plant;* MARIJUANA.)

Some "Stimulant" Amines.—Drugs in this group, including amphetamine (Benzedrine), dextro-amphetamine (Dexedrine), methamphetamine (Desoxyn) and phenmetrazine (Preludin), are abused sporadically, mainly in North America, Europe and Japan. Taken by inhalation, orally or by injection, they produce elevation of blood pressure, anorexia, insomnia, increased optimism and decreased subjective fatigue. In large doses taken intravenously or over long periods orally, they may produce paranoid psychoses. Somewhat similar effects have been observed in habitual users of khat (leaves of *Catha edulis,* or infusions thereof) in northeast Africa and the southwestern portion of the Arabian peninsula; the active principle appears to be *d*-norisoephedrine. (*See* also CATHA.)

Treatment of persons habituated to these agents consists of abrupt withdrawal of the drug (no abstinence phenomena ensue) with such symptomatological medical and psychiatric care as may be required.

See also AMPHETAMINE. (AB. W.)

SOCIOLEGAL ASPECTS

The production, manufacture and distribution of opium and its derivatives and of synthetic opioids are regulated by international agreements that began with The Hague International Opium convention of 1912. One of the mechanisms for such regulation, the import certificate and export authorization system, which is supervised by the Permanent Central Opium board established by the International Opium convention in 1925, now also applies to coca and cannabis products. Other agencies implementing various international agreements include the Drug Supervisory Body, the World Health organization (which supplies scientific information) and the United Nations Commission on Narcotic Drugs. The illicit international traffic in all dangerous drugs is fought by the International Criminal Police organization (Interpol) in Paris. Though such efforts have considerably curtailed drug abuse, it is estimated that at least six times the 900 tons of opium required for the world's legitimate annual medical needs is used in illicit trade, which thrives on enormous profits, especially from the sale of heroin.

In countries that observe the international opium agreements, manufacture and dispensation of opioids are controlled by law. Unauthorized sale and, in most countries, possession of these drugs without medical or other proper prescription is a criminal offense. Partly for this reason, opioid addiction has acquired quasi-criminal aspects in varying degree. In the United Kingdom, opioid addiction has never been a significant problem, possibly because of a homogeneous population and the lack of organized crime. The number of known addicts there is about 500. A British addict may or may not be maintained on opioids by his physician, depending on the physician's judgment.

In the United States, where opioid addiction has been a significant problem for more than a century, possession of these drugs is punishable by imprisonment, with the term increasing with each successive offense, regardless of whether or not the offender is addicted. Extensive facilities for medical and psychiatric treatment of drug users are provided at federal hospitals in Lexington, Ky., and Fort Worth, Tex., and at state hospitals in New York and California.

In the far east, where the number of opioid addicts has long run in the hundreds of thousands (*e.g.,* in Hong Kong one in eight adult males uses opium or heroin), addiction usually entails imprisonment. In Formosa, the death penalty may be imposed after three relapses. The behaviour patterns of addicts are determined in part by these and other factors, which vary from country to country. Introduction to abuse of opioid or cannabis drugs is usually brought about by users among the individual's peers. Many times more men than women abuse such drugs. In different countries, different kinds of people figure largely in the addiction problem. Such differences suggest that the use of addicting drugs may serve different functions in each country. Even within a single country, varying personality types may become addicts.

A few famous persons (*e.g.,* Edgar Allan Poe, Thomas De Quincey) have been opioid or cocaine users, but their abilities were not necessarily enhanced by drug use. Relatively few persons subsequently become addicted from taking drugs for the relief of pain under medical supervision. In the U.S., large cities in which there are large minority group populations tend to have concentrations of drug users, many of whom are young adults. Throughout the world, addiction has tended to increase following war, during economic depression and otherwise about every 20 years (*i.e.,* about once every generation).

In the U.S. and Europe, many users find themselves outside established channels of family, work and community participation and they develop their own argot and style of life. For some, this way of life and the procedures they develop to obtain money for the illegal purchase of drugs, including theft, prostitution and other crimes, may be as impelling as the effect of the drug itself. The opium den in the far east and the apartment ("pad") in New York share a ritual that sets the addict apart. This is not true of physician and nurse addicts, who are seldom gregarious about their drug abuse.

The use of alcohol, barbiturates and allied drugs and "stimulant" amines is controlled by each country individually. These drugs do not have the "dope fiend" connotations of and do not require the apparatus for self-administration sometimes involved with opioids. Little was known in the mid-1960s of the social determinants of the behaviour of barbiturate addicts and habitual users of the "stimulant" amines and related drugs, or of the extent of such abuse and its long-term consequences. (C. WI.)

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DRUIDISM, according to the traditional belief, was the religion of the Celts of ancient Gaul and the British Isles. The extravagant modern notion of the druids, as members of an esoteric religious order performing secret rites at midnight in oak groves or at such places as Stonehenge, is attributable largely to the antiquarian researches of John Aubrey and, especially, William Stukeley, in the 18th century. In fact, as the following article shows, practically nothing is known about the druids. (X.)

The earliest tolerably reliable evidence concerning the druids comes from Julius Caesar and his sources, which would place them as an established institution in southern and central Gaul at least as early as 100 B.C. How much earlier they existed in Gaul itself and how widely spread their institution was among the other Celtic tribes is a matter of pure conjecture. It is significant that Caesar, who gives the druids a position of great influence in one short passage of his *Gallic War,* never again refers to them, although such reference would have been most apposite if the druids had formed a centre of tribal cohesion and national resistance to the Roman invader. Just as little is heard of the druids in the following two

generations. The tradition merely states that they were banned by Tiberius and Claudius, chiefly because of their superstitions and human sacrifices, while Pliny in his *Natural History* merely enlarges on their magical cures. The tradition concerning them stands in need of a critical appraisal.

The main authority for Celtic ethnography, apart from the historians, is the Stoic philosopher Poseidonius, who also, therefore, provides the chief evidence for statements about the influential and cultured classes among the Celts, to whom the druids belonged. His work, which was contained in book 23 of his history, is not extant, but his material on the Celts is reproduced, in summary and with some changes and additions, in three later Greek authors, the historian Diodorus Siculus, the geographer Strabo and the writer of miscellanies Athenaeus. The similar material in Caesar's *Gallic War* is taken from Poseidonius without acknowledgment and with significant omissions and additions.

While Poseidonius may rightly be admired as the most learned man of his day and while his ethnographic digressions may properly be regarded as the high-water mark of ancient ethnography, yet it cannot be forgotten that his history was composed from a Stoic viewpoint, which becomes peculiarly obvious in his discussions of the cultured classes in barbarian nations. This was first hinted at by Karl Reinhardt, who in his book on Poseidonius (1921) said that the druids are stylized by him as representative of the *Logos*, the higher power of the soul that holds the instincts in check. This view was next referred to by G. Pasquali in 1931 and elaborated somewhat by a student of Pasquali in 1935. Reinhardt again mentions the topic briefly in his last full-length treatment of Poseidonius in 1953 (see *Bibliography*).

The reasoning runs as follows: For Poseidonius the universe is a pantheistic god whose leading principle is the *Logos*, the reason which also inhabits the mind of man. The great men of the past who have led humanity on its long road to civilization were the kings and philosophers who, particularly endowed with reason and fresh from their divine origin, were able to understand the divinity and proclaim his wishes to their people. Such a man was Moses, who taught the Jews that there was only one God, variously called heaven, the universe or nature; this god bestowed his gifts on the virtuous and gave good counsel to those who practised divination. Such also were the druids of Gaul, who were philosophers and theologians, possessing the highest political authority, and were in charge of divination and sacrifice. They studied theology, ethics and natural science, including the physics of the earth and stars, and were the teachers of the upper-class Gauls. Among their main tenets were that the soul of man is immortal and that the universe is indestructible, although from time to time it would be temporarily consumed by the action of fire or water.

When this account of the druids is examined soberly, it becomes impossible to believe that it is historical. It is known that the Celts at this period, about 80 B.C., were still practising divination by human sacrifice and preserving the skulls of slain enemies by nailing them as trophies to the porches of their houses. The alleged studies of the druids are simply a program of Stoic philosophy including some of their specific doctrines such as that of the periodic destruction of the universe by fire and water. The general position of the druids, with their political and religious authority and their control of divination, confirms this theory of cultural development with its strong Stoic traits. This picture of the druids is no more historical than that of the god of Moses.

It is not, however, as a consequence necessary to maintain that the druids were not to some extent both political and religious leaders in Gaul. Poseidonius was, after all, one of the most acute observers of antiquity, and whatever factual knowledge he had obtained about the druids prompted him to embroider it with Stoic fiction, for the reasons given above. It is probable that their influence has been exaggerated by Poseidonius for his philosophical reasons, and by Julius Caesar for his own different political reasons. It is difficult to believe that the druids possessed any body of coherent religious doctrine, much less the philosophy so liberally bestowed upon them by Poseidonius. Present knowledge of Gallic religion as detailed by J. Vendryes is rather one of multiplicity and diversity than of anything resembling a system.

What may reasonably be accepted of the tradition about the druids is problematical and depends primarily on the view taken of the relationship of the four secondary sources to Poseidonius. The two chapters in Julius Caesar (*De Bello Gallico*, vi, 13–14) appear to be an abbreviated rendering of Poseidonius. Ch. 13 emphasizes and exaggerates the political importance of the druids, and ch. 14 does the same for their position as teachers, philosophers and theologians. Caesar's interest may be indicated by his omission of the other educated classes in order to concentrate on the druids, and perhaps by addition of detail. Perhaps Caesar changed what had been stated with qualification by Poseidonius merely of a tribe or tribes in the south into the idea of druidism regarded as a national system throughout the whole of Gaul.

The third chapter (*De Bello Gallico*, vi, 16), in which the druids are connected with the Gallic practice of human sacrifice, is again clearly taken from Poseidonius, since it illustrates his theory of degeneracy from the primal Golden Age, a degeneracy that leads to superstition and tyranny.

The old problem of whether Poseidonius had described two or three educated classes among the Celts (*i.e.*, whether the seers should be included as a separate class) should be decided in favour of three classes in view of the importance divination possessed in Poseidonius' view of the early history of mankind.

It seems that a critical consideration of the tradition regarding the druids must lead to the conclusion that this priesthood was not in any way a distinguished exception among the priesthoods of the contemporary barbarian nations, but that the Celts were in this respect very like the Germans. According to Strabo (vii, 290), Poseidonius says that the habits and way of life of both peoples are almost the same, but the Germans are somewhat less civilized. Caesar's distinction therefore in regard to their priesthoods cannot be regarded as historically correct. (J. J. T.)

The word *druí* (n. pl. *druid*) is found in Old Irish and may be analyzed as **druvids*, where the second element means "he who knows" and the first may either be an intensive prefix or the word meaning "oak." No genuine tradition of druids exists in the Brythonic languages; the ceremonies of the modern Welsh Gorsedd are a product of 18th-century romanticism (*see* EISTEDDFOD). In early Irish literature, which comes through Christian sources, the druids (*magi*) are represented as malignant magicians who bitterly opposed the introduction of the new faith. The situation cannot have been so simple, since the *filid* ("seers"), who also practised divination and are often confused with druids in the sagas, assumed an honoured place in early Irish Christian society as literary men and historians. It is probable that the druids represented the learned class in its religious and magical function and were thus replaced by the ecclesiastics in positions of power and authority; it is significant that many of the contests between saints and druids are represented as taking place over possession of land. In later Irish the words *draoi*, *draoidheacht* come to mean simply "magician, magic." Owing to the nature of the sources it is not possible to construct any coherent account of the beliefs of the druids in pre-Christian Ireland. *See* also IRELAND: *History;* IRISH LITERATURE. (D. GE.)

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DRUM, in music, a percussion instrument common to most nations and ages. Unlike most musical instruments that have their origins in the practice of ritual magic, the drum has never completely lost these associations. In its form the drum is basically either a cylinder or a bowl of wood, metal or earthenware; the "shell" is covered at one or both ends with a membrane, called the "head," that is set in vibration by direct percussion of hand or stick (for primitive drums *see* PERCUSSION INSTRUMENTS). European drums may be divided into three groups according to the

(CENTRE LEFT) MESSRS. HENRY POTTER & CO., LONDON; (CENTRE RIGHT) PENGUIN BOOKS LTD.; (RIGHT) BOOSEY & HAWKES LTD.

(LEFT) TAMBOURINE; (CENTRE LEFT) MILITARY SIDE DRUM, 17TH CENTURY; (CENTRE RIGHT) MODERN SIDE DRUM, SHOWING SNARES; (RIGHT) MODERN ORCHESTRAL BASS DRUM

nature of their construction: (1) a single head on a shell open at one end, as the tambourine; (2) a single head on a closed shell, as the kettledrum; (3) two heads, one at each end of the shell, as the side drum and tabor. Of the several drums used in the modern orchestra only the kettledrums are designed to produce a note of a definite musical pitch. In oriental and African countries drums are often played by striking them with the hand; in these countries this technique is developed to an astonishing degree of rhythmic intricacy and virtuosity. In Europe the drum—generally played with one or two sticks—is, traditionally, a less sophisticated instrument that fulfills the relatively simple purpose of marking the rhythm for dancing or marching.

Very little is known about European drums and drumming in the middle ages, the only evidence being that of representations in paintings and sculpture and a certain amount of not very helpful information from literary sources. No medieval drums have survived, and it is not until the 16th century that written percussion parts appear, and even then only in instruction books. In fact, before the middle of the 17th century the composer did not feel obliged to notate any percussion parts, knowing that the player's training would have made him thoroughly conversant with what was then a traditional technique. By the 13th century three types of drum appear to be established: the nakers, the tabor (in several forms) and the tambourine.

The Nakers, a 13th-century importation derived from the Arab *naqqara,* were a pair of hemispherical drums like very small kettledrums and were played by one drummer. The shells were made of metal or wood, the head was tensioned by ropes or thongs and sometimes the instrument was equipped with a snare, *i.e.,* a string of gut or silk stretched across the head to cause a rattling sound. They were suspended from the waist and played with two sticks. The pairs of nakers were tuned to a high and a low note of rather indefinite pitch and were used to accompany bands of "loud" instruments—trumpets, shawms, bagpipes, etc.—in ceremonial music.

The Tabor was a small cylindrical drum of variable depth with a wooden shell and a drumhead at each end. It was a rope-tensioned and usually had a snare on both heads. The tabor was always used in conjunction with the "tabor pipe," a long three-holed whistle-flute; both instruments were played by one musician. The pipe was played with the left hand while the tabor, generally suspended from the left wrist, was struck with a stick held in the right hand. The pipe-and-tabor combination dates from at least the 13th century and, despite early pastoral associations, provided court dance music until as late as the 16th century. It is still used in the popular music of Provence.

The Tambourine, a shallow wooden hoop with a single head and metal "jingles" set in the sides, is struck with the hand, rubbed with the thumb or shaken. The tambourine (a similar instrument was the ancient Greek *tympanon*) was a medieval adaptation of an instrument used by the Arabs. Like its Arabic prototype, the tambourine in the middle ages often had a snare. By the end of the 15th century its use seems to have declined except where it survived as a folk instrument. Early in the 19th century the tambourine was introduced to the orchestra via the opera (the usual route to respectability for percussion instruments) for special Spanish or gypsy effects.

The Kettledrum is a large drum with a bowl-shaped shell, usually of copper; the head is tensioned (and tuned) by handles set around the circumference or by a mechanical device. It is the most important of the drums used in the modern orchestra. The standard number in the modern orchestra is three. Although similar in many respects to the earlier nakers, the kettledrums have a completely separate history. In the mid-15th century the pairs of large kettledrums of the Ottoman Turks were brought to Europe by way of Hungary and Germany. Like the modern instrument, the shells—one larger than the other—were generally of copper, and the calfskin heads were tensioned and tuned by screws around the circumference. They were military and ceremonial instruments and formed an important part of the retinue of emperors, kings and noblemen. From the time of their introduction to Europe the kettledrums were associated with trumpets; the players of both instruments belonged to the same exclusive guild. By the beginning of the 16th century trumpet and kettledrum players were established in most important noble households in Europe and the word "dromme" (having the same derivation as "trumpet") first appears in the English language at about this time. Kettledrums were often played on horseback, one drum on either side of the horse, as the Turkish armies used kettledrums on camelback. Although no written drum parts survive from the 16th century, such works as the chanson *La Bataille de Marignon* by Clement Janequin, in which the voices imitate the calls of the trumpets and drums, give a reasonably clear picture of a technique based on a tonic and dominant tuning of the kettledrums that was not to be substantially altered for more than two centuries. An early example of trumpet and drum music is the *toccata,* or fanfare (the contemporary English word was "tucket"), at the beginning of Claudio Monteverdi's opera *Orfeo* (1607). During the 17th and 18th centuries kettledrumming developed into an elaborate ceremonial and ostentatious art that used complicated drum patterns based on the multiple tonguing technique of the trumpeters. The orchestral use of the instrument was confined to passages that expressed rejoicing, as in J. S. Bach's cantata *Tönet, ihr Pauken! erschallet Trompeten,* or supported the brass in loud passages. The expressive use of the kettledrum in the 19th-century orchestra (played *piano, crescendo* and with the drums not necessarily tuned to the tonic and dominant) was largely due to the innovations of Beethoven. Later Hector Berlioz, who in his *Requiem* (1837) used the formidable number of 16 kettledrums, discussed in his book on orchestration (1843) the use, for the kettledrum, of drumsticks with wooden ends and with ends that were covered with leather or sponge; he said that it was worse than negligence for the composer not to indicate in his score which should be used. For a discussion of modern developments *see* TIMPANI.

The Side Drum, a larger form of the tabor, has a cylindrical

shell, two heads that are tensioned with rope, and snares on the lower head; it is played with two wooden sticks. It was introduced to the rest of Europe by Swiss mercenaries in the 15th century who brought with them their fife and drum bands. The side drum was the drum of the infantry—as the kettledrums were the drums of the cavalry—and as such were used not only to mark the rhythm for marching but also (to quote Toinot Arbeau, a 16th-century writer) ". . . as a signal and warning to the soldiers to break camp, to advance, to retreat and give them heart, daring and courage to attack the enemy and to defend themselves with manful vigour." The side drum was much in favour in the 17th and 18th centuries with the increase in popularity of the military bands for display and ceremonial occasions. The side drum in the 18th century was a much smaller, more manageable instrument than that of the 16th century and of a higher pitch. As an orchestral instrument it was used to supply special military effects. The modern orchestral side drum has a shallower shell and is screw-tensioned.

The Tenor Drum is similar in size and shape to the 16th-century side drum but has no snares. The military tenor drum is rope-tensioned while the orchestral tenor drum is screw-tensioned. The tenor drum is an important instrument in military fife, bugle and drum bands but is infrequently used in the orchestra.

The Bass Drum is the largest orchestral and military drum. It has a shallow shell and the military instrument has two heads while the orchestral instrument often has only one. The diameter of the head is much greater than the depth of the shell. It has no snares and is usually played with a felt-headed stick. The military bass drum is rope-tensioned while the orchestral one is screw-tensioned. The bass drum has a long history in the east but was uncommon in Europe before the 18th century, when it was used in *Musica alla Turca*. The 18th-century instrument (known in England as the "long drum") had, like its Turkish prototype, a deeper shell and heads of a smaller diameter than the modern bass drum. It was played in the Turkish manner; *i.e.*, it was struck with a padded stick in the right hand and a switch of birch twigs in the left; the drummer often was a Negro in exotic dress. The leopardskin of the British army drummers today is a curious survival of these Negro drummers. The bass drum was first introduced to the orchestra via the opera toward the end of the 18th century in order to supply military or Turkish effects.

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DRUM, in zoology, the name given to certain perchlike, carnivorous fishes belonging to the family Sciaenidae, so called because they make a peculiar grunting noise by rapid contraction and expansion of muscles round the air bladder. The sea drum (*Pogonias cromis*), found along the Atlantic coasts of North and South America, attains a length of four feet. The body, which is oblong, with an elevated back, has large scales except on the breast. The throat is paved with stony teeth adapted for crushing shellfish. In colour the sea drum is brownish-gray or brownish-red, the young being marked with broad, vertical bands of a darker shade. It is not valued for food and, as it destroys great quantities of oysters, is much disliked by oystermen.

The very similar fresh-water drum (*Aplodinotus grunniens*), called also sheephead and thunder pumper, is a grayish, silvery fish sometimes attaining three to four feet in length and 40–60 lb. in weight. It occurs from Georgia and Texas to the Great Lakes but is especially abundant in the streams and lakes of the Mississippi valley. Its scales are thin and deep, with the larger ones on the breast. The fresh-water drum is a popular food fish (best when it weighs less than three pounds) in the south but is little used in the north. It inhabits muddy waters, feeding on mussels, snails and crayfish, which it crushes in the same manner as its sea counterpart. Of all fishes the fresh-water drum appears to be the most heavily infected with larval mussels (glochidia) which later become planted on the river bed and, after a period of growth, become food for other drum. *See* also FISH.

BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

FRESH-WATER DRUM (APLODINOTUS GRUNNIENS)

DRUMMOND, HENRY (1851–1897), Scottish evangelical writer and lecturer, was born in Stirling on Aug. 17, 1851. He was educated at Edinburgh university, and in 1877 became lecturer on science in the Free Church college, Glasgow. He was associated with Dwight L. Moody and I. D. Sankey in their revival mission in England and Ireland in 1874–75, and again with Moody in 1882. Drummond also was known as a geologist and explorer, one of his writings in this field being *Tropical Africa* (1888). His principal work was *Natural Law in the Spiritual World* (1883), the argument of which was that the scientific principle of continuity extended from the physical world to the spiritual. In 1893 he delivered the Lowell lectures at Boston, which were printed in 1894 under the title of *The Ascent of Man*. Drummond died on March 11, 1897.

See the *Life* by Sir G. A. Smith (1898).

DRUMMOND, JAMES (1835–1918), British Unitarian scholar, was born in Dublin on May 14, 1835, and was educated at Trinity college, Dublin, and Manchester New college, London. In 1860 he became pastor of Cross Street chapel, Manchester, but nine years later returned to his old college in London as lecturer in biblical and historical theology. From 1885 to 1906 he held the principalship, moving with the college to Oxford in 1889. Drummond died on June 13, 1918.

As a Unitarian, Drummond advocated doctrinal freedom. He regarded Christ as the highest revelation from God but rejected the Resurrection and the nature miracles. His acceptance of the apostle John as author of the Fourth Gospel is elaborated in his *Inquiry Into the Character and Authorship of the Fourth Gospel* (1903). Among his other chief works are *The Jewish Messiah* (1877), *Philo-Judaeus* (1888), *Via, Veritas, Vita* (Hibbert lectures, 1894) and *Studies in Christian Doctrine* (1908).

See the "Memorial Introduction" by his daughter, E. Drummond, and G. D. Hicks, prefixed to his *Pauline Meditations* (1919).

DRUMMOND, WILLIAM, called "OF HAWTHORNDEN" (1585–1649), Scottish poet, translator and man of letters, was the first notable poet in Scotland to write deliberately in English, with almost no admixture of Scots forms. Born on Dec. 13, 1585, at Hawthornden, near Edinburgh, the son of John Drummond, first laird of Hawthornden, he studied at Edinburgh university and took his M.A. degree in 1605. After a few years in France (1606–08), ostensibly in the study of law at Bourges and Paris, he returned to Scotland, and on the death of his father in 1610 settled down on his Hawthornden estate, leaving law for literature, and devoting himself to the life of a cultured and rather detached man of means. A certain natural retiringness in Drummond's character was perhaps confirmed and deepened by the emotional shock of his fiancée's death in 1615 shortly before they were to have been married; certainly his love and grief for Mary Cunningham are deeply interwoven in the poems he wrote at this time. But he had many friends, including Michael Drayton, Sir William Alexander and Ben Jonson; and he found happiness in his marriage to Elizabeth Logan in 1632. He died at Hawthornden on Dec. 4, 1649.

Jonson visited Drummond at Hawthornden at the end of 1618, and the record of their conversations throws light on both personalities. Jonson's mild objection that Drummond's poems, though good, "smelled too much of the Schooles, and were not after the fancie of the tyme" is both a shrewd thrust at the conservative and imitative character of his writing and a tribute to his unusually wide reading in European literature. Drummond enjoyed, adapted and translated poems from French, Italian and Spanish, in addition to making curious mosaic raids into such English poets as Sir Philip Sidney. The chief foreign influences on his verse come from the Renaissance love poetry of Ronsard, Petrarch, Tasso, Giambattista Marino and Garcilaso de la Vega. Some of his best-known poems are in fact translations, or near translations. This might suggest a mind of little originality or

strength, and it is true that Drummond's poetic effectiveness is limited by the narrow range of literary influence which stimulated him; yet he transforms his borrowings, and he has his own genuine quality, a strange blended glow of warmth and melancholy withdrawal which is of some poignancy.

Apart from his *Poems* (1614, 1616) and *Flowres of Sion* (1623), Drummond wrote *Forth Feasting* (1617), a poem celebrating James I's visit to Scotland in that year, and he was apparently, although surprisingly, the author of *Polemo-Middinia*, a hilarious macaronic piece intermingling Scots and Latin (published 1684). His prose writings include a group of Royalist political pamphlets; a *History of Scotland, from the year 1423 until the year 1542* (1655); and *A Cypresse Grove* (1623; earlier version, *A Midnight's Trance*, 1619), a meditation on death and mutability which combines a rich, cadenced prose with a too commonplace statement of the great inevitables.

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(E. G. M.)

DRUMMOND, WILLIAM HENRY (1854–1907), Canadian poet, whose works give a sympathetic but sentimentalized picture of the French-Canadian peasant, was born at Mohill in County Leitrim, Ire., on April 13, 1854. He was the son of an officer in the Royal Irish constabulary who emigrated with his family to Canada about 1864. His father died soon after, and Drummond left school at the age of 15 to help support his family. He worked as a telegraph operator at Bord-à-Plouffe on the Rivière des Prairies near Montreal and afterward attended McGill university, Montreal, and Bishop's college, Lennoxville, Que., where he took his degree in medicine in 1884. After four years in country practice, he moved to Montreal, where he became prominent in the social and athletic life of the city, being much in demand as an after-dinner speaker. He gave public readings with great success of his humorous dialect poems dealing with characters and incidents drawn from the life of the French-Canadian *habitant*. These were collected and published as *The Habitant*, which appeared in 1897. It was followed by *Phil-o-rum's Canoe and Madeleine Vercheres* (1898); *Johnnie Courteau* (1901); *The Voyageur* (1905); and *The Great Fight* (1908). These were collected in 1912, with an introduction by the French-Canadian poet Louis Fréchette and an appreciation by the Scottish novelist Neil Munro. Drummond's verses mingle humour and pathos and are written in a synthetic patois and from the point of view of a British imperialist. After 1905 Drummond made his home in northern Ontario to look after the operation of the Drummond mine, near Cobalt, which he owned in conjunction with his brothers. He died in Cobalt, Ont., on April 6, 1907.

See J. F. Macdonald, *William Henry Drummond* (1923), which contains a bibliography. (A. J. M. S.)

DRUMMONDVILLE. A city in the southeastern part of Quebec, Can., on the St. Francis river, about 60 mi. E. of Montreal; the seat of Drummond county. Its main characteristic is intense industrialization which began during the 1920s when a hydroelectric plant was built on the river. Products are varied, ranging from synthetic textiles to paper, pencils and rubber goods. The main railroad lines and direct roads to Montreal, the Maritime provinces and the United States plus a municipal airport provide distribution of the manufactured products all over Canada and the U.S.

Founded in 1815 by Maj. Gen. Frederick George Heriot and incorporated as a village in 1874, as a town in 1888 and as a city in 1936, Drummondville has a population of 27,909 (1961), mostly of French origin and Roman Catholic. The city has many French and English schools where courses leading to university degrees can be followed. (GA. M.)

DRUNKENNESS: *see* ALCOHOLISM; LIQUOR LAW.

DRUSUS, MARCUS LIVIUS, the name of two Roman statesmen, father and son. The elder Drusus (d. 109 B.C.) was a colleague of Gaius Gracchus (*q.v.*) as tribune in 122 B.C. The senatorial party, in an attempt to thwart Gracchus' program of reform, put up Drusus to try to outbid him and thus win over popular support. Gracchus had proposed the establishment of colonies, but some at least of the colonists were to be drawn from the middle classes; Drusus now proposed the foundation of 12 colonies in Italy and Sicily, each to comprise 3,000 men with no property qualification. He also proposed that all land that had been distributed since Tiberius Gracchus' bill should be rent-free. Further, he proposed immunity from corporal punishment (even on military service) for the Latins; this was a skilful measure since many Latins wanted protection from Roman magistrates rather than all the other privileges that Roman citizenship would confer. A commission was set up to carry out these *leges Livianae*, but Drusus was not a member (inclusion of the proposer of the law was probably illegal). The laws were certainly not implemented in full, and possibly not at all. This would suggest that Drusus' aim had been primarily to undermine Gracchus' position rather than to carry out genuine economic reform. He was consul in 112 and became governor of Macedonia, where he campaigned successfully against the Scordisci; on his return he celebrated a triumph in 110, and was censor in 109, but died in office.

His son, also named Marcus Livius Drusus, (d. 91 B.C.), tribune in 91 B.C., was a man of great integrity who recognized the need for reform. He sponsored a more generous senatorial policy, and tried to build up sufficient support to achieve his ultimate aim of enfranchising the Italian allies. He supported colonial and agrarian bills, and proposed a judiciary law which aimed at reconciling the senate and equites; its provisions are uncertain, but it probably envisaged that the law-courts, then controlled by the equites, should be empaneled jointly from senators and equites, and that all jurors should be liable to prosecution for corruption. This compromise pleased neither group, and opposition increased when Drusus was known to favour a franchise bill and was alleged to be plotting with the allies. The senate declared his legislation invalid on a technical point, disturbances increased and Drusus was murdered; the assassin was never discovered. If his methods were not prudent, and if his aristocratic manner suggested undue personal ambition, at least his aims were statesmanlike and he had the courage to seek to achieve them. (H. H. SD.)

DRUSUS, NERO CLAUDIUS (38–9 B.C.), younger brother to Tiberius (later emperor), was born in 38 B.C. shortly after his mother, Livia Drusilla, had been divorced from Tiberius Claudius Nero and married to Augustus. Like his brother he was allowed to seek office five years before the legal age, becoming praetor in 11 and consul in 9 B.C. With Tiberius (*q.v.*) he conducted a creditable campaign against the Alpine tribes, the Raeti and Vindelici, in 15, and in 13 he was made governor of the Three Gauls, where he carried out an important census and next year erected the altar of Augustus at Lugdunum (Lyons). In 12–9 B.C. he led expeditions into Germany, based first on Vetera (where the Lippe river joins the Rhine) and then on Moguntiacum (Mainz). The Frisii, Chauci, Cherusci and Chatti were all subdued and a canal, the Fossa Drusiana, was dug from the Rhine to the North sea. In 9 Drusus reached the Elbe river, but he was thrown from his horse and died 30 days later. Tiberius followed the body on foot to Rome, where Drusus was given a public funeral and buried in the imperial mausoleum. A cenotaph was erected in his honour at Moguntiacum, and he was posthumously given the cognomen of Germanicus.

It was believed in antiquity that Drusus' German operations, for which he had been awarded triumphal honours and minor triumph in 10 B.C., were the successful first steps toward creating a Roman province between Rhine and Elbe. There is no adequate reason to doubt this view, though archaeology has not revealed the nature of the Roman occupation. Suetonius (2nd century A.D.) says that Augustus (who was naturally suspected of being Drusus' real father) declared that he would make him his heir along with his own grandsons; but in Drusus' lifetime Augustus chose his

brother Tiberius as his son-in-law; and it is probably a later anti-Tiberian tradition which allows preference to the younger stepson. Still less is it possible to substantiate the story that Drusus wanted to restore the "republic" if he came to power.

Drusus married (*c.* 16 B.C.) the younger Antonia, daughter of Mark Antony and Octavia. Their surviving issue were Germanicus, Livilla and Claudius, later emperor.

See, for ancient sources, E. Groag and A. Stein, *Prosopographia Imperii Romani*, 2nd ed., part ii, pp. 194 ff. (1936). (G. E. F. C.)

DRUSUS CAESAR (*c.* 13 B.C.–A.D. 23), only son of Tiberius (later emperor) and Vipsania Agrippina. Through his father's adoption by Augustus he entered the Julian house in A.D. 4; but Tiberius had simultaneously to adopt Germanicus and Drusus took second place to his elder cousin. Yet despite faction by their adherents the two were on excellent terms, and Drusus married Germanicus' sister Livilla. He suppressed a dangerous mutiny in Pannonia in 14, and became consul next year; then as governor of all Illyricum in 17–20 he engineered the fall of the formidable king Maroboduus of the Marcomanni. After Germanicus' death Drusus, though reputedly violent and dissolute, showed ability in public business and was clearly designated as Tiberius' successor, becoming consul again in 21 and receiving tribunician power next year. But in 23 he died; eight years later it was alleged to have been revealed that he had been poisoned by his wife Livilla and by Sejanus (*q.v.*). Livilla bore him twin sons (in 19 according to Tacitus though it may have been later); one died in 23, and the other, Tiberius Gemellus, was executed by Caligula in 37. A daughter, Livia Julia, was married to Germanicus' son Nero, and subsequently to Rubellius Blandus.

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DRUZE (DRUSE; Anglicized forms of Arabic DURŪZ; sing. DARAZI, colloquial DURZI), the name of a small community of hill people, numbering fewer than 200,000 souls, living in southern Lebanon and neighbouring Syria and Israel, who have a special closed religion of their own. They are interesting because of their cohesion and loyalty (at times politically significant) and because they have managed actively to maintain through almost a thousand years of turbulent history their close-knit identity and distinctive faith. The Druze permit no conversion, either away from or to their religion, and no intermarriage. They practise *taqiyah*, "concealment" or dissimulation, a principle that permits or even enjoins them to profess publicly the creed and to conform externally to the mores of any group among whom they may find themselves, if interest so dictates. In these circumstances the survival of their religion and community across almost a millennium is the more remarkable in that their religious system is kept secret not only from the outside world but in part even from their own numbers; only an elite of initiates, known as *'uqqal* ("knowers"), participate fully in their religious services and have access to their scriptures.

It is not known to what extent this people was self-conscious and distinct before adopting their present religion. This was an amalgam promulgated in Cairo in A.D. 1017, by a band of whom the chief was Hamzah ibn 'Ali ibn Ahmad and a subordinate called Darazi, from whom this people take their name. Into the system went elements of messianism, incarnationism, gnosticism, Neoplatonism, transmigration and of other currents then flowing in the near east; they were brought into a pattern under a doctrine of the soteriological divinity of the *khalifah* (caliph) of the then ruling Fatimid dynasty of Egypt, al-Hakim bi-Amri-llah. It is apparently believed that al-Hakim did not die but vanished and will one day return in triumph to inaugurate a golden age. There is some suggestion that a number of people in widely scattered areas accepted this system, but only the Druze have survived. It is known certainly that a great many groups in the near east at that time, most of whom came under the various headings of the heretical Shi'ah Muslim sects and movements, accepted similar notions and joined similar causes (*see* SHI'ISM). There are no elements in the Druze system, as far as this is discernible, for which more or less exact parallels are not well known from contemporary Shi'ah, Batini, Christian and other systems, except perhaps a calf figure, of which the connections are somewhat more remote and the role is still obscure (some Druze vehemently deny its existence). What is unique is the particular Druze constellation and the fact that they have survived into the 20th century.

The Druze people have figured prominently at various periods in the local history: in the Arab stand against the crusades; in the century following the Ottoman conquest (1516 ff.), prospering as powerful vassals (until their leader and early westernizer Fakhr al-Din Ma'n was driven out, to take asylum at the courts of Tuscany and Naples); in the 19th century, with imperialist involvements, under the prominent Shihab family, which has also Sunni Muslim and Christian branches; in the 20th century, in many of the vicissitudes of Arab and Lebanese development.

BIBLIOGRAPHY.—Most general histories, and many travel books, dealing with Lebanon-Syria include something on the Druze, as do most works treating Muslim sects. *See* also Philip K. Hitti, *The Origins of the Druze People and Religion, With Extracts From Their Sacred Writings* (1928); N. Bouron, *Les Druzes*, 2nd ed. (1930); F. Massey, *Druze History* (1952), a translation of Bouron with extensive commentary by the translator, who is a member of the community. (W. C. SM.)

DRYAD (HAMADRYAD), in Greek mythology, one of the nymphs of trees and woods. It is sometimes said by late authors that a dryad is a nymph who lives among trees (Gr. *drys*, tree, especially oak), a hamadryad the spirit of a tree, living and dying with it. *See* NYMPHS.

DRYAS, a genus in the rose family, containing five species commonly called mountain avens, dryads and feathers. They are hardy evergreen subshrubs 3 to 12 in. high, with horizontal branches; leaves are small, entire or toothed, smooth or hairy; solitary flowers are on erect scapes; the petals are white or yellow; and the fruits are feathery tailed in heads. Distribution is circumpolar in rocky situations in the northern hemisphere, south to the Gaspé peninsula and Colorado in the new world, to the Pyrenees and Urals in Eurasia.

Propagation is by cuttings, division or seed. *D. octopetala* is suited to rock gardens but should not be moved after planting. Porous calcareous soil, frequent watering in summer and some shade in winter give best results. Plants live many years and form dense mats.

See also ROSACEAE. (I. L. W.; X.)

DRY CLEANING. Dry cleaning is the process of cleaning fabrics with liquids other than water. Although methods vary according to the composition of the fabric or article, the basic process removes dirt, stains and spots by immersion and agitation in organic solvents and detergents, in contrast with the laundering of fabrics in soap and water.

For many years the dry-cleaning process was based on the use of highly flammable solvents such as gasoline and naphtha. Initial cost was low, but fire hazards led to a search for other dry-cleaning fluids. In 1925 the Stoddard solvent, a petroleum distillate separated from impurities and odour compounds, was developed, and another petroleum solvent known as "140° F.," with a higher initial boiling point and higher flash point, appeared. Both solvents gained wide acceptance despite the successful introduction of such manufactured chlorinated hydrocarbon solvents as carbon tetrachloride, trichloroethylene and perchloroethylene. The majority of dry-cleaning plants in the United States continued to use petroleum solvents, with the remainder favouring perchloroethylene. Trichloroethylene is widely used in countries other than the United States. The high toxicity of carbon tetrachloride led to its almost complete disuse in commercial dry cleaning.

The conventional dry-cleaning operation begins with the inspection of the garments in the plant for spots, stains, tears, etc. The garments are then tagged for identification by the marker, who also removes buttons, belts, shoulder pads, ornaments and other fragile accessories, and next are sorted into classifications by fabric type and colour. Each garment is accompanied through the operation by special handling instructions for the spotter, dry cleaner, seamstress, finisher, etc. In the fundamental process, a load of soiled clothing is placed in the dry-cleaning washer containing the petroleum or synthetic solvent. The solvent dissolves much oil

and greasy soil. Insoluble soil, consisting largely of lint, earth, dust, ashes and carbon particles, is loosened by agitation. The loosened dirt, as a result of the continuous flow of solvent and detergent that is maintained through the fabric, is flushed out, washed free of the fabric's surface and passed into suspension in the solvent, which is constantly force-filtered.

The dry-cleaning process is followed by extraction, which removes excess solvent from the garments by centrifugal force. Drying takes place in a tumbler, where the last traces of solvents are removed.

One of the most skilled workmen in a dry-cleaning plant is the spotter, who identifies and removes stains by the use of chemicals, steam or tamping and dry brushing. The spotter identifies fibres and combinations of fibres, selects the correct solvent from among 20 reagents for the specific fabric and stain, and knows when to stop the application before the colour or fabric is damaged.

The finishing process applies only to the pressing of cleaned garments. After the garments are pressed on specialized steam-air machines, they go to seamstresses who replace the buttons, trimmings, etc., that were removed in marking, and do minor tailoring repairs. Certain fragile garments are ironed by hand.

The dry-cleaning plant requires high-pressure steam and many highly specialized machines and appliances, including marking machines, washers, stills, pumps, extractors, dry tumblers, wind whips, drying cabinets, presses, puff irons, wet-cleaning and steam tables, sleevers, glove units, steam irons, bagging and assembling racks, and sewing machines. Utility presses in a variety of shapes are used for the finishing of different types of garments.

(V. Kr.)

DRYDEN, JOHN (1631–1700), English poet, dramatist and critic, was born on Aug. 9, 1631, into a Puritan family at Aldwinkle, Northamptonshire. He went to Westminster school as a King's scholar; and entered Trinity college, Cambridge, in 1650. Fortified by a legacy of landed property from his father, he left Cambridge after graduation in 1654. "His head," says a contemporary, "was too roving and active, or what else you'll call it, to confine himself to a College life; and so he . . . went to London into gayer company, and set up for a poet." He seems first to have been employed as secretary to his cousin Sir Gilbert Pickering, who was then in the service of Cromwell. After the death of the protector in 1658 he is said to have worked for the publisher Henry Herringman.

Dryden was, on his own testimony, a boy poet; but his earliest surviving verses, a "conceited" elegy on Lord Hastings, belong to his last year at Westminster. His first substantial poem, "Heroique Stanza's" on the death of Cromwell (1659), shows some of the energy of style, the rhetorical assurance and the facility in panegyric, which mark his mature verse. In 1660, with most of his prudent compatriots, he modified his political sympathies and quickly established himself as the poet of the new court in *Astraea Redux* (1660), *To His Sacred Majesty . . . on His Coronation* (1661) and *To My Lord Chancellor* (1662). He allied himself to the royalist family of the earl of Berkshire, first in a friendship with Sir Robert Howard and then in his marriage to Lady Elizabeth Howard (1663). *Annus Mirabilis . . . 1666. An Historical Poem* (1667) was suggested by Sir Robert, and written at the Howard house in Wiltshire. The theme of this, the most ambitious of Dryden's early poems, is heroic—superficially, the Anglo-Dutch naval war and the Fire of London; essentially, the security of the new reign, the maritime power of England and the promise of commercial wealth and scientific achievement. Virgil, says Dryden, "has been my Master in this Poem"; and his influence goes deeper than imitations in language and style. *Annus Mirabilis* is a modern Georgic. It celebrates the material enrichment of the community by native skill and diligence under the guidance of providence and a great king. In 1668 Dryden succeeded James Howell as historiographer royal and Sir William Davenant as poet laureate. He held these appointments until the revolution of 1688.

At the Restoration Dryden turned for a livelihood to the drama, then the only form of literature which offered much security to the professional writer. *The Wild Gallant*, a first attempt in comedy presented at the Theatre Royal in 1663, was overshadowed by *The Adventures of Five Hours*, Sir Samuel Tuke's adaptation from the Spanish at the rival Duke's theatre. In *The Rival Ladies* (1664) Dryden, who had a keen business sense, followed Tuke with a complicated "Spanish" plot in blank verse and couplets and won Pepys's approval for "a very innocent and most pretty witty play." Turning then to a new, more elaborate form of verse drama, he collaborated with Sir Robert Howard in *The Indian Queen. A Tragedy*, acted in Jan. 1664 "so beautified with rich Scenes as the like had never ben seene here" (Evelyn). Dryden set out his arguments for rhymed plays in the dedication of *The Rival Ladies* (published in the summer of 1664), and made his first independent contribution to the heroic drama in *The Indian Emperour*, a sequel to *The Indian Queen*, in 1665. The success of this play put him at once among the leading dramatists of the day and he worked with resourceful energy in the next decade to confirm his place, both in the heroic mode—*Tyrannick Love, or The Royal Martyr* (1669), the two parts of *The Conquest of Granada* (1670–71; presented with "very glorious scenes and perspectives") and *Aureng-Zebe* (1675)—and in comedy.

The matter of Dryden's comedies at this time is mainly French. *Secret Love, or The Maiden Queen* (1667), "mightily commended for the regularity of it, and the strain and wit" (Pepys), is a tragi-comedy written strictly to the French rules and based on Mlle de Scudéry's romance *Le Grand Cyrus*. *Sir Martin Mar-all, or The Feign'd Innocence* (1667) draws on Molière's *L'Étourdi* and Philippe Quinault's *L'Amant indiscret*. *An Evening's Love, or The Mock-Astrologer* (1668) is based mainly on Thomas Corneille's *Le Feint Astrologue*. "'Tis true," says Dryden in his preface (1671), "that where ever I have lik'd any story in a Romance, Novel, or forreign Play, I have made no difficulty . . . to build it up, and to make it proper for the *English* Stage." These comedies depend on plots of intrigue and on the witty dialogue of pairs of lovers which is Dryden's main contribution to the comedy of manners. In his touches of romance and sentiment, however, and in a preference for emotional tensions over intellectual sparkle, he looks back to the early 17th-century tradition rather than forward to the comedy of William Congreve.

Most of Dryden's early criticism, worked into the prefaces and dedications of his plays, deals with problems he had to face as an experimental dramatist in a new theatre. There are important passages on the poetic imagination and on the modern style in English verse in the dedication of *The Rival Ladies;* the preface to *An Evening's Love* is "a cry for a new artist in comedy; it places the Siege Perilous for Congreve to occupy" (W. P. Ker); but the main theme of the early essays is the heroic play, and especially the dramatic use of rhyme. The defense of rhyme in the dedication of *The Rival Ladies* was answered by Howard in the preface to *Four Plays* (1665); Dryden returned to the topic in *Of Dramatick Poesie, An Essay* (1668); Howard replied in the preface to *The Duke of Lerma* (1668); and the dispute ended in Dryden's essay published with the second edition of *The Indian Emperour* (1668)—"as I was the last who took up Arms, I will be the first to lay them down." *The Conquest of Granada* (1672) contains two essays, one on heroic plays and another on the superiority of modern over Jacobean drama in language, wit and conversation.

Dryden's most ambitious piece of criticism on these topics is the essay *Of Dramatick Poesie*, a defense of English drama against the champions of both the classical and the modern French theatre and an attempt to discover general principles of dramatic criticism. It takes the form of a dialogue with four speakers "under borrowed Names": Crites, Lisideius, Neander (who, in a long examen of Ben Jonson's *Silent Woman*, gives one of the earliest critical analyses in English) and Eugenius. Traditionally, these speakers have been identified as Howard, Sir Charles Sedley, Dryden and Lord Buckhurst; but they are primarily vehicles for critical attitudes which Dryden wishes to set against each other. The *Essay* is built round Lisideius' definition of a play as "a just and lively Image of Human Nature, representing its Passions and Humours, and the Changes of Fortune to which it is subject, for the Delight and Instruction of Mankind." Which drama best illustrates this description? Crites argues for, and Eugenius against, the an-

cients; Lisideius argues for the French, Neander for the Elizabethans and Jacobeans; Crites argues against, Neander for, contemporary drama. By deploying his disputants so as to break down the conventional oppositions of ancient and modern, French and English, Elizabethan and Restoration, Dryden deepens and complicates the discussion. This is the first substantial piece of modern criticism—sensible, judicious, exploratory, combining general principles and analysis—in a gracefully informal style. Dryden's approach, here and in all his best criticism, is characteristically speculative and shows the influence of disengaged scientific inquiry: "My whole Discourse was Sceptical, according to that way of reasoning which was used by Socrates . . . and which is imitated by the modest Inquisitions of the Royal Society. . . . it is a Dialogue sustain'd by persons of several opinions, all of them left doubtful, to be determin'd by the Readers in general" (*Defence of An Essay*).

Aureng-Zebe was Dryden's last rhymed heroic play. Too much has been made of the effect on his career of *The Rehearsal* (1671, by Buckingham and others), which ridicules him and parodies his plays. He was not uncommonly sensitive, and knew the faults of his heroic writing as well as any of his critics; and the plays were still commercial successes. But he was growing dissatisfied: "I desire to be no longer," he wrote in 1675, "the *Sisyphus* of the Stage; to rowl up a Stone with endless labour . . . which is perpetually falling down again. I never thought my self very fit for an Employment, where many of my Predecessors have excell'd me in all kinds; and some of my Contemporaries . . . have out-done me in Comedy" (dedication of *Aureng-Zebe*). He persisted in comedy for a time, gaining a last triumph for a pair of witty lovers in the romantic tragi-comedy *Marriage A-la-Mode* (1672), but declining into sheer indecency and dullness in *The Assignation* (1672), *The Kind Keeper; or, Mr. Limberham* (1678) which "express'd too much of the Vice which it decry'd" and *The Spanish Fryar* (1680). Thereafter there were no comedies apart from *Amphitryon* (1690), which is good entertainment, but offers lewdness for wit and lacks the energy and grace of the early plays. Dryden's first attempt at political satire was made in the theatre, in the deplorable tragedy *Amboyna* (1673); he wrote—with predictable ill-success—a stage version of *Paradise Lost, The State of Innocence* (1676), probably for a court performance; but the main interest in his work in the later 1670s lies in his experiment with a form of tragedy which would combine the structural principles of the French theatre with the Shakespearean tradition in character and style.

In *All for Love: or, The World well Lost* (1677) he reshaped the story of Shakespeare's *Antony and Cleopatra,* elaborating the last phase into a five-act tragedy and observing "the Unities of Time, Place, and Action . . . more exactly . . . than perhaps the English theatre requires." This restriction in scope and setting confines him to a much narrower field of emotion—he is concerned only with the culmination of a tragic love. He thus gives us nothing of Shakespeare's earlier, nobler Antony, and his Cleopatra is less vital and magnificent. Shakespeare's tragedy is acted out under "the wide arch of the ranged empire"; the world of Dryden's play is the closer world of love. He has little of Shakespeare's poetry, an imagery integral to the theme and the characters, full of passion and light; his imagery is more simply decorative and the tone of the play more sombre. Yet it is a great play in its kind and the richest illustration of French influence on English tragedy. Dryden's experiment with *Troilus and Cressida* (1679) was less successful. There is the same thinning of Shakespeare's poetic wine but no compensating energy of spirit. The story and characters are recast in the mold of the Restoration heroic convention despite the whole tradition of false Criseyde; and there is "something too nice and fastidious in the critical rule which exacts that the hero and heroine of the drama shall be models of virtuous perfection" (Sir Walter Scott).

All for Love was the last play Dryden wrote for the King's company. *The Kind Keeper; or, Mr. Limberham* was first acted by the rival Duke's company in March 1678 and *Oedipus* (written with Nathaniel Lee) after the following August. The King's company protested in a petition, against conduct which was contrary to Dryden's "promise, and all gratitude to the great prejudice, and almost undoing of the Company"; but since the fire at the Theatre Royal in 1672 they had been in a bad way, and Dryden cannot have got his due share of profit for the plays he wrote between 1672 and 1678. The defection of Dryden and Lee accelerated the decline of the King's company, and they merged with their rivals in Nov. 1682.

Dryden's later plays have little intrinsic interest. He felt more and more that he had no natural bent for drama; a younger generation of comic dramatists was out-pacing him; and he was finding fuller satisfaction in poetry. *The Duke of Guise* (1682) is a political satire on the Whigs, built up in collaboration with Lee from an early draft by Dryden. *Albion and Albanius* (1685) is a slight and unsuccessful opera written to celebrate the political triumph of Charles II and the duke of York. A final series of plays was written under the pressure of poverty, when Dryden's fortune turned with the abdication of James II: *Don Sebastian,* a tragedy (1689), *Amphitryon,* a comedy (1690), *King Arthur . . . A Dramatick Opera* with music by Purcell (1691; "the last Piece of Service . . . for my Gracious Master, *King Charles* the Second"), *Cleomenes,* a tragedy (1692), and *Love Triumphant,* a tragi-comedy (1694).

While *All for Love* was bringing Dryden's work for the theatre to its climax, he began to discover his powers in verse satire. *Mac Flecknoe,* a mock-heroic lampoon on the dramatist Thomas Shadwell, was written in 1678 and circulated in manuscript until its first (unauthorized) printing in 1682. Its immediate occasion is unknown. The basis of the satire, which represents Shadwell as a literary dunce, is the disagreement of the two men over the quality of Ben Jonson's wit. Dryden thought Jonson deficient in "the *Urbana, venusta, salsa, faceta* . . . the Ornaments of Wit," and defended his opinion against Shadwell, who regarded Jonson with uncritical reverence. But in the essays which make up his part in the controversy (1668–73) Dryden shows no personal animosity toward Shadwell; and it seems likely that *Mac Flecknoe,* though its substance is literary, was provoked by some later personal quarrel. It is a concentrated, hilariously comic piece—the first English mock-heroic poem, and the immediate ancestor of Pope's *Dunciad.*

Dryden soon had a chance to display his heroic-satiric art on the grand scale. In March 1681 Charles II dissolved the Oxford parliament and threw the Whig opposition into disorder. Their leader, Shaftesbury, was committed to the Tower on a charge of high treason and tried on Nov. 24. During the months of Charles's triumph Dryden was at work on *Absalom and Achitophel,* a long poem in the heroic mode which summarizes the growth of the opposition party, the fomented scare of the Popish plot, the attempt to exclude the Catholic duke of York from the succession and the king's counterattack. It appeared in mid-November, probably with the design of prejudicing Shaftesbury's trial, and ran to at least three London editions in four months. *Absalom and Achitophel* is not primarily a satire, but a political narrative written to vindicate the king and his court party. It consists of a witty historical introduction leading up to the seduction of Absalom (Monmouth, the "Protestant Duke") by Achitophel (Shaftesbury); a brilliant series of satiric portraits of Whig personalities; a medial discussion of the fundamental political issues behind the crisis of 1676–81; a series of panegyrical portraits of the king's friends; and a statement of Charles's own case. The application of the biblical story of Absalom is not a novelty; but Dryden's use of the Old Testament is wonderfully consistent, complex and witty, and the whole story is beautifully turned to serve his political design. The heroic style, with echoes of the grand seduction in *Paradise Lost* and the exalted debates of the heroic play, is an instrument of both panegyric and satire; and the portraits of the Whigs illustrate the notion of satire as a kind of heroic poetry, gaining its effects by irony and "fine raillery," which Dryden later set out in his essay on Juvenal and Persius. In *Absalom and Achitophel* he lifts the tradition of English satire, as represented in the work of John Oldham, Andrew Marvell and Samuel Butler, to a new level of art and sets the tone of the dominant mode in Augustan verse. A *Second Part* which followed in 1682 is

mainly the work of Nahum Tate, with a number of satiric portraits by Dryden. Dryden's later attack on Shaftesbury in *The Medall* (1682), following the failure of the indictment for treason, has great energy and intensity; but it is on a smaller scale, with neither the variety nor the heroic ironies of *Absalom*.

Dryden turned now to religious controversy—in his day a natural concomitant of politics. *Religio Laici or A Laymans Faith* (1682) is a discussion of authority in religion, written in a plain "Legislative" style: "A Man is to be cheated into Passion, but to be reason'd into Truth." Dryden follows the sceptical Pyrrhonist tradition in rejecting reason as the ultimate guide to truth; but he criticizes both the Papist claim to infallibility and the Protestant reliance on personal interpretations of Scripture with the aid of the inner light. His position is a compromise, accepting the doctrines established by the double tradition of the Bible and the Fathers, and curbing "private Reason" in the interests of "Common Quiet."

His conversion to the Roman Church a few years later has been regarded as an act of expediency following the accession of James II; but there is a logical advance from the troubled antirationalism of *Religio Laici* to the defense of fideism and Catholic authority in *The Hind and the Panther* (1687), Dryden's most ambitious original poem. It is a finely sustained piece of apologetics, in the rather clumsy framework of a beast fable: the animal disputants represent the Roman and Anglican churches. The style ranges from "the Majestick Turn of Heroick Poesie" to the simplicity of "Domestick Conversation," carrying theological argument, historical narrative, vigorous satire on the Reformation and the Protestant sects, and a long satiric allegory (also in beast-fable form) of current ecclesiastical politics. *The Hind* is the culmination of Dryden's religious development: he did not "except in outward profession, abandon the Church of England for that of Rome, but was converted to the Catholic faith from a state of infidelity, or rather of Pyrrhonism" (Scott).

In the 1680s Dryden wrote a substantial amount of political and historical prose—including *His Majesties Declaration Defended* (1681), a life of Plutarch for a translation of the *Lives* (1683), a translation of Louis Maimbourg's *History of the League* (1684) and another of Dominique Bouhours' *Life of St. Francis Xavier* (1688). Some of his best panegyrical verse dates also from this decade. From the "Stanza's" on Cromwell to his epistle to John Driden of Chesterton (1700) he reflected the ideals of virtue and heroism so inconstantly realized by the great men of his time, in a long series of verse eulogies. The greatest artist in compliment in English literature, he had "all forms of excellence, intellectual and moral, combined in his mind with endless variation . . . He considers the great as entitled to encomiastick homage, and brings praise rather as a tribute than a gift, more delighted by the fertility of his invention than mortified by the prostitution of his judgment" (Dr. Johnson).

But in 1680, in a collaborative translation of Ovid's *Epistles*, Dryden began the work which was to absorb the energies of his last years. To the first three volumes of Jacob Tonson's *Miscellany—Miscellany Poems* (1684), *Sylvae* (1685) and *Examen Poeticum* (1693)—he contributed some of his best criticism, on the Latin poets and the art of translation, and a mass of translation from Ovid, Theocritus, Lucretius, Homer, Horace and Virgil. In 1693 he edited a translation of the *Satires* of Juvenal and Persius, with five of Juvenal's poems and all of Persius by himself, and a long essay on the history and art of satire. In 1697 he completed, singlehanded, a translation of *The Works of Virgil*, with a dedication of the *Aeneis* containing a fine critique of Virgil; and in 1700, just before his death, he published a miscellany of *Fables Ancient and Modern . . . from Homer, Ovid, Boccace, and Chaucer*. In variety and quality this is one of the best books of narrative verse in the language, and the preface is the most delightful of all his critical essays.

The quality of Dryden's translation is variable. His method was "paraphrase"; he attempted to hold true to the sense and spirit of his authors, and at the same time to make them speak the kind of English they would have used had they "been born in *England*, and in this present Age." The success of this difficult policy must depend mainly on an affinity of spirit and style between original and translator, and Dryden works best with Ovid, Lucretius and the Roman satirists. Within the limits of the method he adopts, and the scholarship of his day (over which he is more conscientious and critical than is often supposed), he manages the rhetorical wit of Ovid, the assertive exposition of Lucretius and the *saeva indignatio* and energy of Juvenal with conspicuous success. He fails with Theocritus, and catches hardly enough of Horace's delicacy and grace. His *Virgil* is a heroic achievement, and one of the monuments of English Augustan verse; but he misses the essence of Virgil's art, its imaginative richness, its feeling and its complexity of style. Chaucer and Boccaccio were not classical authors, and demanded less fidelity from a translator. Dryden rewrites three of Chaucer's *Tales* in a modern romantic style, and boldly recasts three prose stories from the *Decameron* with all the baroque ornament and heroic passion—and a satiric salt—at his command. In his translation as in his original verse, he set the dominant tone of English poetry—its strength, harmony, clarity and pervasive wit—for nearly a century. He died in London on May 1, 1700, and is buried in Westminster abbey.

See also references under "Dryden, John" in the Index volume.

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DRYDEN, JOHN FAIRFIELD (1839–1911), U.S. senator and businessman, was the founder of the Prudential Insurance Company of America, the first company to issue industrial life insurance in the United States. Born at Temple Mills, Me., on Aug. 7, 1839, Dryden made a study, while attending Yale university, of industrial or "workingman's" insurance (small policies usually based on weekly premiums) as developed by the Prudential Assurance company of London, Eng., and by private benevolent societies. In 1873 Dryden and a few backers founded the Widows and Orphans Friendly society in Newark, N.J. It was succeeded in 1875 by the Prudential Friendly society, which took its present name in 1877.

Dryden was secretary of the company (1875–81), and president from 1881 until his death on Nov. 24, 1911. He was U.S. senator from New Jersey, 1902–07. His son Forrest succeeded him as Prudential's president in 1912.

See Earl Chapin May and Will Oursler, *The Prudential* (1950). (W. O.)

DRY DOCK, a structure designed to permit maintenance work on ships too heavy to be lifted from the water. There are two principal types: the fixed dry dock, called a graving dock, is a basin dug into the side of a channel and fitted with watertight gates and pumps to remove the water inside; the floating dry dock is a barge-like structure that can be partially submerged so that a vessel can enter it. The dock is then raised in the water and pumped dry to permit work on the vessel. *See* DOCK.

DRY FARMING. Dry farming is farming without irrigation in areas where the moisture supply is the chief limitation to crop production. Such farming practices have existed approximately as long as man has been an agriculturist, particularly as subsistence farming on desert margins and in areas having dry summers, such as the Mediterranean basin. Dry farming in the

U.S., under that name and as a type of commercial agriculture, began perhaps in Utah in 1863. It became a general practice in many parts of the subhumid and semiarid grasslands of continental interiors of North America, Australia, Asia and, to a lesser degree, South America and Africa. Such areas generally have less than 20 in. of precipitation yearly; but temperature, evaporation and soil characteristics, as well as rainfall season and reliability, are very important. Wind erosion as well as occasional drought and dust-bowl characteristics afflict most of these areas. Yet they have contributed greatly to both the abundance and the variability in commercial food supplies of the 20th century, particularly of wheat, barley and grain sorghums.

Efficient dry farming consists of making the best use of a limited water supply by storing in the soil as much of the rainfall as is possible and by growing suitable crop plants by methods that make the best use of this moisture. Storing water is accomplished by maintaining a surface condition that permits water to enter the soil readily and by preventing its loss by killing weeds and other unwanted plants. Storing moisture in advance of seeding is accomplished in different ways. In the moister portions of the dry-land winter wheat regions of the U.S. and the U.S.S.R., tilling the soil shortly after harvest and keeping the land free from weeds until seeding time in the fall has resulted in better yields through increased moisture storage.

In latitudes where harvest is late and crops are spring seeded, the snow caught by stubble may be more important than fall weed control in storing moisture. In the drier areas, alternate fallow, by which land is cultivated to keep the land free of live vegetation one year and a crop grown the next, may be needed to ensure a supply of water for the crop (*see* FALLOW). This practice is particularly adapted to large-scale operations where it stabilizes yields and reduces costs. In more favourable areas an intertilled crop such as corn (maize) or potatoes may leave a residue of moisture sufficient to help materially in insuring a yield of a small grain crop following. Moisture control while a crop is growing consists largely of prevention of runoff and destruction of weeds. The ideal surface, to absorb water and prevent wind and water erosion, is one that is free from live weeds but has enough clods or dead vegetable matter to hinder runoff and prevent erosion. Cultivation that controls weeds is generally sufficient to maintain such a surface condition, but loosening a packed surface is sometimes necessary. The depth of plowing has little to do with moisture storage, since the quantity of water that enters a soil is governed chiefly by the condition of the immediate surface. In some dryland areas of the world plowing to a depth of eight or nine inches has been more productive than shallower plowing, but usually this is associated with nitrification rather than with moisture storage. Loosening the soil to extreme depths as by subsoiling has not been profitable.

Crops adapted to dry farming may be either drought resistant or drought evasive. The drought-resistant crops, of which sorghums may be selected as an example, are able to reduce transpiration and may nearly cease growth during periods of moisture shortage and then resume development when conditions again become favourable. Drought-evasive crops make their greatest growth at times of the year when heat and drought conditions are not severe. They may either be crops that are planted in fall or early spring and mature in time to miss much of the hot part of summer or those that are planted late and make much of their growth after the period of greatest summer heat has passed. Crops adapted to dry farming are usually smaller in stature and quicker in maturing than those grown under more humid conditions. Planting rates are also generally lower and the individual plants are given more space. Primitive tribes in many lands have made use of wide plant spacings to help avoid failure of corn and sorghums.

Dry farming of the commercial sort, whether of the family farm or large size, illustrates large-scale, highly capitalized and mechanized agriculture. Special implements have been developed, not only adapted to extensive farming but designed to keep the surface weed-free, water absorbent and yet resistant to wind erosion. Net agricultural incomes per hour of labour in good years are among the highest, yet fixed costs are high; the risk involved may be partly offset by such income supplements as insurance and credit improvements, livestock production and irrigation agriculture where possible. *See* also AGRICULTURE (ARTICLES ON).

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DRYGALSKI, ERICH DAGOBERT VON (1865–1949), German geographer and polar explorer who, although his chief interests lay in Antarctic geography, glaciology and glacial geology, in the later years of his life turned his attention to political geography and the methods of regional geography. He was born on Feb. 9, 1865, at Königsberg, then in East Prussia, and died at Munich on Jan. 10, 1949. In 1891 Drygalski was chosen by the Gesellschaft für Erdkunde in Berlin to lead an expedition to Qarajaks Isfjord in west Greenland. The resulting publications established his reputation. In 1899 he became professor of geography and geophysics in Berlin. Two years later he was selected to lead the German Antarctic expedition in the "Gauss," 1901–03, sent out by the German government as part of an international program of concerted Antarctic exploration. This expedition reached the continent in about longitude 90° E. in what is now called Kaiser Wilhelm II Land, and wintered about 50 mi. east of Gaussberg. The lack of dramatic new land discoveries evoked imperial displeasure, but the scientific merit of the expedition could be measured more truly by the extraordinarily comprehensive series of scientific reports that were published during the next 30 years. On his return, Drygalski published a general account of the expedition, *Zum Kontinent des eisigen Südens* (1904). In 1906 he became professor of geography in Munich, a post which he retained until he retired in 1934. In 1910 he took part in Count Zeppelin's expedition to Spitsbergen, and studied the influence of glaciers on land features.

After World War I, Drygalski devoted himself to the publication of the "Gauss" expedition reports, *Deutsche Südpolar Expedition*, 20 vol. (1905–31). He summarized his studies of the regional geography of the Antarctic in Fritz Klute's *Handbuch der geographischen Wissenschaft* (1930). His last important work was, in joint authorship with Fritz Machatschek, *Handbuch der Gletscherkunde* (1942), a comprehensive text book of glaciology. (B. B. Rs.)

DRY ICE, the popular name for solid carbon dioxide, a dense, snowlike substance having a temperature of −78.5° C. or lower. Carbon dioxide gas is changed to a liquid when subjected to a pressure more than five times that of the ordinary atmosphere and at −57° C. When this liquid is allowed to expand rapidly from the high pressure to atmospheric pressure, carbon dioxide snow results. This snow is compressed into cakes. Instead of melting, it evaporates to a dry gas that has no corrosive action if moisture free. It makes possible the shipping of perishable products (meats, ice cream) long distances. One pound of dry ice will absorb a little less than twice as much heat as one pound of water ice. A 10-in. cube (1,000 cu.in.) of dry ice weighs about 45 lb. *See* also CARBON, OXIDES OF: *Carbon Dioxide*.

DRYOPITHECUS, the type and European representative of a group of fossil apes, the Dryopithecinae, ranging from early Miocene to late Pliocene (beginning about 21,000,000 years ago and lasting 20,000,000 years) in Europe, north Africa and India, and including at least seven other genera. The Dryopithecinae represent the ancestry of the living anthropoid apes; some students claim that they include the common ancestors of man and the recent apes. *See* also MAN, EVOLUTION OF. (G. G. SI.; X.)

DRY POINT. Though generally classed as a variety of etching, and in practice often combined with that process, dry point is, strictly speaking, a kind of engraving.

In etching the needle scratches only through the etching ground and exposes the surface of the plate (usually copper). The plate

is then placed in a bath of acid, and it is the chemical action of the acid that eats out a line of sufficient depth to hold printing ink. In dry point, on the contrary, as in line engraving, the lines are hollowed out by the tool itself in direct contact with the metal as directed by the artist's hand, without the intervention of any chemical action. Zinc can be used instead of copper, but work on this metal wears out quickly under the pressure of the printing press. Celluloid plates have been used, but no heat can be applied during the inking and printing of the plates. *(See* ENGRAVING, LINE; ETCHING.)

HISTORY

Earliest Work.—The first appearance of dry point was before that of etching. There can be no doubt that the scarce prints of the "Master of the Hausbuch," a painter-engraver, possibly of Dutch origin, who worked in western Germany (probably on the middle Rhine) about 1480, were produced with the dry point or possibly with the burin used in the same way, so as to scratch the surface of the copper (or some softer metal such as lead or tin) and throw up a burr, which was not scraped away. This engraver is also called the "Master of the Amsterdam Cabinet" from the fact that the largest collection of his prints, numbering 82 examples of the 91 subjects (plates) which constitute his known work, is owned by the Amsterdam Print room. He was a very original artist and a keen observer of nature, with a technique quite unlike that of any other 15th-century engraver.

Dürer.—One of the next engravers of importance whom we find employing dry point is Albrecht Dürer, who resorted to this process only in or about the year 1512, and probably abandoned the experiment when he discovered how few good proofs a plate engraved in this manner could yield. There are only three dry points by Dürer, "The Man of Sorrows" (1512), "St. Jerome Seated Near a Pollard Willow" (1512) and its companion print, the undated "Holy Family" of similar dimensions. Of the two latter dry points very few good impressions are extant, for the burr wore off rapidly, and the majority of extant specimens were taken from the worn-out plates. Of Dürer's first work in this technique, "St. Jerome," two proofs only exist of a first state before the monogram (in the British museum, and the Albertina, Vienna). These are of superb quality; the Albertina impression of the second state is also very fine. A fourth dry point, "St. Veronica," dated 1510, which figures in the older catalogues as one of the great rarities in Dürer's work, for only two impressions are known, is discredited, for it was proved to be a copy of an unsigned woodcut published at Nuremberg in a *Salus Animae* of 1503. Hans Sebald Beham alone of the followers of Dürer used dry point, and that but sparingly. It is hardly found again in the history of German engraving until a much later date.

Italy.—In Italy also the process was used in early times, chiefly by Andrea Schiavone, or Meldolla (1522?–82), an engraver who worked at Venice, and perhaps also by the monogrammist H. E., for early impressions of his prints show signs of burr which in the usual later prints would not be suspected.

Rembrandt.—In the Netherlands dry point was hardly used, if at all, before the 17th century. Its varied uses, as described below, for the enrichment of the etched plate by the addition of burr to the etched line as well as for the production of pure dry points were first discovered and exploited by the greatest of all painter-etchers, Rembrandt. In his middle period and onward, from about 1639, he used this technique increasingly, in a thoroughly personal manner, for the sake of substituting "colour" and warmth for the drier effect of the pure etchings of his earlier period. From 1640–50 Rembrandt used dry point extensively for retouching his etched plates—"The Death of the Virgin" and "Christ Healing the Sick" (the "Hundred Guilder Print") are examples taken from the beginning and close of this period—while in his last period (1650–61), plates wrought wholly in dry point became more and more frequent. Among the finest of these must be reckoned "The Goldweigher's Field" (1651); "The Vista" (1652); the two large plates, "The Three Crosses" and "Christ Presented to the People," of 1653 and 1655 respectively, and the "Portrait of Arnold Tholinx" (1656).

The 18th Century.—After Rembrandt, little use of the dry point was made by any of the great engravers for a lengthy period. The 17th century was in all countries an age of line engraving and etching, while in the Low Countries, Germany and England, the invention and development of mezzotint were claiming attention. In the 18th century dry point was used here and there by a number of painter-etchers, amateurs in their technique as compared with the professional engravers, who found the medium congenial and probably took hints in their use of it from their study of Rembrandt. A beautiful example of such an 18th-century dry point is the portrait of himself, dated 1739, by Arthur Pond. One of the little subjects illustrating the destruction by fire of the Foire de Saint-Germain in 1762, by Gabriel de St. Aubin, is a dry point which seems in its modernity a precursor of the 19th century. In the period which preceded what is known as "the revival of etching," that is to say, during the first half of the 19th century, several English and Scottish etchers produced dry points of remarkable merit. Among these were D. C. Read of Salisbury (1790–1821), E. T. Daniell of Norwich (1804–42) and especially the two Scottish painter-etchers Andrew Geddes (1783–1844) and Sir David Wilkie (1785–1841). Geddes' "Portrait of the Artist's Mother," his "Peckham Rye" and some other landscapes, and Wilkie's one pure dry point, "The Lost Receipt," are of conspicuous merit if compared with the dry points of any period.

The French etcher Charles Jacque also produced, long before 1850, a number of dry-point landscapes, with figures or horses, of great beauty.

Modern Work.—The etchers of the "revival," both in France and England, soon brought the dry point, as well as etching, into renewed favour. In the hands of Sir Francis Seymour Haden it yielded masterpieces like "Windmill Hill" and "Sunset in Ireland"; in those of Whistler, "Finette," the "Portrait of Axenfeld," "Weary" and many more. Alphonse Legros, soon after 1860, produced "Le Cours de phrénologie," "Les Baigneuses," "Pecheurs d'ecrevisses" and several landscapes. Legros' pupil, William Strang, half a century later, did much fine work in dry point; so did Sir D. Y. Cameron, especially in his work after 1903, and particularly after 1910. Another master of the technique was Theodore Roussel (1847–1926). Of outstanding excellence among French dry points of the late 19th century are those of the sculptor Auguste Rodin, whose portraits of Victor Hugo, of Henri Becque, of A. Proust, and "Allégorie du printemps" and "La Ronde," are among the masterpieces of the medium. The French painter and etcher J. L. Forain produced some superb dry points about 1909–10 and later. Among British engravers, Sir Muirhead Bone became pre-eminent as a master of dry point, in which medium almost the whole of his numerous plates after 1898 were wrought. Another excellent engraver in dry point was Edmund Blampied.

With many other modern artists, dry point found favour, both as an independent medium and an auxiliary to the etching process. It has been used to express talents as divergent as those of Edvard Munch, Pierre Bonnard, Lovis Corinth, Pablo Picasso, André Dunoyer de Segonzac, Max Beckmann, Marc Chagall, Stanley William Hayter and Jacques Villon.

TECHNIQUE

The "dry" point is so called because no bath of acid supplements its use. It is a tapering pointed instrument of steel, of stronger build than the point or needle used by the etcher and sometimes sharpened at both ends; many artists have substituted for steel a diamond point, or more rarely a ruby. The artist works directly upon a plate of hard and polished copper, either shiny or blackened, or merely dimmed with grease, producing a line, shallow or deep, according to the amount of pressure used. The instrument is drawn toward the artist, like a pencil (in making a line engraving, on the contrary, the burin is pushed forward). Along one edge of this line, if the point is slanting, or along both edges if it is held upright, a raised edge of copper is turned up by the tool, and this ridge is termed the "burr." The burr, when the plate is inked for printing, becomes clothed with ink and produces in the impression the rich, soft and velvety effect which

DRY POINT

BY COURTESY OF (1) THE DIRECTOR OF THE ALBERTINA MUSEUM, (8, 9) H. NAZEBY HARRINGTON, PHOTOGRAPH, (6) COPR. H. BONNAIRE

DRY POINTS BY ENGRAVERS AND ETCHERS FROM THE 16TH TO THE 19TH CENTURY

1. "St. Jerome Seated Near a Pollard Willow" (1512) by Albrecht Dürer, the first of three dry points. From the impression of the second state in the Albertina museum, Vienna
2. "Holy Family" by Albrecht Dürer. Undated, but about 1512
3. "The Man of Sorrows" (1512) by Albrecht Dürer. This plate and the two preceding were the only dry points made by Dürer
4. "Portrait of Himself" (1739) by Arthur Pond, one of the English painter-etchers of the 18th century who used the dry-point technique with success
5. "Spectacle des Tuileries" (1760) by Gabriel de St. Aubin. Touched up with dry point in 1763
6. "L'Orage" (1848) by Charles Jacque, a French etcher who produced a number of dry-point landscapes with figures or horses
7. "Portrait of the Artist's Mother" (1822) by Andrew Geddes
8. Trial proof (Oct. 7, 1877) of "Windmill Hill," dry point by Sir Francis Seymour Haden, one of the leading English etchers of the 19th century
9. "Sunset in Ireland" by Sir Francis Seymour Haden, 1863

DRY POINT

BY COURTESY OF (1) MISS R. BIRNIE PHILIP, (3, 4) THE TRUSTEES OF THE BRITISH MUSEUM, (5) CAMPBELL DODGSON, (7) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (8) SIR MUIRHEAD BONE, PHOTOGRAPH (6) COPR. H. BONNAIRE

EXAMPLES OF THE DRY-POINT TECHNIQUE

Dry point is generally classed as a variety of etching, though actually a kind of engraving. In dry points no acid is used on the plate, as in pure etching, but the lines are hollowed out of the copper with a sharp-pointed instrument. The raised edge of copper turned up by the tool is called the burr. This, in printing, produces the soft velvety effect peculiar to dry points

1. "Weary" by James Abbott McNeill Whistler, finished in 1872
2. "Christ Healing the Sick" (the "Hundred Guilder Print") by Rembrandt. An etching of his middle period (1640–50) retouched with dry point
3. "Portrait of Arnold Tholinx" by Rembrandt, 1656
4. "Portrait of Victor Hugo" by Auguste Rodin (1840–1917)
5. "La Ferme des bordes" by Alphonse Legros (1837–1911)
6. "Portrait of Victor Hugo" by Auguste Rodin
7. "The Vista" by Rembrandt, 1652
8. "Wells Cathedral" by Sir Muirhead Bone, 1919

constitutes the peculiar charm of a dry-point proof. If the burr is removed (as it easily can be with a scraper) the somewhat thin line thus produced is less easily distinguished, except by a practised eye, from the characteristic lines produced by the burin in line engraving, or the needle in etching. The burr is delicate and is easily worn out, either by too vigorous wiping with rag or muslin when the plate is inked or by too great pressure in the printing press. In any case the burr does not last long and the "bloom" of the early proofs of a dry point soon wears off. The first two or three proofs, though they may be rough and uneven, often have a charm which can never be replaced by the more even printing of the bulk of the edition; and at some stage, it may be after a dozen proofs, or 20 or 50, according to the manipulation of the plate and the depth to which the lines have been sunk, deterioration inevitably becomes noticeable, unless the plate has been protected from wear by steel facing.

The comparative ease with which changes can be made in dry point results in a multiplicity of states (*i.e.*, stages of development; impressions taken in different states are distinguishable by the changes that the artist has made in the plate). Of a celebrated dry point by Sir Muirhead Bone, "A Spanish Good Friday," there are no less than 39 states, the artist having repeatedly changed his mind about some detail, or thought of a fresh improvement that he could introduce, after he had begun to take proofs.

Dry Point and Etching.—Dry point has sometimes been used by line engravers in the first preparatory stage (outline) of plates which are subsequently to be finished with the burin. However, dry point is much more often used in combination with etching. Such a combination may be made in a second or subsequent state either for the general enrichment of an etched plate, by the addition of the dry-point burr, or for the sake of introducing small corrections. Corrections to an etched plate can be made far more easily (though less permanently) by a few touches with the dry point than by an additional biting of the plate, involving as this does the stopping-out or laying of a fresh ground. Dry-point additions to an etching can be readily distinguished by a trained eye in early impressions, but they can wear away gradually in the course of the printing until almost every trace of them is lost. It is the presence of the clearly visible dry-point work, lending richness where it was intended, that confers value on such an etching as the second state of Rembrandt's "Hundred Guilder Print." Yet these rich early impressions and the bare-looking late ones after the worn plate has lost its dry-point burr have, it should be remembered, to be described as impressions of the same state. (C. Do.; H. Es.)

Dry point has several striking advantages over etching: (1) the work can be more easily judged on the bare plate, being positive in character, *i.e.*, the lines appearing black (if filled in with black paint) exactly as in the print; (2) corrections are more easily made since the lines are shallower, and the metal, being thrown up in furrows and not removed from the plate, can be forced back into the groove with a burnisher; additions to the work can be easily made since the plate requires no regrounding and rebiting as in etching; (3) a trial print can be easily taken at any stage of the work, though it should be remembered that the fewer trial proofs that are taken the better, since a dry point may easily be worn out in the course of a protracted series of trial proofs.

Materials.—Some dry-point artists use a plate prepared or blackened as for etching, taking care to cut through the varnish to the metal surface underneath, and using the varying emphasis required by their design; in dry point everything must be drawn delicately or strongly by the artist himself as in ordinary drawing. The difficulty of working on the blackened plate is that it is not easy to judge exactly what emphasis has been used in making the lines, so the bare plate is more often used and a little weak black paint rubbed into the lines to mark their progress. Great care should be taken to do such inking of the lines as gently and as sparingly as possible, since the burr is easily injured during the progress of an elaborate plate with the result that the earlier portions of the work may look quite different from the later. Another difficulty will be found in the varying degrees of sharpness of the point used. A steel point requires resharpening frequently, and the sharpening may not be exactly the same each time. This difference will be found reflected in the work. Diamond or ruby points work very smoothly when in good condition. They are, however, somewhat brittle and apt to flake away in strong crosshatching or by striking the edge of the plate.

The point, the burnisher and the scraper are the three instruments used in dry point; the use of the scraper is of much more importance than it is in etching since the burr can be wholly or partly removed by it and the whole significance of the line altered. Some artists even remove the burr altogether and depend on the "nervous" character of the dry-point line for their effect.

Characteristics.—One great disadvantage of dry point is the difficulty of obtaining a large number of prints of equal excellence because of the delicate character of the work compared with etching or line engraving. This was largely overcome by the practice of steel-facing the plate before printing. It led to the mixed plate, where dry point is strengthened and stiffened by engraved lines done with the burin. The result is work obviously clearer and firmer in character than many pure dry points, but lacking the particular charm of the best dry-point prints where spontaneity and vivacity (not characteristics of the burin) are most important assets. The best qualities of the two mediums are really incompatible. It is difficult to imagine a burin line introduced into the masterpieces of dry point without producing fatal results. Dry point is also used to lend to etched plates a warmth or accent, or simply as the easiest method of making necessary additions. The difficulty then is that the dry-point lines wear out under the pressure of printing much earlier than the etched lines, and it becomes necessary to renew the dry-point work from time to time. From the pictorial point of view dry point has the disadvantage of producing a picture too often out of tone and spotty, because of the somewhat accidental emphasis of the burr. From the point of view of style the dry-point needle is capable of too many different kinds of strokes; yet these difficulties only add to the fascination of trying to overcome them as they have been overcome by the great masters of the art.

Because of its very simplicity, dry point is a peculiarly autographic medium, very sensitive to the display of the temperament of the artist. All etched work bears a strong family resemblance, and still more so work with the burin. But a collection of the best dry points shows an astonishing difference in the mere appearance of the lines. This is the great fascination of the craft, since a peculiarly personal style has been attained in it again and again. It is as responsive to as many styles as drawing itself, to which it is the nearest of all methods of making prints. There is no chemistry to overcome—no accidentals—the old gibe, leveled at etching, of "a blundering art" does not apply. Any artist who draws interestingly can probably with a little practice be a good dry pointer—it is as simple as that. Hence every draftsman should at least attempt the medium and new triumphs of individual method in dry point may yet have to be recorded.

Steel Facing.—The question of steel facing is surrounded by a prejudice in the eyes of collectors because it allows larger editions to be printed. The old steel facing was heavy and clumsy compared with the modern method, and must have injured the dry point on its application. Then, too, editions used to be printed from the copper and only after that steel-faced for a commoner kind of print. And the steel-faced plate being considered foolproof was handed over to unintelligent printing—the fact not being recognized that a steel-faced plate really requires more and not less care in printing; the delicate tones of the printing ink are more difficult to estimate with nicety on the less "sympathetic" surface of the steel. Still, it is true that for certain plates requiring delicate tones of printing ink to supplement the line work, steel facing is not appropriate. If steel facing is determined on, this should be done immediately after the plate is completed. It should be remembered that the cleaner the plate and its lines have been kept during working the better, since the plate has to be made chemically clean before the electrosteeling, and the smaller the amount of cleaning required the better for the preservation of the burr and the delicate lines.

Printing.—Printing dry points is a difficult art, for the line

and its burr lends itself to many different styles of printing. Care should be taken to give a clearness and purity to lines which easily become clogged and heavy. The aim should be, while retaining the ink caught by the burr, to remove all the smudginess and heavy tone between the lines. This can best be done by repeated hand wiping of the plate from all directions while the plate is fairly warm. Dry-point printing—or rather the preparation of the plate for the press—is thus a much slower process than etching printing, as so much more careful hand wiping is required. *Retroussage* should be sparingly used, since the ink on the burr is easily smudged. A soft paper shows a dry point to best advantage.

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DRY ROT, a term applied to a type of wood decay often found in houses and caused by fungi of the class Basidiomycetes, the mushroom group (*see* FUNGI). The wood becomes lighter in weight, weaker and less elastic, so that when struck it emits a muffled sound and snaps readily. In more advanced stages the wood may warp, show cracks (cross-shakes) at right angles to the grain and tend to soak up available liquids. The causal fungus does not attack living trees.

Merulius lacrymans is the common species causing dry rot in Europe, whereas in North America *Poria incrassata* is the common causal agent. These fungi belong to the Polyporales or pore fungi, so-called because the underside of the fruiting body bears a layer in which are thousands of small holes or pores. Most members of the Polyporales are tough to woody, and the pileate forms are popularly called bracket fungi.

The fungus plant is composed of spawn (mycelium) as in a mushroom. In the case of wood-rotting fungi, this spawn lives in the wood and feeds on it by liberating enzymes that digest the materials of which the wood is made. This process goes on outside the threads of the spawn. The digested material is then absorbed by the fungus and used to produce more spawn and, eventually, also a fruiting body. This process goes on until all the food material present in the wood has been used up by the fungus. Then the fungus dies.

The fruiting body varies in its characters, depending on the species to which it belongs. That of *Merulius lacrymans* is pliant to nearly membranous and has broad, shallow cavities (pores) on the undersurface, the edges of which may be beaded with the drops of a liquid that is not pure water but instead a rather well-buffered mineral salt solution (hence the name *lacrymans,* from the Latin for "tears"). Clavate cells form a palisade over the inside surface of the pore, and these bear spores that are discharged and carried away by air currents. Some alight on surfaces that can serve as a source of food, and here they germinate and initiate the process known as decay.

Dry-rot fungi have an additional means of moving from one place to another. The main body of the mycelium is in the rotting wood, but a second type is produced in the form of ropelike strands, called rhizomorphs, that grow out and away from the parent spawn to some location often several feet away. Such strands have been known to penetrate brick walls, and since they may carry excess water with them, they can attack and decay perfectly dry wood.

Contrasting such "contagious" species, there are many merely "infectious" kinds typically living only in the interior of the wood until they fruit. This internal decay may be difficult to detect unless the wood is bored for a sample.

Treatment.—Two important procedures are used to combat dry rot: sanitation and fungicidal treatment.

Sanitation.—This is the cheapest method of combating dry rot, but is often ineffective if the treatments are not continued. Any process that retards or inhibits the growth of the mycelium, short of applying specific chemicals to kill it, comes under this heading. Since high humidity, a source of adequate moisture and proximity to living mycelium or exposure to infection from spores are the conditions that favour development of the mycelium, it follows that sanitation techniques are devised to produce the opposite conditions; *i.e.,* low relative humidity, lack of adequate moisture, removal of all wood debris to get rid of any potentially harmful mycelia and covering of all wood surfaces so that germinated spores cannot penetrate the wood and initiate decay.

Regulation of moisture is of first importance. In the construction of buildings great care must be used to select well-dried lumber. If there is no basement, there must be good ventilation between the floor and the earth. Wood should never be in direct contact with the soil. This is important both from the standpoint of wood decay and activity of termites. In warm or humid regions untreated wood should not be closer to the soil than 18 in. at any place. Standing water near a building can be a hazard. Wood should never be thrown in the pit around a house as a fill because it will serve as a source for mycelium. Dry-rot fungi can thrive on such material, and their rhizomorphs can grow out and into the wood above the basement masonry.

Plumbing should be watertight; leaks will cause the adjacent wood to take up moisture and hence cause decay. If wood flooring is laid directly on a concrete slab in contact with the soil, sweating will occur and decay can be expected. Fungi causing dry rot may grow luxuriantly on the hidden faces of floor boards, panels and skirting boards without being visible on the exposed surfaces.

Once a fungus is established, merely cutting off the current source of moisture will not kill the spawn. In the process of digesting wood, water is a by-product, and a species such as *Merulius lacrymans* can continue to grow on the water produced by the decay. If infected wood is thoroughly dried at relatively low temperatures, the mycelium may simply remain dormant until moisture conditions again become favourable.

Fungi causing rot are active only within certain ranges of temperature. Low winter temperatures in temperate regions will not kill spores or mycelia of wood-rotting fungi. High temperatures (over 50° C.) are much more effective. Hence local infection in a building may be treated by application of relatively high temperatures for short periods of time; with this method, however, it is difficult to be sure that all the mycelium has been killed.

Antiseptic (Fungicidal) Treatment.—Compounds that render wood unsuitable for fungus growth are classed as preservatives. Compounds that actually kill the fungus already in the wood are called fungicides. The most familiar preservative is the so-called coal tar "creosote oil" used on railway ties (sleepers), paving blocks, telegraph poles, etc.; it is not used on wood in homes because of its odour. The method of treatment is as important as the preservative used. Sapwood, which generally decays more readily than heartwood, should be completely permeated. Heartwood should be permeated with the preservative to a depth of at least ¼ in. and preferably more.

Penetration is accomplished by applying the preservative under pressure within a container.

A good preservative should (1) have high penetrating ability; (2) not be dangerous to handle; (3) be odourless (for most uses); (4) not increase fire risk; (5) not leach out readily; (6) not make painting difficult; (7) be inexpensive. Preservatives may be grouped into three general classes: (1) oils or mixtures of oils of low volatility and only slight solubility in water; (2) inorganic salts and similar substances that can be used in water solution; and (3) toxic chemicals dissolved in something other than water. Corrosive sublimate, a fungicide, should not be used in a house because it is highly poisonous. Merely painting a preservative or fungicide on the surface of the wood is seldom effective for any length of time. (AR. H. S.)

DRY TORTUGAS, the last eight in a long string of coral islands, or keys, and sand bars that extend westward from the tip of Florida, U.S., into the Gulf of Mexico. In 1513 Juan Ponce de Leon discovered these islands 65 mi. W. of Key West and named them Las Tortugas because of the numerous tortoises in the area. Later, mariners added the word "dry" because of the lack of fresh water in the group. In 1825 the U.S. government built a lighthouse on Garden Key, and in 1856 the lighthouse on Loggerhead Key was erected. The construction of Fort Jefferson began in 1846. Though building continued for 30 years, the massive fortification that was one-half mile in perimeter and covered most of

Garden Key was never finished. The fort remained in federal hands during the American Civil War and served as a prison until 1873. The Tortugas possess abundant bird and marine life, and in 1935 Fort Jefferson, the islands and a surrounding water area of 75 sq.mi. were proclaimed a national monument. (J. E. D.)

DUALA, a west African people of Cameroon, who live on the estuary of the river Wuri (earlier known as the Cameroons river). In 1949, I. Dugast quoted an indigenous population of 22,927, of whom the great majority live in the modern town of Douala (total population [1949] 59,899; [1956] 125,000), which grew from their original settlement. They belong to the most northwesterly branch of the Bantu-speaking peoples. Their language is well documented, J. Ittmann's being the definitive grammar. Traditionally they are said to have migrated from the east and south, displacing the Bakoko-Basa, possibly before the end of the 17th century. The Wuri (Oli), Limba and other neighbouring tribes claim relationship. The Wuri estuary supports a fishing and agricultural economy (oil palms, cassava, cocoyam, plantain, maize).

By 1800 the Duala controlled the Cameroons' trade with Europeans, and their concentrated settlement pattern developed under this influence. The Duala have a patrilineal descent system (there may have been an older double-unilineal system) and are remarkable for a system of chieftaincy partly founded on trading wealth. For much of the 19th century there were two politico-commercial "kingdoms," Bell and Akwa. By 1884, however, when their kings signed the treaties with the Germans which led to the establishment of the Kamerun protectorate, they were already weakened and under competition from other formerly subordinate lineages. The position of associations ("secret societies") as instruments of social control may be noted. By 1961 the great majority of Duala were nominal Christians. Before Christianity the religious system recognized a "High God" but no further pantheon and no true shrines or priests; other beliefs concerned the power of ancestors, witchcraft and impersonal fetishes; influences from the Ekoi people of the Cross river were strong. Many Duala are now found in various urban occupations. In the 1960s the chiefly houses remained an elite, some members being active in politics, but their influence was waning. *See* also CAMEROONS.

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DUALISM is a term first used by Thomas Hyde in his *Historia religionis veterum Persarum* (1700) to denote the fact that the ancient Persian religion knew two supreme principles, one good and the other evil. Christian Wolff later applied it in his exposition of Cartesian (*q.v.*) metaphysics. But the words dualism and dualistic are liable to multiple connotations. Generally speaking, they refer to any system which, in the interpretation of the universe as a whole or of some particular aspect of reality, postulates the existence of two heterogeneous and irreducible principles; for example, God and the world, matter and spirit, being and thought, or good and evil. In asserting that certain opposed terms are dualistic, the intention is not merely to acknowledge their dissimilarity but primarily to insist on the irreducibility of their difference. A dualism is said to be relative if one term is held to be subordinate to, derivative from, explicable by or in any manner dependent for its being upon the other; if neither term is held to be dependent in any such sense, then the dualism is absolute.

In Comparative Religion.—A certain kind of dualism is implied in every religion by the simple fact that the *sacred* is considered to be radically different from and opposed to the *profane*. Moreover, all polytheistic religions recognize a class of supernatural beings (such as demons, Titans, monsters) which are different from and antagonistic to the gods. Even within a single pantheon of divinities there may be noted a tension and a conflict between the celestial and the terrestial or chthonian gods; such is the case, for instance, in Germanic mythology, with the Asen and the Vanen. A very characteristic type of religious dualism is illustrated by a cosmogonic myth widely diffused in central and northern Asia and among the North American tribes: a demonic being or a demiurge attempts to collaborate with God in the creation of the world, either finishing the creation or spoiling it by introducing suffering and death. This type of cosmogonic myth, which is a desperate effort to explain the imperfections of the world and the existence of evil, is not dependent upon Iranian dualistic influences.

The extreme form of religious dualism is to be found in ancient Persia, though not so much in the original teaching of Zoroaster as in later Zoroastrianism, and especially in Iranian gnosticism and in Manichaeism (*q.v.*). Zoroaster proclaimed an irreducible opposition between Ahura Mazda, the Wise Lord (or Ormazd, as he later came to be called), and Angra Mainyu, the Evil Spirit (or Ahriman). Ahura Mazda incarnates truth, righteousness and order, while Ahriman represents the lie, unrighteousness and disorder. But Zoroaster also pointed out that Ahriman has freely chosen to do evil, thus bringing misery, illness and death into the world; hence, for Zoroaster, dualism is the result of the free choice of the two supernatural beings. Later Zoroastrianism presented Ormazd and Ahriman as two coeternal principles of good and evil: one is good by virtue of his very mode of being, the other is evil; one is the creator, the other is the destroyer. Manichaeism took over this pessimistic valuation of late Mazdean dualism, and blended it with the gnostic myth of the corrupted creation.

Under the influence of Iranian eschatology, dualistic elements found their way into the Jewish apocalyptic (*see* APOCALYPTIC LITERATURE). The Qumran texts exalt the "Sons of Light" combating the "Sons of Darkness." But, unlike the Iranian figures, the two rival angels guiding the human armies are God's creatures. The New Testament utilizes some old dualistic formulas, but in a different sense. Antithetical terms such as new and old, inner and outer man, pneumatic and psychic body are not the expressions of a dualistic anthropology but rather phases in the history of salvation. Christian dogma denounced dualism as a heresy and condemned it repeatedly in Marcion, in Manichaeism, etc. Though Christianity accepts a radical difference between good and evil, it rejects a metaphysical dualism. In Roman Catholic theology, God and creature, Spirit and matter, etc., are only different modalities in the absolute unity of being.

In Philosophy.—The Chinese cosmological conception of *yin-yang* can be interpreted as a presystematic dualism. *Yin* represents the feminine, passive and negative principle and *yang* the masculine, active and creative principle. The interplay of these contrasting but complementary forces engenders and sustains the universe. In India, the irreducible heterogeneity between the body and the self constitutes the central theme of the speculations of the Upanishads. The same problem plays a most important role throughout the history of Indian philosophy. The Sankhya and Yoga systems, for instance, have elaborated a radical and very coherent dualism. On the one hand there is *prakrti*, the dynamic and creative Substance; on the other, *purusa*, the autonomous and transcendent Self. Both principles are real and eternal. The whole creation of inanimate and animate beings, as well as all psychomental experiences, is the emanation of *prakrti*. Similar views are held by Jainism and Buddhism, with the difference that Buddhism does not recognize the existence of an autonomous spiritual principle, a "Self," corresponding to *purusa*.

A philosophical dualism of a rather Platonic structure was also elaborated by the Iranian Zervanists, who held that every terrestrial phenomenon has its counterpart in some celestial, transcendent and invisible phenomenon.

Empedocles reduced the totality of existence to two antagonistic principles, love and hate. Anaxagoras tried to explain the world by the interplay of passive Substance and the Logos. This metaphysical dualism survives in the system of Plato and Aristotle; *i.e.*, an eternal and passive Substance confronts the Supreme Intelligence. For Plato, the intelligible world is separated from and opposed to the sensible world; the pre-existent soul is forcibly united with the body. The ideal world, though transcendent, is not hostile to the material one; there is a duality rather than a dualism. Neoplatonism, however, accentuated the opposition between spirit and matter, soul and body, reason and the senses.

For Descartes (*q.v.*), body and mind, *res extensa* and *res cogitans*, are in their intrinsic natures irreducibly heterogeneous. Neither interacts with the other, neither derives from or in any way depends upon or is explicable by the other. Their duality is absolute. Even so, neither mind nor body is self-sustaining; each depends for its existence on something else of quite a different nature—that is to say, on God, who alone is absolutely and unconditionally existent. Spinoza (*q.v.*), while retaining Descartes' absolute duality of the physical and the mental, makes body and mind both depend on an ultimate uncaused existent (*Deus sive Natura*) as a part depends on its whole (in contrast to the Cartesian dependence upon a separate third existent). For *Natura*, Spinoza holds, is itself diversified into innumerable interdependent parts ("modes"), each at once doubly manifested in parallel orders, the physical and the mental. Certain constellations of those parts manifested in one order are bodies, the same manifested in the other are minds. This parallelism involves an absolute dualism which denies interaction between the mental and physical.

Leibniz (*q.v.*) retains the dualism of matter and mind, combining it first with a relative dualism of appearance and reality, then with a final, major dualism of God and the world. A gnosiological dualism of appearance and nonapparent reality ("phenomena" and "noumena") underlies the whole critical philosophy of Kant (*q.v.*). His moral philosophy introduces two further dualisms: those of practical reason and desire, and of reason and faith. *See* Body and Mind; Occasionalism; Pluralism and Monism; Pre-Established Harmony; *see* also references under "Dualism" in the Index volume.

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DUALITY. A statement capable of two different meanings, both of them true, one obtained from the other, by simply interchanging two words, is an illustration of the principle of duality. An important application of the principle is found in projective geometry. In the plane this is accomplished by interchanging the words "point" and "line"; it is well illustrated by the theorem of Pappus, which may be stated as follows:

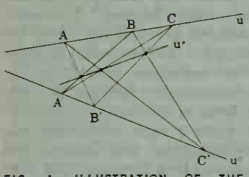

FIG. 1.—ILLUSTRATION OF THE THEOREM OF PAPPUS

Given any two straight lines u, u′ in the plane; choose any three points A, B, C on u, and any three points A′, B′, C′, on u′. The three points of intersection AB′, A′B; AC′, A′C; BC′, B′C lie on a straight line u″ (*see* fig. 1). The dual theorem is:

Given any two points U, U′; draw any three lines a, b, c through U and a′, b′, c′ through U′. The three lines joining the points ab′, a′b; ac′, a′c; bc′, b′c all pass through a point U″ (*see* fig. 2). If the first proof has been established, the second follows by duality, since the determining elements of lines in terms of points are identical with those of points in terms of lines. The principle was first recognized by J. V. Poncelet in the *Journal für Mathematik* (1829), and by J. D. Gergonne in the *Annales de Mathématiques pures et appliquées* (1825–27), and first generally applied by J. Steiner in his *Systematische Entwickelungen* (1832).

In geometry of three dimensions there is a corresponding duality between points and planes. In this case the line is self dual, as it is determined by any two distinct points on it or by any two distinct planes through it.

Many other illustrations of the principle can be given. A geometry can be constructed in the plane by replacing the word "line" wherever it occurs in a proposition by the word "circle," if the circle associated with any given line is constructed as follows: Given a fixed circle C with centre O. Let a given line meet

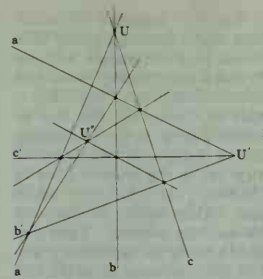

FIG. 2.—ILLUSTRATION OF THE DUALITY OF THE THEOREM OF PAPPUS

it in A, B. Draw the circle through A, B, O. After this has been done for every line, think of the point O being removed from the plane. The resulting system of incomplete circles furnishes a non-Euclidean interpretation of plane geometry. The line-sphere transformation of Lie is an illustration of a complete duality between lines and spheres in space. Much of higher geometry is concerned with the principle of duality; every new application practically doubles the extent of existing knowledge. *See* also Projective Geometry.

DUAL ORGANIZATION. The basic feature of dual organization is the division of a society into two complementary parts called moieties. Often associated with this social division is a wider dualism which relates natural phenomena to the moieties, as among the Caingang of South America who divide up the entire cosmos and associate the parts with one or the other of the moieties. Dual organization is commonly found in Australia, Melanesia, Indonesia, Assam, North America and South America. It also occurs in tribal India, western Siberia and in parts of Africa. Dual divisions occur in two basic forms: as a feature of social organization related to but not necessarily determining the regulation of marriage (kinship moieties), and as a ceremonial organization. Usually the two forms are combined, but in some cases only one form occurs or the two forms appear concurrently as separate systems. The Canella of South America have four dual schemes, one of which regulates marriage while the other three are independent ceremonial groupings.

Kinship moieties are ordinarily unilineal exogamous divisions whose members consider themselves to be blood relations. Membership is thus determined by birth and descent, through either the father or mother, and a person must marry outside his moiety. Variant rules occur, such as that among the Fox of North America where the first child belongs to the division opposite that of his father and then membership alternates, each successive child belonging to the moiety opposite that of his preceding sibling. On a world-wide basis, matrilineal moieties are far more common than patrilineal moieties. In general, moieties are found in association with smaller kin groups such as lineages and clans.

Where exogamous unilineal moieties embody the same rule of affiliation as smaller kin or local groups in the society, as for example, patrilineal moieties and patrilineal clans, the moieties group together such smaller segments into two opposed divisions. If the rule of affiliation in moieties is other than that employed in smaller kin or local groups, as with matrilineal moieties and patrilineal clans, then the moiety divisions crosscut the other groups, as in the section systems of Australia where adjacent generations in any one local descent group belong to opposite moieties.

Occasionally, dual organization with endogamous or nonexogamous moieties is reported. In many but not all such cases where adequate information is available, it appears that the in-marriage possibility is due to a shift from a previous rule of exogamy. Where dual organization is not associated with the regulation of marriage, the principles determining membership vary from group to group.

Certain antitheses linked with dual organization recur in widely separate geographic areas: sun-moon; war-peace; white (or red)-black; upper-lower; male-female. The Creek Indians of the southeastern United States are divided into exogamous matrilineal moieties, phratries and totemic matrilineal clans with the entire tribe dichotomized into upper and lower divisions and a division of towns into red and white, the former associated with war and the latter with peace. Often the dual divisions are given geographic expression by localizing the moieties in different sections of the settlement, as among some of the Ge peoples of Brazil.

Moieties may be of unequal status in a given society and reci-

procity may be incomplete. C. Lévi-Strauss has suggested that dual organization should be viewed as a triadic structure in which the two sides are opposed not to each other, but to a centre.

Functions.—The functions of the dual organization vary from society to society, but usually the moieties interact reciprocally. In the case of exogamous kinship moieties, men from one moiety receive their wives from the other. Reciprocity may involve services, as when one division assists in initiations or disposal of the dead for members of the opposite side. Particularly in North and South America, the moieties frequently furnish teams for competitive sports. Rivalry is a common feature of intermoiety relations, and in some areas the two groups may be hostile to one another. In the Banks Islands and in the northern New Hebrides in Melanesia, the members of one division are assumed to be clever and peaceful while those of the other are ignorant and quarrelsome. Dual organization does not generally enter directly into political affairs, but there are numerous exceptions. The council of the Iroquois of North America was organized on a moiety basis, the members of one moiety assembling on one side and those of the opposite moiety assembling on the other. Iroquois moieties adjudicated in disputes as representatives of their respective clans.

In all cases, whether the moieties are exogamous or nonexogamous, unilineal or not, or whether they are aligned on the basis of season, geographic position, name bestowal or other criteria, these dichotomies serve to divide society into two opposed parts which channel reciprocal rights and duties, competition and co-operation, and thus function as integrative devices.

Theories of Origin.—A common assumption is that kinship moieties, phratries and clans are kin groups of essentially the same order. Moieties differ from the other groups in that there are only two in the society. Phratries comprise two or more related clans, there being more than two such groupings in the society. This assumption of similarity underlies theories of origin which attribute moieties to the fission or fusion of kin groups such as clans.

However, certain characteristics distinguish moieties from clans. Clan members emphasize descent from a common ancestor. Members of a moiety, while regarding themselves as related, do not stress common descent although this may be implicit. In north Pentecost (New Hebrides) the moieties are named for two culture heroes, Tagaro and Supwe, and members of the respective moieties have traits characteristic of these two heroes. Despite this, it is never suggested that moiety members are descended from these supernatural beings. Individuals trace descent from the mythological founding ancestors of the matrilineal clans within the moieties. Clans function frequently as land-holding units and in co-operative economic enterprises; moieties do so rarely. (*See* CLAN.)

A second interpretation holds that kinship moieties are only coincidentally descent groups and thus are qualitatively different in origin from kin groups such as clans. According to this view, kinship moieties are structural phenomena automatically produced by the interaction of other features of a kinship system such as localized lineages or clans and symmetrical or matrilateral cross-cousin marriage. This sort of interpretation is employed especially to account for moieties which crosscut local descent groups (as in section systems) and which therefore cannot be attributed either to amalgamation or subdivision of such groups. Moieties of opposite linearity to other kin groups in the society may be implicit in the structure and unrecognized or unformulated by the society. This presumably accounts for some of the so-called implicit moieties in Australia, Melanesia and Indonesia. Where such divisions receive recognition, society may be segmented simultaneously in several ways including local unilineal descent groups divided into two large moieties with these crosscut by moieties of opposite linearity, as occurs frequently in Australia. Whether the moieties comprising local unilineal groups are regarded as descent groups or not, it seems clear that their origin and development differs from that of moieties which crosscut local unilineal groups. *See* also KINSHIP.

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(R. B. LA.)

DUARS (DWARS; DOOARS), a tract of country in northeast India divided by the Sankosh river into Western (Bengal) and the Eastern Duars. Both belonged to Bhutan before the Bhutan War of 1864–65, as a result of which they were ceded to the British. The Eastern Duars was assigned to Assam and the Western to Bengal. The Eastern Duars is in Goalpara district, Assam, forming a strip of flat country below the Bhutan mountains. It is only slightly developed and sparsely populated. The Western Duars lies at the foot of the Himalayas in northeast Jalpaiguri district, West Bengal. It is traversed by the North-Eastern railway and is an important centre of the tea industry.

DUARTE, JUAN PABLO (1813–1876), father of Dominican independence, determined to win freedom from Haiti for the Spanish-speaking portion of the island of Santo Domingo while studying in Europe (1828–1833). His first attempt in 1843 collapsed, forcing him to flee the country, but his followers succeeded in ousting the Haitians in Feb. 1844. Returning home, Duarte joined the government but a rift soon developed between his and an opposing faction which sought the protection of a European power. Defeated and exiled by Gen. Pedro Santana (*q.v.*), Duarte eventually established residence in Caracas, Venez., (1845), remaining there until recalled to his homeland in 1864 during the War of Restoration against Spain. Fearing his popularity, the provisional government despatched him on a diplomatic mission to South America. He served for about a year and then resumed his residence in Caracas where he died in 1876.

(K. M. S.)

DUARTE, a province in northern Dominican Republic. Area 499 sq.mi. Pop. (1960) 161,326. It occupies part of a wide alluvial lowland formed by the Camú river in the fertile eastern section of the La Vega Real valley and is one of the nation's most densely populated agricultural regions. Its numerous small farms produce nearly one-half of the nation's cacao, as well as significant quantities of rice, bananas, coffee and corn. Duarte has railroad connections with the port of Sánchez to the east on Samaná bay. The province was established in 1936. Its capital, San Francisco de Macorís (pop. [1960] 26,000), was founded in 1777.

(D. R. D.)

DU BARRY, MARIE JEANNE BÉCU, COMTESSE (1743–1793), the last and loveliest of the mistresses of the French king Louis XV, was born at Vaucouleurs on Aug. 19, 1743. Educated in a convent, she became a shop assistant in a fashion house in Paris, where she went under the name of Mademoiselle l'Ange, or Jeanne Vaubernier. There she became the mistress of Jean du Barry, a Gascon nobleman who had made a fortune as a war contractor. She was launched into the artistic world of the capital as the comtesse du Barry, though she had no right to the title, since her protector's wife was still alive. Her beauty captivated a succession of lovers before she attracted the attention of Louis XV in 1768. Du Barry, anxious that she should occupy the place of royal mistress, vacant since the death of Madame de Pompadour in 1764, arranged a nominal marriage for her with his brother Guillaume. This allowed her to be presented at court, after the death of the queen, on April 22, 1769. Apart from helping in the overthrow of the duc de Choiseul in Dec. 1770, Madame du Barry, unlike her predecessor, exercised little political influence at the French court. Louis XV made over to her the crown property of Louveciennes, near Marly, where she became a great patron of the arts. On the accession of Louis XVI (1774) she was banished to this estate, where, till the Revolution, she lived in retirement with the duc de Brissac (Louis Hercule Timoléon de Cossé). In 1792 she made several journeys to England to place her wealth at the disposal of

the *émigrés*. For this, and because she was accused of being in league with the British government, she was condemned to death by the Revolutionary tribunal and executed on Dec. 7, 1793.

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DU BARTAS, GUILLAUME DE SALLUSTE, Seigneur (1544–1590), French poet, author of *La Semaine* (1578), a popular and influential biblical epic on the Creation. Born into a prosperous merchant family at Montfort, near Auch, he lived chiefly on his estates, with occasional attendances at the court of Henry of Navarre, who, wishing to profit from James VI's high regard for his poetry, sent him on a diplomatic mission to Scotland and England in 1587. James had published a translation of his *L'Uranie* in 1584, and tried to persuade him to remain at his court. Du Bartas took only a reluctant and late part in the wars of religion and although his *Cantique de la Victoire à Ivry* (1590) has encouraged a belief that he fought there, this is incorrect. He died in July 1590 at Coudon.

A convinced Huguenot, Du Bartas long cherished the idea of writing an epic with a religious theme, to replace the literary paganism lately fashionable. His first epic, *Judith*, appeared in a volume with which he was later dissatisfied, *La Muse Chrétienne* (1574). The publication of *La Semaine* in 1578 made him admirers who placed him on a level with Pierre de Ronsard. His reputation was perhaps greatest abroad, where translations retained the grandeur of his range and vision while omitting his newly coined words and mitigating the many bizarre metaphors and awkward classical constructions which made the original unrestrained and graceless. Sir Philip Sidney began a translation of *Le Semaine;* Spenser, Joseph Hall and Jonson praised the poem highly; and Milton is said to have been influenced by it. *La Seconde Semaine* (1584) was intended to take the narrative beyond the birth of Christ but was never completed: the surviving portion shows more of the faults, particularly the didacticism, than of the merits of his earlier work.

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DUBAWNT, a river and lake of Mackenzie and Keewatin districts, Northwest Territories, Can. The Dubawnt river, mapped by J. B. Tyrrell in 1893, rises in Mackenzie district, northeast of Lake Athabasca, at a height of about 1,500 ft. It flows first in an easterly direction to Wholdaia lake before turning northeast to Beverly lake (140 ft.) on the Thelon river, which carries the water via Baker lake and Chesterfield inlet to Hudson bay; its total length is 580 mi.

The river flows through undulating country and connects many lake expansions. The largest one, Dubawnt lake, at 700 ft. above sea level, measures 60 mi. in north-south extent. Its 1,600 sq.mi. are covered with ice for most of the summer. East of the mouth of Kamilukuak river a 20-mi. long peninsula projects north from the south shore. Wholdaia lake (275 sq.mi.), second largest in the river course, is strewn with islands; others are Barlow lake, Carey lake and Wharton lake (180 sq.mi.). (An. Kr.)

DUBBO, a town on the Macquarie river in New South Wales, Austr. It lies 267 mi. by road N.W. of Sydney, with which it is connected by rail and daily air services. Pop. (1954) 12,009. First settled in the 1840s, it is the centre of an extensive wheat and wool-growing district that also yields fruit, vegetables and dairy products. Industries include flour mills and clothing manufacture.

DU BELLAY, GUILLAUME, Sieur de Langey (1491–1543), French soldier and writer, one of Francis I's cleverest diplomats, was born at the château of Glatigny, near Montmirail, of an Angevin noble family. The eldest of six brothers, he was educated at the Sorbonne, but became a soldier, fought in Flanders and in Italy and was taken prisoner with Francis I at the battle of Pavia (1525). Afterward he was employed by the king as a diplomat. He was concerned with the execution of the treaty of Cambrai between Francis I and the Holy Roman emperor Charles V and was also sent three times to England between 1529 and 1530. On the question of the English king Henry VIII's divorce, Guillaume, with the help of his brother Jean du Bellay (*q.v.*), obtained a decision favourable to Henry from the Sorbonne (July 2, 1530). From 1532 to 1536 he was principally employed in uniting the German princes against Charles V: he signed the treaty of Scheyern with the dukes of Bavaria, the landgrave of Hesse and the elector of Saxony in May 1532 and the treaty of Augsburg in Jan. 1534. During the war of 1536–37 between Francis and Charles, Du Bellay was sent on two missions to Piedmont. Having been governor of Turin for two years from Dec. 1537 he became governor of the whole of Piedmont in April 1540. At the end of 1542, overwhelmed by work, he returned to France and died near Lyons on Jan. 9, 1543. Rabelais, an eyewitness, has left a moving story of his death (*Pantagruel* iii, ch. 21, and iv, ch. 27). Charles V is said to have remarked that Guillaume du Bellay thwarted more of his schemes than all the rest of the French together.

Guillaume du Bellay, without joining the Protestants, defended them against their opponents. In 1534–35 he tried to bring about a meeting between Francis I and Melanchthon, and in 1541 he intervened in favour of the Vaudois. He was also the friend of many writers and scholars, including Rabelais, who stayed with him in Piedmont from 1540 to 1542. Du Bellay wrote, in the style of Livy, a history of the rivalry between Francis I and Charles V from 1521. Of this work, the *Ogdoades*, only fragments remain: the first part, covering the years 1515–21 in Latin (ed. by V. L. Bourrilly, *Fragments de la première Ogdoade*, 1905); and the rest in French (incorporated by Guillaume's brother Martin du Bellay in his *Mémoires*, 1st ed., 1569). The first four books of a preliminary history by Guillaume were published by Martin in 1556 as *Épitome de l'Antiquité des Gaules et de France*. The famous *Instructions sur le faict de la guerre* (1548), formerly attributed to Guillaume, are believed not to be his. There is a modern edition of the *Mémoires de Martin et de Guillaume du Bellay* by V. L. Bourrilly and F. Vindry, 4 vol. (1908–19).

See V. L. Bourrilly, *Guillaume du Bellay* (1905). (Ro. M.)

DU BELLAY, JEAN (*c.* 1492–1560), French cardinal and diplomat, one of the chief counselors of Francis I, was a younger brother of Guillaume du Bellay (*q.v.*). He was made bishop of Bayonne in 1526, a privy counselor in 1530 and bishop of Paris in 1532. Francis I also employed him as a diplomat, sending him on five missions to England between Sept. 1527 and Jan. 1534. Du Bellay also went to Rome in 1534 to defend the English king Henry VIII's divorce. He was made a cardinal in May 1535. Returning to France from a second mission to Rome in Feb. 1536, he was appointed lieutenant general of the kingdom during the war of 1536–37 between Francis I and the Holy Roman emperor Charles V. He was sent to the diet of Speyer in 1544 and took charge of negotiations with the German Protestants. During the last years of the reign, Du Bellay was in favour with the duchesse d'Étampes, Francis I's mistress, and received many benefices including the bishopric of Limoges (1541–44), the archbishopric of Bordeaux (1544–53) and the bishopric of Le Mans (1546–56).

On the accession of Henry II (1547), Du Bellay fell into disfavour. He spent the years 1547–50 mainly at Rome. After living in France from 1550 to 1553, he finally retired to Rome, where he became bishop of Ostia and dean of the Sacred College of Cardinals (1555). He died in Rome on Feb. 16, 1560.

Jean du Bellay played an important role as a protector of humanists and reformers. He was a friend of Guillaume Budé, whom he helped to persuade Francis I to found the Collège de France. Rabelais was his secretary and doctor, and other men of letters such as Étienne Dolet and the poet Salmon Macrin were indebted to him for assistance. His own writings include three books of Latin poems (printed with Salmon Macrin's *Odes* by Robert Estienne in 1546), and a defense of Francis I (1542). His correspondence is preserved in the Bibliothèque Nationale in Paris.

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DU BELLAY, JOACHIM (1522–1560), French poet and critic, member of the Pléiade, who with Pierre de Ronsard (*q.v.*) founded the French school of Renaissance poetry, was born at the château of La Turmelière, not far from Liré, near Angers, being the son of Jean du Bellay, seigneur de Gonnor, cousin-german of the cardinal Jean du Bellay and of Guillaume du Bellay. Both his parents died while he was still a child, and he was left to the guardianship of his elder brother, René du Bellay, who neglected his education, leaving him to run wild at La Turmelière. When he was 23, however, he went to Poitiers to study law, no doubt with a view to obtaining preferment through his kinsman the cardinal. At Poitiers he came in contact with the humanist Marc Antoine Muret, and with Jean Salmon Macrin (1490–1557), a Latin poet famous in his day. There too he probably met Jacques Peletier, who had published a translation of the *Ars poëtica* of Horace, with a preface in which much of the programme advocated later by the Pléiade is to be found in outline.

It was probably in 1548 that Du Bellay met Ronsard in an inn on the way to Poitiers, an event which may justly be regarded as the starting point of the French school of Renaissance poetry. The two immediately became fast friends. Du Bellay returned with Ronsard to Paris to join the circle of students of the humanities attached to Jean Dorat (*q.v.*) at the Collège de Coqueret. While Ronsard and Antoine de Baïf were most influenced by Greek models, Du Bellay was more especially a Latinist and perhaps his preference for a language so nearly connected with his own had some part in determining the more national and familiar note of his poetry. In 1548 appeared the *Art poétique* of Thomas Sibilet, who championed the cause of Clément Marot and his disciples and poured scorn on the sonnet and on newfangled ideas. The famous manifesto of the Pléiade, the *Défense et Illustration de la langue française* (1549), was at once a complement and a refutation of Sibilet's treatise. This book was the expression of the literary principles of the Pléiade as a whole, but although Ronsard was the chosen leader, its redaction was entrusted to Du Bellay. To obtain a clear view of the reforms aimed at by the Pléiade, the *Défense* should be further considered in connection with Ronsard's *Abrégé d'art poétique* and his preface to the *Franciade*. Du Bellay maintained that the French language as it was then constituted was too poor to serve as a medium for the higher forms of poetry, but he contended that by proper cultivation it might be brought on a level with the classical tongues. He condemned those who despaired of their mother tongue and used Latin for their more serious and ambitious work. For translations from the ancients he would substitute imitations. Not only were the forms of classical poetry to be imitated, but a separate poetic language and style, distinct from those employed in prose, were to be used. The French language was to be enriched by a development of its internal resources and by discreet borrowing from the Latin and Greek. Both Du Bellay and Ronsard laid stress on the necessity of prudence in these borrowings, and both repudiated the charge of wishing to latinize their mother tongue. The book was a spirited defense of poetry and of the possibilities of the French language; it was also a declaration of war on those writers who held less heroic views.

The violent attacks made by Du Bellay on Marot and his followers, and on Sibilet, did not go unanswered. Sibilet replied in the preface to his translation (1549) of the *Iphigenia* of Euripides; Guillaume des Autels, a Lyonnese poet, reproached Du Bellay with ingratitude to his predecessors and showed the weakness of his argument for imitation as opposed to translation in a digression in his *Réplique aux furieuses défenses de Louis Meigret* (1550); Barthélemy Aneau, regent of the Collège de la Trinité at Lyons, attacked him in his *Quintil Horatian* (1551), the authorship of which was commonly attributed to Charles Fontaine. Aneau pointed out the obvious inconsistency of inculcating imitation of the ancients and depreciating native poets in a work professing to be a defense of the French language. Du Bellay replied to his various assailants in a preface to the second edition (1550) of his sonnet sequence *Olive*, with which he also published two polemical poems, the *Musagnæomachie*, and an ode addressed to Ronsard, *Contre les envieux poëtes*. *Olive*, a collection of love sonnets written in close imitation of Petrarch, first appeared in 1549. With it were printed 13 odes entitled *Vers lyriques*. Du Bellay did not actually introduce the sonnet into French poetry, but he acclimatized it.

About this time Du Bellay had a serious illness of two years' duration, from which dates the beginning of his deafness. He had further anxieties in the guardianship of his nephew. The boy died in 1553, and the poet, who had up to this time borne the title of sieur de Liré, became seigneur of Gonnor. In 1549 he had published a *Recueil de poësies* dedicated to the Princess Marguerite. This was followed in 1552 by a version of the fourth book of the *Aeneid*, with other translations and some occasional poems. In the next year he went to Rome as one of the secretaries of Cardinal du Bellay. To the beginning of his four and a half years' residence in Italy belong the 47 sonnets of his *Antiquités de Rome*, which were rendered into English by Edmund Spenser (*The Ruins of Rome*, 1591). These sonnets were more personal and less imitative than the *Olive* sequence, and struck a note which was revived in later French literature by the comte de Volney and Chateaubriand. His stay in Rome was, however, a real exile. His duties were those of an intendant. He had to meet the cardinal's creditors and to find money for the expenses of the household. Nevertheless he found many friends among Italian scholars, and formed a close friendship with another exiled poet whose circumstances were similar to his own, Olivier de Magny. Toward the end of his sojourn in Rome he fell violently in love with a Roman lady called Faustine, who appears in his poetry as Columba and Columbelle. This passion finds its clearest expression in the Latin poems. Faustine was guarded by an old and jealous husband and Du Bellay's eventual conquest may have had something to do with his departure for Paris at the end of Aug. 1557. In the next year he published the poems he had brought back with him from Rome—the Latin *Poemata*, the *Antiquités de Rome*, the *Jeux rustiques* and the 191 sonnets of the *Regrets*, the greater number of which were written in Italy. The *Regrets* show that he had advanced far beyond the theories of the *Défense*. The simplicity and tenderness specially characteristic of Du Bellay appear in the sonnets telling of his unlucky passion for Faustine and of his nostalgia for the banks of the Loire. Among them are some satirical sonnets describing Roman manners and the later ones written after his return to Paris are often appeals for patronage. His intimate relations with Ronsard were not renewed; but he formed a close friendship with the scholar Jean de Morel, whose house was the centre of a learned society. In 1559 Du Bellay published at Poitiers *La Nouvelle Manière de faire son profit des lettres*, a satirical epistle translated from the Latin of Adrien Turnèbe, and with it *Le Poète courtisan*, which introduced the formal satire into French poetry. These were published under the pseudonym of J. Quintil du Troussay and the courtier poet was generally supposed to be Melin de Saint-Gelais, with whom Du Bellay had always, however, been on friendly terms.

A long and eloquent *Discours au roi* (detailing the duties of a prince, and translated from a Latin original written by Michel de l'Hôpital, now lost) was dedicated to Francis II in 1559, and is said to have secured for the poet a tardy pension. In Paris he was still in the employ of the cardinal, who delegated to him the lay patronage which he still retained in the diocese. In the exercise of these functions Joachim quarreled with Eustache du Bellay, bishop of Paris, who prejudiced his relations with the cardinal, less cordial since the publication of the outspoken *Regrets*. His chief patron, Marguerite de Valois, to whom he was sincerely attached, had gone to Savoy. Du Bellay's health was weak; his deafness seriously hindered his official duties; and on Jan. 1, 1560, he died in Paris. There is no evidence that he was in priests' orders, but he was a clerk and as such held various preferments.

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Merrill, *The Platonism of Du Bellay* (1925); J. Vianey, *Les 'Regrets' de Du Bellay* (1930); V. L. Saulnier, *Du Bellay. L'homme et l'oeuvre* (1951).

DUBLIN (Atha Cliath), a county of the Republic of Ireland, in the province of Leinster, is bounded north by County Meath, east by the Irish sea, south by County Wicklow, and west by counties Kildare and Meath. The area is 311 sq.mi. and the population (1961) 180,668, apart from Dublin city (area 44.5 sq.mi.; pop. 535,488). The county includes the borough of Dun Laoghaire (*q.v.*) and, though one of the smallest counties, is among the most populous in Ireland. Of the population the great majority are Roman Catholics. The central and northern portions of the county are low-lying and composed chiefly of Carboniferous Limestone, with some Millstone Grit to the north and northwest, and some Silurian and Ordovician rocks behind Balbriggan. The peninsula of Howth, connected by a raised beach with the mainland, is formed of old quartzites and shales, crushed and folded, and probably of Cambrian age. The rocks of the county show many signs of ice action, and Leinster granite underlies the whole southern part as far north as Blackrock.

The mountains which occupy the southern border of the county are the extremities of the great group belonging to adjacent Wicklow (*q.v.*). The principal summits are Glendoo (1,919 ft.) and Two Rock (1,699 ft.) within the county, and the border group of Kippure, reaching in that summit a height of 2,473 ft. The mountains are chiefly covered with heath, except where a subsidence in the ground affords a nucleus for the formation of bog, with which about 2,000 ac. are covered. There are also a few small tracts of bog in the northern part of the county. The mountain district is well adapted for timber. The northern coast of the county from Balbriggan to Howth has generally a sandy shore, and affords only the small harbours of Balbriggan and Skerries. But in the promontory of Howth, the coast suddenly assumes a bolder aspect. Between the town of Howth and the rocky islet of Ireland's Eye an unsuccessful artificial harbour was constructed; Dun Laoghaire harbour on the south side of Dublin bay superseded this and is by far the best in the county. The chief river is the Liffey, which rises in the Wicklow mountains about 12 mi. S.W. of Dublin, flows through the city and into Dublin bay. The course of the river is so tortuous that 40 mi. may be traversed and only 10 mi. gained in direction.

Among early remains, raths or domestic earthworks are frequent and there are also dolmens and round towers, notably that of Clondalkin and the example at Lusk, incorporated in a later church tower by medieval builders. The ancient church of St. Doulough's with its stone roof, and the 15th-century castle at Dunsoghly are also noteworthy. Malahide castle, near the coastal resort of Malahide, was founded in the 12th century by Richard Talbot and still remains in the possessions of his descendants. Lord Talbot de Malahide (d. 1948), a great-great grandson of James Boswell (*q.v.*) sold to an American the collection of Boswell manuscripts which were acquired by Yale university in 1950. They contain many passages suppressed by Boswell before publication of his *Life of Samuel Johnson* and other items relating to contemporary figures.

Dublin is among the counties generally considered to have been formed in the late 12th century by King John. It comprised the chief portion of country within the English pale. The limits of the county, however, were uncertain and underwent many changes before they were fixed. As late as the 17th century the mountainous country south of Dublin offered a retreat to the lawless, and it was not until 1606 that the boundaries of the county received definition in this direction, along with the formation of County Wicklow. Although so near the seat of government, much land was forfeited in the Civil War of 1641 and in the revolution of 1688. In 1867 the most formidable of the Fenian risings took place near the village of Tallaght, about 7 mi. from the city. Because of its proximity to the capital, with which its history is closely associated, the county was the scene of much sporadic fighting in the troubled years between 1914 and 1922. The gun-running by Nationalists, in answer to that already carried out by Unionists at Larne, took place at Howth in June 1914, and numerous incidents followed until peaceful conditions returned after the establishment of the Irish Free State.

Administration is by a county council and a county manager. Dun Laoghaire is a borough with its own corporation and Balbriggan is administered by town commissioners. County Dublin returns three members to *dáil éireann*.

Wheat, barley and potatoes are the principal crops, but livestock breeding, especially cattle, receives greater attention. There is manufacture of cotton hosiery at Balbriggan and chocolate and cement goods are made in the west of the county. There are some light industries, mostly established under protective tariffs. Several important railways converge upon Dublin city.

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(M. J. Co.; Hu. S.)

DUBLIN (Baile Atha Cliath), is a county borough, seaport and the capital of the Republic of Ireland. It lies on the bay of the Irish sea to which it gives its name at the mouth of the river Liffey, about midway on the eastern coast of the island and 64 mi. W. of Holyhead, Wales. The Gaelic name, meaning "Town of the Ford of the Hurdles," is used by the post office. Pop. (1961) 535,488.

The river Liffey divides the town into two almost equal parts, north and south Dublin, and is crossed by nine road bridges, two railway bridges and a footbridge. Dublin castle was built on a ridge overlooking the Liffey to the north and the low ground to the east. Within the limits of the old walls are found Christ Church cathedral, the city hall, municipal offices and several business premises. John Speed's map of 1610 gives a good idea of this settlement and also shows some buildings to the north of the river. With the exception of some of the churches, however, the buildings in the old centre of the city are themselves later than the 17th century. The castle was originally built in the first two decades of the 13th century, but nearly the whole of the extant structure is early 18th century or later. With the castle as a nucleus, but mainly to the east, the city developed regularly to the first half of the 19th century with wide streets and large squares, the most famous of the latter being Merrion square (1762 onward). To the northwest of Merrion square is Trinity college and to the southwest St. Stephen's green (which became a public park in 1880), while Grafton street, Dublin's chief shopping street, Dawson street, with the Mansion house and the Royal Irish Academy, and Kildare street run between them.

The Protestant cathedral of Christ Church, or Holy Trinity, to the west of the castle was founded by Sigtrygg, a Christianized king of the Norsemen of Dublin, in 1038. It was elevated to a deanery and chapter in 1541. In 1870, at the disestablishment of the Church of Ireland, St. Patrick's became the national cathedral and Christ Church became the diocesan cathedral within the Anglican communion. The building was restored in 1870–78 by G. E. Street, who rebuilt the choir and south side of the nave, following the model of the ancient building. The older parts are Transitional Norman and Early English in style. Among the tombs is that reputedly of Richard de Clare, 2nd earl of Pembroke, called Strongbow, the invader of Ireland by whom the earlier part of the superstructure (1172) was founded. Synods were occasionally held in the church, and parliaments also, before the Commons' hall was destroyed in 1566. There also the pretender Lambert Simnel was crowned in 1487.

A short distance south from Christ Church, outside the walled area, stands the cathedral dedicated to St. Patrick, founded about 1190 by John Comyn, archbishop of Dublin, in an attempt to supersede the older cathedral of Christ Church. However, there was an earlier church dedicated to the same saint. The building was burned about 200 years later, but was rebuilt. It is mainly Early English and has a 14th-century tower. At the Reformation St. Patrick's was deprived of its status as a cathedral, and the building was used for some of the purposes of the courts of justice. Edward VI contemplated changing it into a university but the project was defeated. In the succeeding reign of Mary I, it was restored to its original purpose. The installations of the knights

of St. Patrick were originally held there. St. Patrick's contains the grave and monument of Jonathan Swift, who was dean of the cathedral. Attached is Marsh's library, incorporated in 1707, the gift of Narcissus Marsh, archbishop of Armagh.

In the 18th and 19th centuries there was considerable growth to the north of the river where O'Connell (formerly Sackville) street is one of the principal thoroughfares. It was badly damaged in the Easter Monday rising of 1916 and again in 1922. Down its centre are many statues, among them the Nelson pillar, 134 ft. in height, with a statue of the admiral on the top. In nearby Marlborough street is the Metropolitan pro-cathedral (1816), the principal Roman Catholic church of the city. Farther to the east are the docks below O'Connell bridge, the widest road bridge. Westmoreland street continues to the south of O'Connell street, and where it meets Dame street, which leads up to the castle, are situated the Bank of Ireland and Trinity college. The Bank of Ireland was formerly the house of parliament. Its original portion was designed by Sir Edward Lovett Pearce in 1729, and faces College green as an Ionic colonnade with a central portico and two projecting wings. The eastern portico is by James Gandon, and this and the western portico are connected to the centre by quadrant walls with engaged columns as remodeled by Francis Johnston after 1803, when the bank bought the building. The octagonal house of commons was burned in 1792, but the house of lords survives and remains in its original condition, with tapestries of 1733. The parliament (*dáil éireann*) meets in Leinster house (1745) in Kildare street.

Of the later 18th-century buildings of Dublin the most important are the city hall, formerly the Royal exchange (1769–79), by Thomas Cooley, adjoining the castle, the bluecoat school (1773) by Thomas Ivory and the customhouse and Four Courts by Gandon, on the north bank of the river. The customhouse (1781–91) has a prominent riverside site and four decorated fronts, and is crowned by a slender dome. The Four Courts (central courts of justice) was begun in 1786 and finished in about 1800. Also on the riverside, it has a massive central colonnaded dome and wings enclosing two courtyards open to the river except for triumphal arcaded screens. Both the customhouse and the Four Courts were heavily damaged in the fighting of 1921–22, but were restored. Gandon's last work, the King's Inns (Inns of Court, begun 1795) survives intact. The most important building remaining from the 17th century is the Royal hospital, Kilmainham, in the western suburbs, which preceded the sister institution at Chelsea, London, being designed by Sir William Robinson in 1679, but is no longer devoted to its original purpose. Near the Four Courts is St. Michan's church, with an organ used by Handel. It is notable chiefly for the remarkable manner in which the bodies in the vault are preserved. Another church of interest is St. Werburgh's, which served as the castle chapel until late in the 18th century. Lord Edward Fitzgerald, a leader of the conspiracy of the United Irishmen in 1798, is buried there.

J. ALLAN CASH

THE FOUR COURTS ON THE RIVER LIFFEY, DUBLIN; LATE 18TH CENTURY

Cultural Institutions.—Trinity college, or the University of Dublin, founded in 1591, has a Palladian façade (1759) with statues of Oliver Goldsmith and Edmund Burke by John Henry Foley. Above the gateway is a hall called the Regent house. The first quadrangle, Parliament square, contains the chapel (1798), which has a Corinthian portico; the public theatre or examination hall (1787), where hang portraits of Queen Elizabeth I, William Molyneux, Burke, Bishop George Berkeley and other celebrities; and the wainscoted dining hall, also containing portraits. A beautiful campanile (1853) separates the square from Library square. The library, housed in a building (1712–32) by Thomas Burgh, is one of those scheduled in the Copyright act as entitled to receive a copy of every volume published in the United Kingdom. It has a notable collection of early Irish manuscripts, including the Gospel books of Kells and Durrow. In Library square are the oldest buildings of the foundation, dating in part from the close of the 17th century, and the modern Graduates' Memorial buildings (1904) which contain a theatre, library and reading room and the rooms of the college societies. Other buildings are the provost's house (1760), printing house (1734), the museum by Sir Thomas Deane and Benjamin Woodward (1857), the medical school buildings, including the Moyne Institute of Preventive Medicine (1952), and the 20th-century chemical laboratories. The college (recreation) park and fellows' garden are of considerable beauty. The college observatory at Dunsink, about 5 mi. N.W. of Dublin, was erected in 1785, and in 1791 was placed by statute under the management of the royal astronomer of Ireland. It is administered by the state. The magnetic observatory of Dublin was erected in 1837–38 in the gardens attached to Trinity college. The botanic garden is at Ball's Bridge, 1 mi. S.E. of the college.

In Kildare street stand the National library, with about 500,000 books, and the National museum, which is particularly rich in prehistoric gold ornaments and early Christian metalwork. The National gallery in Merrion square, founded in 1864, has a rich collection of moderate size. The principal learned society is the Royal Irish Academy (1786). The Institute for Advanced Studies (founded 1940) specializes in theoretical and cosmic physics and Celtic philology. The Royal Dublin society, founded in 1731, is known for the annual horse show which it promotes at Ballsbridge in August. The small Abbey theatre (*q.v.*; founded in 1904, burned in 1951) had an influence on world theatre far out of proportion to its size. The other distinguished theatre in Dublin is the Gate, founded in 1928.

Near St. Stephen's green is University college (nonsectarian), which occupies the site of the International exhibition of 1865. It is a constituent college, with Cork and Galway, of the National University of Ireland. Dublin is well known as a medical centre, the Rotunda hospital being the first maternity hospital to be established (1745) in the British Isles. In Phoenix park (1,750 ac.), formed in 1662 and lying west of the city, are the zoological gardens, founded in 1830 and one of the oldest in the world.

Trade and Communications.—Considering its size, Dublin has never been an important commercial or industrial centre. About the time of the English Civil War, the woolen trade flourished there, and Dublin woolens were widely known. The cheapness of labour attracted capitalists, who started extensive factories in that quarter of the town which came to be known as the Liberties. About 1700 the English parliament prevailed on William III to assent to laws directed against the Irish trade. All exportation except to England was forbidden, and the woolen manufacture soon decayed. Nevertheless, at the close of the 18th century there

were about 5,000 persons at work in the looms of the Liberties.

By 1715 parliament had begun to favour the manufacture of linen, and the Linen hall was built. The cotton trade was soon afterward introduced, and silk manufacture was begun by the Huguenots, who had settled in Dublin in considerable numbers after the revocation of the Edict of Nantes. Acts favourable to these enterprises were passed, and they flourished. English opposition arose again in the reign of George I, and in the reign of George III another restrictive act was passed which tended directly to the ruin of the manufacture. Dublin poplins, however, maintained their reputation. Dublin's principal export products are whisky and stout, the Guinness brewery, one of the world's largest, being a major tourist attraction. A considerable export trade, principally in agricultural produce, passes through Dublin from the country. The manufacturing industries of the city include mineral water (soft drink) works, biscuit making, glassmaking, cigarette making, foundries and shipbuilding. Many light industries arose following the tariff protection imposed in 1932.

By continual dredging a great depth of water is kept available in the harbour. The Dublin Port and Docks board, which was created in 1867 as successor to the old Ballast board of 1707, undertook considerable works of improvement at the beginning of the 20th century. These improvements, among other things, enabled vessels drawing up to 23 ft. to lie at low tide alongside the extensive quays which border the Liffey. The Alexandra tidal basin, on the north side of the Liffey, admits vessels of similar capacity. The Custom House docks on the north side have about 17 ft. of water. The Royal and Grand canals, connected with docks named after them, pass respectively to the north and south of the city, the one penetrating the central plain of Ireland on the north, the other following the course of the Liffey. Both join the river Shannon.

The direct route to Dublin from London is by rail to Holyhead from where there are steamers to Dun Laoghaire. Passenger boats also sail to Dublin from Liverpool and Glasgow.

Dublin is the centre of the Irish railway network. There are main lines running north to Belfast, Londonderry and Howth, southwest to Cork and Waterford and west to Galway and Sligo. The airport at Collinstown (5 mi. N.) was considerably enlarged in 1957. There are air services to other European capitals and, via Shannon airport, to New York.

Administration.—The county borough of Dublin is divided into 6 constituencies sending 24 members to *dáil éireann*. Dublin is governed by an elected corporation and a manager. The chief magistrate, originally called the provost and later the mayor, was known after 1665 as the lord mayor. He serves a term of one year and his functions are largely ceremonial. The corporation's powers are restricted to imposing rates, raising loans and making by-laws. Other functions are performed by the manager, a paid official who has power over all municipal officers and whose own removal is subject to central authority. Considerable attention has been devoted by the city government toward slum clearance and the provision of modern housing. More than 100 city charters, the oldest dating from the time of Henry II, are preserved by the corporation.

History.—The name of Dublin is corrupted from *Dubh Linn* and signifies "Black pool" after the colour of the Liffey waters. It is recorded that the inhabitants of Leinster were defeated by the people of Dublin in the year 291. Christianity was introduced by St. Patrick in the 5th century. The Norsemen appeared in the country as early as the close of the 8th century but Dublin was not taken until the 9th, when the first Norse king, Thorkel I (832), established himself strongly at Armagh. In 1014 Brian Boru, high king of Ireland, fought the battle of Clontarf against the Norse invaders, and although he, his son and a large number of his followers fell, the Irish won the battle. The Norsemen, however, reoccupied the city. Constant struggles with the Irish resulted in intermissions of the Norse supremacy from 1052 to 1072, at various intervals between 1075 and 1118 and from 1124 to 1136. The Norsemen were finally ousted by the Anglo-Normans in 1170. In 1172 Henry II came to Dublin and held his court there. Prior to his departure for England, Henry bestowed the government on Hugh de Lacy, having granted by charter "to his subjects of Bristol his city of Dublin to inhabit, and to hold of him and his heirs forever, with all the liberties and free customs which his subjects of Bristol then enjoyed at Bristol and through all England." A fresh charter was granted in 1207 by King John to the inhabitants of Dublin, who were constantly feuding with the native Irish. In 1216 Magna Carta was granted to the Irish by Henry III and in 1217 the fee farm of the city was granted to the citizens at a rent of 200 marks per annum. In 1227 the same monarch confirmed the charter of John fixing the city boundaries and the jurisdiction of its magistrates. During most of the medieval period Dublin was less the capital of Ireland than of the pale, a strip of varying width on the eastern seaboard settled by the English. At about this period many monastic establishments were founded.

During the invasion of Ireland by Edward Bruce in 1315–16 some of the suburbs of Dublin were burned to prevent their falling into his hands. The inroads of Bruce had been countenanced by native Irish ecclesiastics. Richard II erected Dublin into a marquisate in favour of Robert de Vere, whom he also created duke of Ireland. Richard entered Dublin in 1394, and after holding a parliament and making much courtly display before the native chieftains, returned to England. Five years later he revisited Dublin, where he remained a fortnight. In 1534 Lord Thomas Fitzgerald, "Silken Thomas," son of the lord deputy, the 9th earl of Kildare, organized a rebellion against the English government and attacked the city of Dublin itself, but later raised the siege.

In 1641, as the English Civil War approached, a conspiracy to seize Dublin castle was disclosed and the city was thus preserved for the king's party. However, there were risings among the Irish outside the city, which in 1646 they unsuccessfully besieged. The city had been put in a state of defense by the marquess of Ormonde, then lord lieutenant, but in the following year, to prevent its falling into the hands of the Irish, he surrendered it to Col. Michael Jones, commander of the parliamentary forces. In 1649 Ormonde was totally defeated at the battle of Baggotrath, near Old Rathmines, in an attempt to recover possession. The same year Oliver Cromwell landed in Dublin, as commander in chief under the parliament.

When James II landed in Ireland in 1689, after his expulsion from England, he held a parliament in Dublin, which passed acts of attainder against more than 3,000 Protestants. The governor of the city, Col. Henry Luttrell, at the same time issued a proclamation ordering all Protestants who were not housekeepers, excepting those following some trade, to depart from the city within 24 hours. After his defeat at the battle of the Boyne, James returned to Dublin for a few hours. William III on the following day proceeded in state to St. Patrick's cathedral to give thanks for his victory.

Dublin was the scene of many disturbances during the Irish struggle for independence. In 1783 a convention of delegates from all the volunteer corps in Ireland assembled in Dublin for the purpose of procuring a reform in parliament, but the house of commons refused to entertain the proposition. In May 1798 a conspiracy planned by the United Irishmen to seize the city was frustrated. The Act of Union of 1800 abolished the Irish parliament and temporarily reduced the status of the capital. The viceregal court, however, continued. In 1803 an insurrection broke out, led by Robert Emmet, but was immediately quelled. There was considerable agitation in 1848, following the famine, but little bloodshed. In 1867 the conspiracy of the Fenian organization came to light. The Habeas Corpus act was suspended at one sitting by both houses of parliament and about 960 arrests were made in Dublin in a few hours. Dublin castle was fortified; and the citizens lived in a state of terror for several weeks.

Although a neutral capital in World War II, the city was bombed by the German air force in May 1941. *See* also IRELAND; IRELAND, REPUBLIC OF.

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DUBNOW, SIMON (1860–1941), Jewish historian, social

philosopher and leading protagonist of Jewish autonomism, was born in Mtsislav, Belorussia, Sept. 10, 1860. He received a traditional orthodox Jewish education, but in his early teens he began to waver in his faith and turned to secular learning for authority as well as inspiration. He read avidly the works of the Haskalah and the Russian classics, and pursued the systematic study of western philosophy, history and the social sciences. He was profoundly influenced by the evolutionary positivism of Auguste Comte, H. T. Buckle and Herbert Spencer; the classic liberalism of J. S. Mill determined his political philosophy. In his intellectual maturing he spurned the way of revolutionary radicalism, and his sober realism led him also to reject political Zionism.

Dubnow was largely self-educated, and his professional life was always that of an independent writer. In 1882 he began his long association with the Russian-Jewish periodical *Voskhod*, to which he contributed in serial form many of his most famous scholarly and literary works. He remained in Russia until 1922, leaving because he detested the Bolshevik dictatorship. He settled in Berlin and lived there until the advent of Hitler forced him again into exile, when he went to Riga, Latvia. There he remained until he met his tragic death at the hands of the Nazis when they liquidated the Jewish population of Riga in Dec. 1941.

Dubnow brought to the study of Jewish history in eastern Europe the methods of western Jewish scholarship. He organized and supervised the collection of source materials for the history of the Jews in Russia and Poland. He was the first to subject Hasidism to systematic and objective study based upon source materials from both the Hasidim and their opponents. Dubnow abandoned the spiritualistic philosophy of history held by Graetz and the older Jewish historians for the sociological view. According to Dubnow, the Jews are not merely a religious community but possess the distinctive characteristics of a cultural nationality and as such create their own forms of autonomous social and cultural life. The history of the Jews is, therefore, a history of the succession of large autonomous centres. The mature fruition of Dubnow's historical studies is found in his monumental *Weltgeschichte des jüdischen Volkes* (10 vol., 1925–29). It was the first secular and purely scholarly synthesis of the whole course of Jewish history, free from dogmatic and theological trappings, fully cognizant of social and economic currents, and sane and realistic in its approach.

In keeping with his philosophy of Jewish history, Dubnow also developed his theory of autonomism, or Diaspora nationalism. As a humanitarian and cultural nationalist he rejected the way of Jewish assimilation, but he was also convinced that political Zionism was messianic and unrealistic. Most of the Jews, he maintained, would remain in the Diaspora. There, he held, they should oppose the political principle of the monolithic nation-state, which identifies state and nationality, and fight for the recognition of the autonomous rights of nationalities within larger multinational federations. The Jews, as such a cultural nationality, would also be entitled to national minority rights. In his famous "Letters on Old and New Judaism," published between 1897 and 1906, he subjected the various current idcologies of Jewish life to critical analysis, and formulated his own doctrine of autonomism. Dubnow's ideas came to be assimilated by almost all groups in Jewish life in eastern Europe and by leading figures in western Europe and the United States; and these inspired the activity in behalf of the minority provisions of the treaty of Versailles after the close of World War I, which granted minority rights to the Jews as well as to other national minorities, and which placed these minorities under the protection of the League of Nations. (*See* also DIASPORA.)

See *Nationalism and History, Essays on Old and New Judaism*, by Simon Dubnow, edited with biographical essay by Koppel S. Pinson (1958), for full bibliographical data. Other important works are: *History of the Jews in Russia and Poland*, 3 vol. (1916–20); *Geschichte des Chassidismus*, 2 vol. (1951); *Kniga zhizni*, 3 vol. (1934–35). (K. S. P.)

DUBOIS, (MARIE) EUGÈNE (FRANÇOIS THOMAS) (1858–1940), Dutch discoverer of Java man, was born at Eisden, Limburg, on Jan. 28, 1858. He studied medicine at Amsterdam, where he was appointed university lecturer in anatomy in 1886, and investigated the comparative anatomy of the larynx in vertebrates. He was, however, becoming more and more preoccupied with problems of human descent and attempted to obtain a government commission for paleoanthropological work in the East Indies, but without success. He therefore resigned his university post, against all advice, to become in 1887 military surgeon in the East Indies and, while stationed at Pajokumbu in Sumatra, began to excavate caves, first at his own expense, then with government support. Unsuccessful in his search for early human remains, he moved to Java, where in 1890 at Kedung Brubus near Trinil, he found a jaw fragment, the following year a skullcap and subsequently a thighbone, remarkable in that they represented a small-brained creature intermediate between ape and man which had already attained an erect posture. In 1894 he published his discovery as *Pithecanthropus erectus* (*see* PITHECANTHROPUS; MAN, EVOLUTION OF: *Pithecanthropus*). He returned to Europe in 1895, subsequently to become professor of geology at Amsterdam. Annoyed at criticism of his material, he withdrew it from all examination; and only in 1923, after an appeal by Henry Fairfield Osborn to the president of the Dutch Academy of Sciences, was Ales Hrdlicka invited to see the original bones. It was not until 1920 that Dubois published the finds he had made at Wadjak in 1889–90. He died at de Bedelaer on Dec. 16, 1940. (D. F. R.)

DUBOIS, FRANÇOIS CLÉMENT THÉODORE (1837–1924), French composer, organist and teacher, known for his technical treatises on harmony, counterpoint and sight reading. Born at Rosnay (Marne), on Aug. 24, 1837, he studied at Reims under the cathedral organist and at the Paris Conservatoire under Ambroise Thomas. After winning the Prix de Rome in 1861 he succeeded César Franck as organist at the church of Ste. Clotilde. In 1868 he was choirmaster at the Madeleine and later succeeded Saint-Saëns as organist there. He was professor of harmony at the Paris Conservatoire (1871–90), elected to the French Institute (1894) and followed Thomas as director of the Conservatoire (1896–1905). He wrote music of all types, including operas and choral and orchestral works. He died in Paris on June 11, 1924.

DUBOIS, GUILLAUME (1656–1723), French cardinal, the leading minister of the regent Philippe, duc d'Orléans, and the architect of the Anglo-French alliance of 1716, was born at Brive, in Limousin, on Sept. 6, 1656, the son of an apothecary. Entering the church, he rose to influence at the French court as a tutor to the families of the nobility. In this capacity he was entrusted with the education of the duc de Chartres, the future duc d'Orléans. When the latter, during the minority of Louis XV, became regent and effective ruler of France, Dubois, at the age of 60, saw his opportunity of rising to high civil and ecclesiastical office. He was a man of great ability and finesse with a flair for intrigue and a settled determination to become a second Richelieu. Unscrupulous in the choice of means and immoral in his private life, Dubois had great foresight and courage and some of the higher qualities of statesmanship. He sought and obtained political power by devoting himself to the promotion of the dynastic interests of his patron the regent, becoming his secret adviser and agent in matters of foreign policy.

Dubois conceived and largely carried out the idea of a diplomatic revolution, uniting France and Great Britain in an alliance which lasted from 1716 to 1731. This *rapprochement* was designed mainly in the dynastic interests of the house of Orléans in France and the house of Hanover in Great Britain. The ground for it was prepared, in July 1716, by Dubois' secret mission to The Hague, where he met the English minister James Stanhope. A further mission to Hanover a month later resulted in the conclusion of the convention of Hanover of Oct. 9, 1716. In this Dubois showed his willingness to sacrifice what were generally regarded as French interests by agreeing to expel James the Old Pretender from French soil, to destroy the fortifications of Mardyck, and to recognize the Protestant succession in England. In return Dubois only obtained the confirmation of the treaties of Utrecht and the guarantee of British support for the pretensions of the regent Orléans to the succession to the French crown, in case of the death of the young and sickly Louis XV. On Jan. 4, 1717,

Dubois induced the United Provinces to adhere to this alliance, which thus became the triple alliance, by reducing French tariffs on Dutch imported cloth.

In reward for these achievements Dubois was admitted as an official member of the French council of foreign affairs. Dubois then assisted Stanhope in associating the emperor Charles VI in the triple alliance in the effort to check Spanish aggressive designs in Italy and Swedish ambitions in Norway. The quadruple alliance of Aug. 2, 1718, concluded at London, once more provided reciprocal guarantees of the dynastic interests and claims of the houses of Hanover and Orléans. It attempted to reconcile Austrian and Spanish claims in Italy by allowing the emperor Charles VI to exchange Sardinia for Sicily and by conceding the duchy of Parma to Don Carlos, the eldest son of Philip V of Spain and his second wife Isabella Farnese. When Cardinal Giulio Alberoni, in control of Spanish policy, attempted to advance Spanish territorial ambitions unilaterally by invading Sardinia and Sicily, Dubois joined Great Britain in attacking Spain and forced Philip V to accept the terms of the quadruple alliance and to dismiss Alberoni in 1720. Also in 1720 the French sent representatives to Stockholm to persuade the Swedes to sign peace with the Russians, which they did at Nystadt in 1721.

Timely calculation and opportunism in the later stages of his career enabled Dubois to fulfill all his material ambitions. With his credit firmly established by his successes in diplomacy, Dubois helped to put an end to the experiment in conciliar government (the so-called *Polysynodie*) and, after the reversion to the secretarial system of Louis XIV, he became minister of foreign affairs in Sept. 1718. When John Law's financial system crashed in 1720 Dubois survived politically by drawing nearer to the representatives of the old court of Louis XIV and by pursuing a more popular pro-Spanish foreign policy, which resulted in the conclusion of the Franco-Spanish treaty of March 27, 1721. He remained, however, faithful to the English connection throughout. His support of the recognition of the papal bull *Unigenitus* against the Jansenists, as well as lavish bribery at the papal curia, made possible further ecclesiastical preferment. Dubois was elevated to the archbishopric of Cambrai in 1720 and became a cardinal in July 1721. In Aug. 1722 he was made *premier ministre*. He died at Versailles on Aug. 10, 1723.

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DUBOIS, JEAN ANTOINE (1765–1848), French Roman Catholic missionary in India, was born at St. Remèze in 1765 and ordained in 1792, sailing for India in the same year under the Missions Étrangères. Despite his strongest efforts in many parts of south India, his mission failed, and he returned to Paris in 1823, convinced that the conversion of the Hindus could not be accomplished. In Paris he became director of the Missions Étrangères, and later superior (1836–39). He translated the *Panchatantra* into French (1826), and also a work called *The Exploits of the Guru Paramarta.* His best-known work was his *Description of the Character, Manners and Customs of the People of India,* which was bought and printed by the East India company (1816); an enlarged edition was published in France in 1825 under the title *Moeurs, institutions et cérémonies des peuples de l'Inde.* Abbé Dubois died on Feb. 17, 1848.

DUBOIS, PAUL (1829–1905), French sculptor and painter whose style combined 15th-century Florentine elegance and the academic, detailed naturalism of the mid-19th century, was born in Nogent-sur-Seine on July 18, 1829. He studied with F. C. A. Toussaint, at the École des Beaux-Arts and in Italy from 1859 to 1862. He achieved his first success in 1865 with his statue "A Florentine Singer," which is indicative of the general character of his style. He exhibited a "Virgin and Child" among other works at the Paris exposition of 1867. In 1876–78 he completed his most important commission, the tomb of General Lamoricière, in the cathedral of Nantes. The work reveals his Renaissance predilections, both Italian and French, with its canopied tomb and four allegorical figures representing Military Courage, Charity, Faith and Meditation in bronze at the corners. His greatest success was the statue of Joan of Arc (1889–95) before Reims cathedral, in which the artist attempted to represent both Joan's role as a military leader and her visionary qualities. A member of the Academy of Beaux-Arts, he became *concierge* of the Luxembourg in 1873 and director of the École des Beaux-Arts in 1878. He died on May 25, 1905, at Paris. (L. W. N.)

DUBOIS, PIERRE (*c.* 1250–*c.* 1320), French lawyer and political pamphleteer in the reign of Philip the Fair, whose most important treatise, *De recuperatione Terre Sancte* (*c.* 1306), while ostensibly outlining the conditions for a successful crusade, actually dealt with a wide range of political issues. Dubois studied at the University of Paris and became a successful lawyer in Coutances (Normandy), probably his birthplace. By about 1300 he was advocate of royal cases and he represented Coutances in the estates-general of 1302 and 1308. His brief career of authorship is significant, not because he expressed or demonstrably influenced royal policies, but because he was one of the more intellectually adventurous of contemporary pamphleteers, and perhaps the earliest of the great French lawyers who sought an active role in politics. The theme underlying all his works was that of the twofold opportunity of the king: to create peace in Europe by claiming for France the position of leadership traditionally reserved in political thought for the empire, but left vacant by the weakness of successive emperors; and to create peace in France by reviving royal authority in all aspects of administration, and particularly by resumption of the property and jurisdictions of the church. He also recommended replacement of the papal patrimony by an annual pension, abolition of clerical celibacy, and the radical reformation of French education, law and administration.

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DU BOIS, WILLIAM EDWARD BURGHARDT (1868–1963), U.S. author, editor and Negro leader, was born in Great Barrington, Mass., on Feb. 23, 1868. He was proud of his French and Dutch ancestry but identified himself with Negroes. Du Bois received the Ph.D. degree from Harvard university in 1895 and wrote the first monograph in the *Harvard Historical Series,* "The Suppression of the African Slave-Trade to America" (1896). This volume, *The Philadelphia Negro* (1899), and his *Atlanta University Studies* (1897–1911) were his most scholarly publications. *Souls of Black Folk* (1903) established his reputation as a superb stylist and crystallized the revolt of Negro intellectuals against the compromises of Booker T. Washington. The Niagara movement, which he founded in 1905, evolved into the National Association for the Advancement of Colored People by 1910. As editor from 1910 to 1932 of the association's organ, *Crisis,* his invective against the injustices inflicted upon Negroes created new concern for the shortcomings of American democracy and made him the idol of most of the leading Negro intellectuals of the first half of the 20th century. He was professor of economics and history at Atlanta university (1897–1910) and head of the department of sociology at Atlanta university (1932–44). At the first Pan-African conference, London, 1900, he urged the liberation of African colonies and led this movement in four later Pan-African congresses, 1919, 1921, 1923 and 1927. Du Bois was an authentic American radical until the 1940s when he espoused pro-Soviet doctrines. He and Kwame Nkrumah were co-chairmen of the fifth Pan-African congress in 1945. In 1947 he published *The World and Africa* and, in 1952, *In Battle for Peace.* Du Bois, at the age of 93, joined the Communist party in Nov. 1961. The following year he settled at Accra, Ghana, where he became editor of a government-sponsored encyclopaedia. He died on Aug. 27, 1963, in Accra, a few months after becoming a citizen of Ghana.

Du Bois' incisive eloquence and encyclopaedic knowledge made him an almost Olympian public speaker. Somewhat arrogant and

at times bitter in public, his sophisticated wit and charm delighted his few close friends. (For portrait *see* NEGRO, AMERICAN.)

See Francis L. Broderick, *W. E. B. Du Bois, Negro Leader in a Time of Crisis* (1959); W. E. Burghardt Du Bois, "My Evolving Program for Negro Freedom" in Rayford W. Logan (ed.), *What the Negro Wants* (1944). (R. W. LN.)

DUBOIS-CRANCÉ, EDMOND LOUIS ALEXIS (1747–1814), French soldier and statesman, eminent as a specialist on military problems during the Revolution, was born at Charleville on Oct. 17, 1747, of an ancient family of Champagne. After attending the college at Charleville, he entered the musketeers of the king's guard in 1762. When this corps was disbanded in 1775, he retired to Châlons-sur-Marne. In April 1789, he was sent to the estates-general as deputy for the third estate of the *bailliage* of Vitry-le-François.

Dubois-Crancé was a resolute defender of the interests of the third estate, and an active member of the Constituent Assembly. He did much to promote the taking of the Tennis Court oath (June 20, 1789). He distinguished himself in the military committee and on Dec. 12, 1789, in the discussion on recruitment, upheld the need for a national army. Having commanded a battalion of the Parisian national guard from May 1791, he returned to the army after the ending of the Constituent Assembly and was promoted to adjutant-general on Sept. 9, 1792. A few days later he was elected deputy to the Convention by the *département* of the Ardennes.

After the opening of the Convention, Dubois-Crancé was sent on missions to the armies of the Midi and of the North. He entered the committee of general defense on Jan. 3, 1793. In the trial of Louis XVI he voted the death of the king without reprieve. On Feb. 21, 1793, he obtained a vote in favour of the *amalgame* or system of *embrigadement* whereby *demi-brigades* were to be formed by joining together two battalions of national volunteers and one battalion of regulars of the former royal army. The purpose of this plan was to combine the revolutionary patriotism of the volunteers with the experience and discipline of the regulars.

One of the most important episodes of Dubois-Crancé's career occurred during his mission to the army of the Alps (from April 30, 1793). When Lyons rebelled against the Convention, Dubois-Crancé, who had the rank of general of division from May 15, prompted F. C. Kellermann to undertake the siege and was largely responsible for the fall of the town on Oct. 9, 1793, though he was recalled to Paris three days earlier.

Recalled to Paris by the Jacobins, Dubois-Crancé resumed his seat on the military committee of the Convention. On Feb. 5, 1794, he was sent to enforce this policy in the armies of the West and Côtes de Brest.

Having been attacked by Robespierre and Georges Couthon in the Jacobin club during the crisis of the spring of 1794, Dubois-Crancé joined the Thermidorians after Robespierre's fall but abandoned them in the spring of 1795. He opposed the suggestion of a bicameral system in the debates on the Constitution of the Year III. He also called for strong measures against the royalist insurrection of Oct. 1795.

Under the Directory, Dubois-Crancé sat in the Council of the Five Hundred till May 1797. He then returned again to the army and was appointed inspector-general of the infantry of the army of the Rhine in Sept. 1798. He was minister of war in 1799 from Sept. 14 to the *coup d'état* of Brumaire (November), in which he played no part. Dubois-Crancé was then put on the retired list and withdrew first to Balham (Ardennes) and then to Rethel in 1809, where he died on June 29, 1814.

See T. Iung, *L'Armee et la Révolution: Dubois-Crancé*, 2 vol. (1884). (A. So.)

DU BOIS-REYMOND, EMIL (1818–1896), German physiologist and philosopher who conducted important studies of the electrical activity of nerve and muscle at a time when Galvani's work on animal electricity had fallen into disrepute, was born in Berlin, Nov. 7, 1818. Du Bois-Reymond's book on electrophysiology (*Untersuchungen über tierische Elektricität*) appeared in 1848 and created modern scientific electrophysiology. He was a pupil of Johannes Müller, whom he succeeded in the chair of physiology in Berlin. He died in Berlin, Dec. 26, 1896. Du Bois-Reymond, Hermann von Helmholtz, Carl Ludwig and Ernst von Brücke led a biophysics program that attempted to reduce physiology to applied physics and chemistry. The program did much to purge physiology of vitalistic thinking and also influenced Freud's psychological theories. Philosophically Du Bois-Reymond was a materialist; he was not important among professional philosophers but his lectures had a wide popular audience. He conducted many polemics, both in science and philosophy.

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DU BOS, CHARLES (1882–1939), French critic whose work is of particular interest for its understanding of English literature and for its emphasis on the relation between literature and psychology. Born in Paris, Oct. 7, 1882, Du Bos had an English mother and was educated at Oxford. His books on Shakespeare, Shelley and Byron, and many of his stylish *Approximations* (7 series, 1922–39) helped to make English literature better known in France; his *Journal Intime* (3 vol., 1946–49) was written partly in English and is a sensitive account of a spiritual development which brought him into the Roman Catholic Church in 1927. His other books include *Le Dialogue avec André Gide* (1929; 2nd ed., *Lettres de Charles du Bos et réponses d'André Gide*, 1950); *Qu'est-ce que la littérature* (1945); and studies of Flaubert, Goethe and Merimée. Du Bos died at Celle-St. Cloud, Aug. 5, 1939.

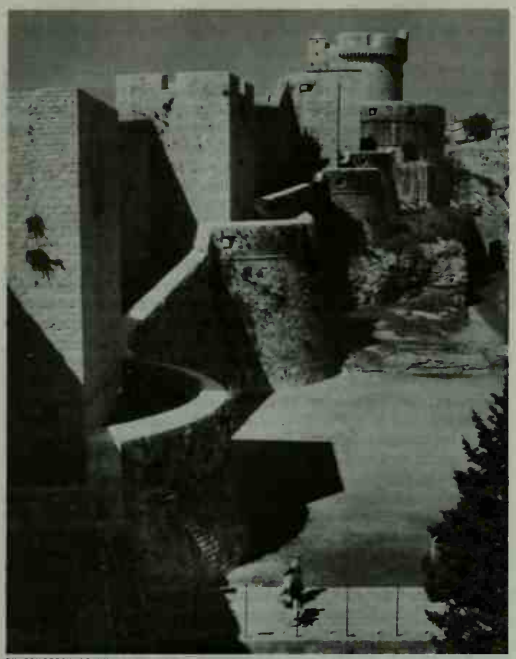
See M.-A. Gouhier, *Charles Du Bos* (1951); A. P. Bertocci, *Charles Du Bos and English Literature* (1949).

DUBROVNIK (Ital. RAGUSA), a port of Dalmatia, in the Socialist Republic of Croatia, Yugos., is situated on the southern part of the Adriatic coast, 579 km. (360 mi.) S.W. of Belgrade by road. Pop. (1961) 22,961.

Dubrovnik is the most picturesque city on the Yugoslav coast, occupying a promontory jutting out into the sea under the bare limestone mass of Mt. Srdj. The sea fortifications rise directly from the water's edge and a massive round tower dominates the city on the landward side. Beyond the walls, mostly a double line, which have always been the pride of Dubrovnik, are many villas surrounded by gardens. The Stradun (Stradone) or main street, with beautiful late Renaissance houses on either side, runs along a valley which, until the 13th century, was a marshy channel dividing the Latin island of Ragusa from the forest settlement of Dubrovnik (*dubrova* in Serbo-Croat means "woody"). No motor vehicles are allowed inside the walls and, except for the Stradun, the old city is a maze of picturesque narrow streets, many of them steep and twisting. Two 14th-century convents stand at the ends of the city, for the Franciscans were set to guard the western gate while the Dominicans kept the eastern one. The rector's palace is one of the masterpieces of Dalmatian architecture. Lokrum, an offshore island, is famous for its gardens and orange groves.

Dubrovnik is connected to Sarajevo and Belgrade by narrow-gauge railway. From its new harbour at nearby Gruz, ships ply to other Dalmatian ports and to Italy. The main industries are the manufacture of liqueurs, cheese, silk, leather, thread, metalwork and soap, oil refining, slate mining and tourism.

Ragusium was founded by Roman refugees from Epidaurus (mod. Cavtat, 12 mi. S.E. of Dubrovnik) fleeing from the advancing Slav tribes. A colony of Slavs soon joined the Latin settlers at Ragusa and thus from an early date the city formed a link between two great civilizations. During the 9th to the 12th centuries Dubrovnik defended itself against attacks by foreign powers, but from 1205 to 1358 it acknowledged Venetian suzerainty, although keeping much of its independence. To refugees of all nations (one of them was the English king Richard I) the city-republic afforded asylum, and by means of treaty and tribute it enlarged its territory until it stretched from the mouth of Boka Kotorska to the town of Ston about 70 mi. N. It achieved a position of great mercantile power, being conveniently situated at the seaward end of a great trade route which divided at Pljevla to go to Byzantium and the Danube. Ragusan land trade flourished throughout the Balkans and colonies were founded in all the big



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DOUBLE WALLS AND THE TOWER OF LOVRJENAC, 14TH–16TH CENTURIES, DUBROVNIK

towns. Sea trade also developed and in the 16th century had reached to America and India. From 1358 to 1526 Dubrovnik was a Hungarian vassal state; later it had to pay tribute to Istanbul, having great trade concessions in the Ottoman empire. For centuries, however, the inhabitants of Dubrovnik were able to preserve their city-republic by skilful maneuvering between east and west. Having treaty obligations to Spain, they sent their men-of-war to the Armada of Philip II which tried to invade England in 1588.

A great development of art and literature, beginning in the 15th century and continuing into the 17th, earned Dubrovnik its title of the "South Slavonic Athens." For the first time in the history of the South Slavs the language of the people was introduced into literature by Dubrovnik's poets, among them Ivan Gundulic (1588–1638).

In 1667 an earthquake destroyed a considerable portion of the city and about one-fifth of the inhabitants. Only during the Napoleonic Wars did the republic regain its prosperity. From 1800 to 1805, as the only neutral Mediterranean state, it secured a large share of the carrying trade. Napoleon subjugated Dubrovnik in 1808, and in 1814 it was annexed to Austria. In 1918 it was incorporated in Yugoslavia. In World War II it was in Italian and German hands from 1941 to 1944. (V. De.)

DUBUQUE, a city in Iowa, U.S., seat of Dubuque county, is on the Mississippi river opposite the boundary line between Wisconsin and Illinois, about 70 mi. N. of Davenport. The business district occupies the lowlands along the river; on the bluffs which rise above it are residential sections. The surrounding area, shaped by streams cutting into bedrock, is notably picturesque.

The city, one of the oldest in Iowa, was named for Julien Dubuque, a French trader, who in 1788 concluded a treaty with the Fox Indians giving him the right to mine lead in the area. After Dubuque's death in 1810 the Indians refused to give other white men mining concessions. It was only after the Black Hawk treaty of 1832 that settlers crossed the river to establish the village of Dubuque.

Municipal government dates from 1837 when the settlement was incorporated. It was chartered in 1841 and a mayor and board of aldermen were elected. The council-manager plan of government was adopted in 1920.

Lead mining and sawmilling were the pioneering industries, but with the development of river and rail transportation, Dubuque became a centre of diversified industry, undergoing expansion at mid-20th century. Among products manufactured are furniture, millwork, tractors, oil-well equipment, pumps and pumping supplies, dry batteries, clothing, packed meats, insecticides, fertilizers, boats and barges. A municipal river-rail terminal is operated by the dock commission.

In the main, residents are of German, Irish, English and Luxembourgian descent. In 1893 Dubuque was made an archdiocese of the Roman Catholic Church, which maintains Loras college (founded in 1839 as St. Bernard's seminary) and Clarke college (1843). Dubuque university (founded in 1852 as the German Theological School of the Northwest) receives support from the Presbyterian Church. Wartburg Theological seminary (1852) is a Lutheran institution. Old world influences can be seen in New Melleray abbey, 10 mi. S.W., founded in 1849 by Trappist monks from Mount Melleray monastery, Ireland, and in the city market patterned after the market of Luxembourg.

Other points of interest include Julien Dubuque's grave; a shot tower used during the American Civil War; the Fourth street elevator, an inclined cable car built in 1884; and Eagle Point park, covering 165 ac. within the city. Pop. (1960) city, 56,606; standard metropolitan statistical area (Dubuque county), 80,048. For comparative population figures *see* table in Iowa: *Population.* (P. W. Gl.)

DU CAMP, MAXIME (1822–1894), French writer, a close friend of Gustave Flaubert and a pioneer of amateur photography, was born in Paris, Feb. 8, 1822. He traveled widely with Flaubert (1844–45 and 1849–51), and his *Égypte, Nubie, Palestine et Syrie* (1852) was one of the first travel books illustrated with photographs. In 1848 he was decorated for counterrevolutionary activity. His *Expéditions des deux Siciles* (1861) recounted his experiences as a volunteer with Garibaldi. In 1851 he was one of the founders of the *Revue de Paris.* He also contributed to the *Revue des deux mondes.* His writings included poems (*Chants modernes,* 1855); art criticism; novels; a monograph on Théophile Gautier; and two volumes of *Souvenirs littéraires* (1882–83), interesting for the light they throw on contemporary literary life, and especially on Flaubert. Du Camp died at Baden-Baden, Ger., Feb. 9, 1894.

DU CANGE, CHARLES DU FRESNE, Sieur (1610–1688), outstanding lexicographer, one of the group of great French scholars of the 17th century who laid the foundations of modern historical and linguistic criticism, was born on Dec. 18, 1610, at Amiens, where he was educated at the Jesuits' college. Later he read law at Orléans. In 1631 he began practice as an advocate at the parliamentary bar in Paris, but soon returned to Amiens where after some years he succeeded his father-in-law in the office of treasurer (1645–68). A severe epidemic made him leave Amiens in 1688; he spent the rest of his life in Paris where he died Oct. 23, 1688. A person of great charm and modesty, he enjoyed the friendship of many of the best scholars of the age.

He was a polymath and a prodigious worker, equally at home in the study of language, history, law, paleography, numismatics and topography. His contributions to Byzantine and older French history (some still unpublished) are considerable. But his chief works are his dictionaries of medieval Latin and Greek, the *Glossarium ad scriptores mediae et infimae latinitatis* (1678) and the *Glossarium ad scriptores mediae et infimae graecitatis* (1688). They are based on the primary material gathered in the course of reading over many years. Their aim is to treat language historically, that is, to distinguish the Latin and Greek vocabularies of the post-classical ages from their classical counterparts. But they are encyclopaedias rather than dictionaries in that Du Cange tends to illustrate from documents and primary sources not only the words but also the matters described by the words. The diffi-

culty of the task may be gathered from the amount of the material, and from the small number of predecessors Du Cange had in preparing the Latin glossary and the virtually complete lack of them in preparing the Greek glossary. It is a measure of his achievement that scholars were content for more than two centuries to produce either reprints or enlarged editions of Du Cange's works rather than new books. The Greek glossary was reprinted in 1958 and L. Favre's ten-volume edition (1883–87) of the Latin glossary in 1954. Preparations for a new Latin "Du Cange" have, however, been made by the International Union of Academies and the first installment of the *Novum glossarium mediae Latinitatis* appeared in 1959.

See M. Esposito in F. Cabrol (ed.), *Dictionnaire d'archéologie chrétienne et de liturgie*, vol. 4, col. 1654–60 (1921). (C. O. Br.)

DUCAS (Dukas or Doukas), the name of a Byzantine family which supplied several rulers to the empire. The family first came into prominence during the 9th century, but suffered a setback when Constantine Ducas, the *domesticus* of the *scholae*, son of the general Andronicus Ducas, lost his life in attempting to become emperor in 913. Toward the end of the 10th century there appeared another family of Ducas, which was perhaps connected with the earlier family through the female line. A member of this family became emperor as Constantine X in 1059, and Constantine's son Michael VII ruled from 1071 to 1078. Michael's son Constantine was nominally co-emperor with Alexius I Comnenus from 1081 to about 1090 and was betrothed to his daughter Anna Comnena but did not live to marry her. The Ducas family continued to take an active part in public affairs. In 1204 Alexius V Ducas, called Murtzuphlus, deposed the emperor Isaac II Angelus and his son Alexius IV, and vainly tried to defend Constantinople against the Latin crusaders. In the mid-14th century one Michael Ducas took a leading part in the civil war between the emperors John V Palaeologus and John VI Cantacuzenus, and Michael's grandson was the historian Ducas (*q.v.*). Many of the rulers who arose after the destruction of the Byzantine empire sought to gain prestige by adding the famous name of Ducas to their own.

See C. Du Cange, *Historia Byzantina*, pp. 160–166 (1680). (J. M. Hy.)

DUCAS (15th century A.D.), Byzantine historian, wrote a vernacular history of the period 1341–1462 in a journalistic style. The dates of his birth and death are unknown, but he was the grandson of Michael Ducas (*see* above) and flourished under Constantine XI Dragases, the last Byzantine emperor (1448–53). He strongly supported the union of the Greek and Latin churches and was bitter against those who refused to appeal to the west for assistance against the Turks. After the fall of Constantine, he was employed in diplomatic missions by Dorino and Domenico Gattilusio, Genoese rulers of Lesbos, where he had taken refuge. He survived the annexation of Lesbos by the Turks in 1462, but no more is known of him. His work is often careless and inaccurate, and his value as a source for the closing years of the Greek empire and the capture of Constantinople has been overestimated.

Bibliography.—For the history *see* edition by I. Bekker in Bonn *Corpus scriptorum hist. Byz.* (1834), and J. P. Migne, *Patrologia Graeca*, vol. clvii (1866). The Bonn edition contains a 15th-century Italian translation by an unknown author, found by L. Ranke in one of the libraries of Venice and sent by him to Bekker. This version fills in some of the lacunae in the original Greek. *See* also K. Krumbacher, *Geschichte der byzantinischen Litteratur*, pp. 305–307 (1897); G. Moravcsik, *Byzantinoturcica*, vol. i, 2nd ed., pp. 247–251 (1958). (J. M. Hy.)

DU CASSE, PIERRE EMMANUEL ALBERT, Baron (1813–1893), French soldier and writer on military subjects, known for his editions of the correspondence of Napoleon I (1852, 1855, 1887). He was born at Bourges, Nov. 16, 1813, educated at St.-Cyr, and in 1849 became aide-de-camp to Prince Jerome Bonaparte, formerly king of Westphalia and then governor of the Invalides. He was attaché to Jerome's son, Prince Napoleon, during the Crimean War and was employed by him to edit the correspondence of Napoleon I. Subsequently *Les Rois frères de Napoléon* (1883) and the *Journal de la reine Catherine de Westphalie* (1893) collected letters which had been omitted. They were edited with little care and are not entirely trustworthy, but their publication threw light on Napoleon I and his entourage. Du Casse was also employed by Jerome Bonaparte and his son to compile historical accounts of their lives.

DUCASSE, ROGER JEAN JULES AIMABLE (1873–1954), French composer and teacher known as Roger-Ducasse. Born, Aug. 18, 1873, at Bordeaux, he was a pupil of Fauré at the Paris Conservatoire and won the second Prix de Rome in 1902. He was inspector of music in the municipal schools of Paris and from 1935 to 1940 professor of composition at the Conservatoire. His works include two operas, *Orphée* (1926) and *Cantegril* (1931), two quartets, the orchestral works *Suite française* (1909) and *Le Joli Jeu de furet* (1920), motets, works for chorus and orchestra and technical studies for the piano. In 1940 he resigned from the Conservatoire and in 1945 retired to his estate in the Gironde. He died at Taillan, near Bordeaux, July 20, 1954.

See L. Ceillier, *Roger-Ducasse* (1920).

DUCCIO DI BUONINSEGNA (*c.* 1255–*c.* 1318), Italian painter, was the first great master of the Sienese school. He is mentioned in Siena in 1278, when he was employed to decorate 12 cases in which public documents were kept. He was still active in Siena in 1279 and 1280, and in 1285 received a commission from the Compagnia dei Laudesi for an altarpiece in Sta. Maria Novella, Florence. Since his name does not occur in Siena between 1280 and 1285, he may have been active in these years outside his native town. Between 1285 and 1295 he received a number of payments in Siena for painting book covers and other work, and in the latter year was involved (with the sculptor Giovanni Pisano and other artists) in discussions regarding the site of the Fonte Nova. In 1302 Duccio was paid for an altarpiece of "The Virgin and Child With Saints" for the chapel of the Palazzo Pubblico, Siena, and in 1308 received the commission for a second altarpiece of the same subject for the high altar of the cathedral. This was completed by June 9, 1311, when, attended by rejoicing crowds, it was installed in the cathedral.

Duccio was still resident in Siena two years after the completion of this altarpiece, and died there probably during 1318, and in any event before Aug. 3, 1319. Duccio was probably trained in the workshop of Guido of Siena. His early activity is conjectural, but is perhaps represented by a "Virgin and Child" from Crevole, now in the Museo dell'Opera del Duomo, Siena.

The altarpiece commissioned from Duccio by the Compagnia dei Laudesi in 1285 is almost certainly identical with the celebrated "Ruccellai Madonna" formerly in Sta. Maria Novella, Florence, and now in the Uffizi gallery. The idiom of this work was profoundly influenced by Cimabue, to whom it was long ascribed. It reveals a capacity for large-scale composition, a rich and individual sense of colour and a mastery of linear design which distinguished it from other paintings of its time. Strong Cimabuesque elements are also present in the scenes and figures on the rose window at the east end of Siena cathedral, which has been tentatively ascribed to Duccio and dates from 1287–88. These elements were much reduced in a somewhat later work, the small "Madonna of the Franciscans" in the Siena gallery, where the style perhaps reflects that of Byzantine illuminations. In two pictures painted at about the turn of the century, a triptych in the National gallery, London, and a "Madonna" at Perugia, Duccio developed an expressive style which looked forward to that of the "Maestà."

The Palazzo Pubblico altarpiece of 1302 is lost, and the "Maestà," the great double-sided altarpiece painted for the cathedral in 1308–11, is thus Duccio's only fully authenticated work. One of the largest altarpieces of its time, it consisted of a wide frontal panel with the Virgin and Child adored by the patrons of Siena and surrounded with saints and angels. Beneath was a predella with seven scenes from the childhood of Christ and above were pinnacles with scenes from the life of the Virgin, while on the back were scenes from the life of Christ between the Baptism and the Ascension. It included in all 59 narrative scenes. The main panel and the bulk of the narrative scenes are now in the Museo dell'Opera del Duomo, Siena, but isolated panels from the altarpiece have found their way to the National gallery, London, the Frick collection, New York city, and the National Gallery of Art, Washington, D.C.

ALINARI

"RUCCELLAI MADONNA" BY DUCCIO DI BUONINSEGNA, 1285. IN THE UFFIZI GALLERY, FLORENCE, ITALY

The central panel of the "Maestà" was more solidly constructed than the "Ruccellai Madonna"; a marble throne was substituted for the wooden throne of the earlier panel, and the figures were arranged in depth. There was a new humanity in the relation of the Virgin and Child. In the "Maestà" the Byzantine-Romanesque style of Duccio's early years evolved in the direction of Gothic art, and in the lateral figures the influence of the Gothic sculptures of Giovanni Pisano can be clearly seen. Gothic influences are less evident in the narrative scenes. When contrasted with the contemporary "Scenes From the Life of Christ" by Giotto at Padua these appear archaic and traditional, but they were treated with great intensity and reveal the master as one of the most eloquent narrative artists of all time. By virtue of its prominent position in the cathedral, of the range of scenes depicted in it, and of the beauty of its colour, the "Maestà" dictated the course of Sienese painting throughout the 14th century, and reflections of Duccio's motifs are encountered in Siena for more than 150 years after its completion. Nothing is known of Duccio's style after the completion of the "Maestà," but it is possible that a triptych of "The Crucifixion" in the English royal collection was painted in the artist's workshop after this time. Other works attributable to Duccio or his studio include a small "Madonna" at Berne and two polyptychs in the Siena gallery.

See C. H. Weigelt, *Duccio di Buoninsegna* (1911); C. Brandi, *Duccio* (1951). (J. W. P.-H.)

DUCETIUS (d. 440 B.C.) was a hellenized Sicel from Menae in Sicily who in the middle of the 5th century B.C. welded the native communities of east Sicily for a short time into a powerful force. He seized his opportunity in the general dislocation that followed the collapse of tyranny in Syracuse and other Sicilian states. At first enjoying the good will of the Syracusan democracy, he acted with them in driving out Hiero's colonists from Catana (which Hiero had renamed Etna) and restored it to its former Chalcidian inhabitants. Hiero's colonists went to Inessa about 10 mi. N.W. of Catana, at the foot of Mt. Etna and renamed the town Etna. He then extended his influence over other Sicel communities, founded a new Sicel centre at Palici next to a traditional Sicel sanctuary, and pursued an independent policy, which led to a combination against him of the forces of Syracuse and Acragas. After minor preliminary successes (including the capture of Inessa-Etna from its Greek colonists) he was decisively defeated by their combined forces in 450 and lost the confidence of the Sicels. On the strength of earlier connections he took refuge in Syracuse and was sent to Corinth. In 446 he returned to Sicily, perhaps with the blessing of Syracuse, now at war with Acragas, and colonized Cale Acte on the north coast with Greeks and Sicels. From this centre he attempted to build up again a unified Sicel power, but he died in 440 before his work was complete.

See *Diodorus*, xi, 76, 78, 88–92; xii, 8, 29.

DUCHAMP, MARCEL (1887–), French-U.S. artist, most famous for his paintings but also an important contributor to modern sculpture with his "ready-mades," was born at Blainville (Seine-Inférieure), on July 28, 1887. His older brothers, Jacques Villon and Raymond Duchamp-Villon (*q.v.*), were also well-known artists. The work by which Duchamp is best known, the "Nude Descending a Staircase," in the Cubist manner, created a sensation at the 1911 Salon des Indépendants show and two years later at the Armory show in New York. In his "ready-mades" (typically, a wine bottle rack, a urinal and cubes of sugar in a cage, titled "Why Not Sneeze?") Duchamp assaulted the traditional preconceptions and values of art. He was in sympathy with the Dadaists and Surrealists, who protested against public taste and reason as the ruling principles of art. Duchamp moved to New York in 1915 (he became a U.S. citizen in 1955) and in 1923 abandoned painting, devoting his time thereafter largely to chess.

See Carola Geidion-Welcker, *Contemporary Sculpture* (1955). (A. E. EL.)

DUCHAMP-VILLON, RAYMOND (1876–1918), French sculptor, whose most important contribution to the art is represented in the series entitled "The Horse" (1914), was born in Paris on Nov. 5, 1876, a member of a highly talented family that included the painter Jacques Villon and the painter-sculptor Marcel Duchamp (*q.v.*), his brothers. Like the Cubists, Duchamp-Villon upheld the sovereignty of the artist's mind over the work of art and rejected descriptive sculpture. His sculpture is of horsepower, and he reconstructs the force and movement of the machine and of a horse with suggestively coiled and pistonlike shapes. His compact, hard and smoothly shaped head of "Baudelaire" (1911) shows his movement away from imitative portraiture and favouring of strong, personally derived shapes. In his "Seated Woman" (1914) and "Head of a Woman," Duchamp-Villon moved toward simple combinations of more abstract shapes which stressed the human head and body as aesthetic objects. His ideas extended into Cubistlike architecture. He died at Cannes on Oct. 7, 1918.

See Carola Geidion-Welcker, *Contemporary Sculpture* (1955). (A. E. EL.)

DUCHENNE, GUILLAUME BENJAMIN AMAND (1806–1875), French physician who was the forerunner of modern neurology, was born on Sept. 17, 1806, at Boulogne. He studied medicine in Paris and in 1833 first tried the effect of electropuncture of the muscles on a patient under his care; from then on he devoted himself to electrophysiology and neurology. His most famous work was *L'Electrisation localisée* (1855), though his *Physiologie des mouvements* (1867) is considered his masterpiece by many. He published the results of his researches on muscular and nervous diseases and on the applications of electricity both for diagnostic purposes and for treatment. His name is connected with the first description of *tabes dorsalis*, progressive muscular atrophy, pseudohypertrophic muscular paralysis, glossolabiolaryngeal (bulbar) paralysis and other nervous troubles. He died in Paris on Sept. 15, 1875.

DUCHESNE, ANDRÉ (Latinized ANDREAS CHESNEUS or QUERCETANUS) (1584–1640), French historian, has been called the

father of French history. He was born at Isle-Bouchard in Touraine in May 1584 and spent his whole life in scholarship, being appointed geographer and historiographer royal through Richelieu's influence. He died in a road accident near Paris on May 30, 1640. The principal works by Duchesne are *Historiae Normannorum scriptores antiqui* (1619), now the only source for some of the texts, and *Historiae Francorum scriptores* (5 vol., 1636–49). The latter work was projected in 24 volumes as a comprehensive collection of narrative sources of French history, but Duchesne died with only two volumes published; his son François (1616–1693), who succeeded him as historiographer royal, brought it down to the reign of Philip IV in three more volumes. Duchesne's other works include *Les Antiquitez . . . des roys de France* (1609), *Les Antiquitez . . . de toute la France* (1609), *Histoires des papes jusqu'à Paul V* (1616) and numerous family histories and genealogies. He left more than 100 folio volumes of manuscript extracts, 59 of which are preserved in the Bibliothèque Nationale (L. De Lisle, *Le Cabinet des manuscripts de la bibliothèque impériale*, vol. i, pp. 333–334 [1868]).

DUCHESNE, LOUIS MARIE OLIVIER (1843–1922), French priest, was an outstanding historian and a pioneer in the application to early church history of archaeological, topographical, liturgical, theological and social studies. Born at St. Servan, Brittany, on Sept. 13, 1843, he was educated for the priesthood and ordained in 1867, later studying in Rome under G. B. de Rossi. The two theses for his doctorate, *De Macario Magnete* (1877) and *Étude sur le Liber pontificalis* (1877), led to a denunciation to the Holy Office. The nature of his researches was likely to upset many cherished pious traditions; besides, he had a witty and mordant pen which did not spare the stupid and pretentious. This rather than his conclusions rendered him suspect. But he was fortunate in writing under the pontificate of the enlightened Leo XIII, who made him a monsignor. It was not, however, until 1887, as he himself said, that he fully realized what his life's work was to be—to serve the church through historical research. He became a leading figure in the 19th- and early 20th-century Roman Catholic revival of learning, and his books are still of fundamental importance. In 1878 Duchesne was appointed professor at the Institut Catholique in Paris, where in 1881 he founded the *Bulletin critique de littérature, d'histoire et de théologie*. In 1888 he was elected a member of the Académie des Inscriptions et Belles-Lettres. While retaining his chair at the Institut he became director of religious studies at the École des Hautes Études in 1892. In 1895 R. Poincaré appointed him director of the École Française de Rome, and in 1910 he was elected to the French Academy. He died in Rome on April 21, 1922.

Duchesne's works include the authoritative edition of the *Liber pontificalis*, 2 vol. (1886–92); *Origines du culte chrétien* (1889; Eng. trans., 1903); *Mémoire sur l'origine des diocèses épiscopaux dans l'ancienne Gaule* (1890), the preliminary sketch for *Fastes épiscopaux de l'ancienne Gaule*, 3 vol. (1894–1915); *Autonomies ecclésiastiques: églises separées* (1896), which treats of the origin of the Greek Church and of the Anglican Church; and *Histoire ancienne de l'église chrétienne*, of which the first three volumes (1905–08) were put on the Index, the fourth volume being published posthumously in 1925.

A close friend of Baron F. von Hügel, Duchesne suffered much from misunderstanding during the days of the Modernist troubles. H. Bremond paid a moving tribute not only to his faith but also to his deep personal piety and loyalty.

See C. d'Habloville, *Grand Figures de l'église contemporaine* (1925); H. Bremond, *Discours de réception à l'académie française* (1923).
(M. de la B.)

DUCHESNE, (ROSE) PHILIPPINE (1769–1852), French religious of the Sacred Heart who founded the first convents of that order in the U.S., was born in Grenoble, on Aug. 29, 1769, the daughter of Pierre François Duchesne, well-known legal and political figure, and Rose Perier, member of a prominent family of Dauphiné.

Her education was advanced for a girl of her day. Entering the Visitation order in Grenoble in 1788, she saw the community dispersed by revolution in 1792, devoted herself to works of charity for nine years and tried in vain to re-establish the Visitandines in their old monastery. In 1804 she turned it over to the newly founded Society of the Sacred Heart and was received into that order by the founder, St. Madeleine Sophie Barat.

For 14 years Mother Duchesne prepared for a missionary career. In 1818 she headed a band of five nuns, the first to pioneer in the trans-Mississippi west. At St. Charles, Mo., they opened a free school and a boarding academy, moving in 1819 to Florissant, Mo., where they did the same work and also founded an orphanage and a novitiate. Two convent schools were founded in Louisiana, at Grand Coteau (1821) and St. Michael's (1825), and an academy and orphanage in St. Louis (1827); the house at St. Charles was reopened in 1828.

In 1841 Mother Duchesne reached the Indian mission among the Potawatomi at Sugar Creek, Kan. Broken in health, she could remain only one year. She spent the last decade of her life at St. Charles, where she died on Nov. 18, 1852. A memorial church was built there in her honour. She was beatified in May 1940, and her feast is celebrated on Nov. 17.

Bibliography.—M. Erskine, *Mother Philippine Duchesne* (1926); L. Callan, *Philippine Duchesne, Frontier Missionary of the Sacred Heart* (1957); *The Society of the Sacred Heart in North America* (1937).
(L. Cn.)

DUCIS, JEAN FRANÇOIS (1733–1816), French dramatist who made the first sustained effort to present Shakespeare's tragedies on the French stage, was born at Versailles on Aug. 22, 1733. His principal adaptations—*Hamlet* (1769), *Roméo et Juliette* (1772), *Le Roi Léar* (1783), *Macbeth* (1784) and *Othello* (1792)—had much success. *Hamlet* and *Othello*, in which the acting of François Joseph Talma (1763–1826) aroused great enthusiasm, remained in the repertory of the Comédie Française until 1851 and 1849 respectively, although they were most popular during the 1830s. Knowing no English, Ducis had to depend on the mediocre translations of Pierre Antoine de Laplace (1707–93) and of Pierre Le Tourneur (1736–88). He sought to remodel the tragedies to suit French taste by confining them within the so-called "classical unities" and by introducing Corneille's motive of conflict between passion and duty, together with the sententiousness and sensibility of his own day. Perhaps oversensitive to public opinion, Ducis constantly revised his plays, sometimes providing alternative denouements, often at the expense of the original Shakespearean elements. Although his own moral seriousness made him see in *Hamlet* mainly a lesson in filial piety and in *Macbeth* a treatise on remorse, his style shows a certain vigorous eloquence, and some of his scenes have genuine tragic force, though this is not sustained. Of his original plays, *Œdipe chez Admète* (1778) and *Abufar* (1795) are his best; the first earned him election to the Académie Française in succession to Voltaire (1779). He died at Versailles on March 31, 1816.

The works of Ducis were published in 3 vol. (1813); his posthumous works were edited by F. N. V. Campenon (1826).

Bibliography.—J. B. O. Leroy, *Études morales et littéraires sur . . . J. F. Ducis* (1832); C. A. Sainte-Beuve, *Causeries du lundi*, vol. 6 (1851–62), *Nouveaux lundis*, vol. 4 (1863–70); P. Albert, *Lettres de Ducis* (1879); H. C. Lancaster, *French Tragedy . . . 1715–1774*, vol. ii (1950), *French Tragedy . . . 1774–1792* (1953).
(G. R. O.)

DUCK, the English name for birds forming the Anatinae, one of the two subfamilies of the family Anatidae. Technically, duck is restricted to the female, the male being called "drake." Ducks have long been favourite and important game birds for the sportsman, and millions are shot annually. Aside from some of the fish-eating sea ducks, most species are good eating and are thus much desired.

Ducks comprise the subfamily Anatinae, with seven tribes as follows: (1) the Anatini or fresh-water ducks; (2) the Tadornini or sheldrakes; (3) the Aythyini or pochards; (4) the Cairinini or perching ducks; (5) the Mergini or sea ducks; (6) the Oxyurini or stiff-tailed ducks; (7) the Merganettini or torrent ducks. The Dendrocygnini or long-legged tropical tree ducks are now considered closer to the geese than to the ducks.

About 115 species of Anatinae are distributed throughout the world, some being confined to small oceanic islands. Males are usually colourful, females duller, but both are dull in some spe-

cies, as, for example, in the American black duck (*Anas rubripes*).

The Anatini, the typical group, are the ones best known. The mallard (*Anas platyrhynchos*) is the most plentiful and best-known species, and is the origin of the domestic breeds of Europe and the U.S. It inhabits the northern hemisphere, reaching Panamá, Egypt and northwestern India in winter, and the Arctic circle in summer. The nest may be on the ground or even well up in a tree; 9–11 pale green eggs are laid on a lining of down that the mother pulls from her breast. As soon as the young hatch, the mother takes them to the nearest body of water. The male may guard the nest before hatching, but takes no interest in the brood and, indeed, is incapable of rendering active assistance by reason of an additional molt that deprives him of the power of flight until the autumn. In bad weather the ducks resort to tidal waters. It is an interesting point that, whereas the male wild duck is monogamous, the domesticated drake is polygamous.

HUGH M. HALLIDAY FROM NATIONAL AUDUBON SOCIETY

FEMALE MALLARD DUCK (ANAS PLATYRHYNCHOS) ON NEST WITH EGGS

Among some ducks, *e.g.*, the red-headed duck and the ruddy duck, individuals frequently lay some of their eggs in each other's nests, especially early in the breeding season. One South American species, the black-headed duck (*Heteronetta*) is entirely "parasitic" on other marsh-nesting birds.

The Anatinae may be characterized as follows: the tarsus is usually scutellated in front (reticulated in the swans and the true geese and in the so-called tree ducks); there are two annual molts (only one in the swans and geese); the sexes are usually dissimilar in coloration, voice and structure of the voice-producing organ, the syrinx.

The group, world-wide in distribution, is a very ancient one, and has produced many varying types. Both in captivity and in the wild state many ducks, especially of the tribe Anatini, are prone to hybridize. The hybrid offspring, being sterile, do not tend to confuse and to conceal the natural classification of the group, however.

Other species of the group are the pintail, baldpate or widgeon (*q.v.*), teal (*q.v.*), shoveler (*q.v.*) and gadwall (*q.v.*). Allied to the sheldrakes are a number of species commonly but erroneously called geese: Egyptian goose (*Alopochen*), Orinoco goose (*Neochen*), Abyssinian blue goose (*Cyanochen*) and upland, kelp and Magellanic geese of South America (*Chloephaga*). These ducks are as big as large geese, hence their common name. Allied to the pochard (*q.v.*) are the canvasback, scaup (*q.v.*), ring-necked duck and white-eyed duck. Among the perching ducks are the North American wood duck (*Aix sponsa*), Asiatic mandarin (*Aix galericulata*), so-called maned goose (*Chenonetta*), comb duck (*Sarkidiornis*) and pygmy goose (*Nettapus*). The sea ducks include the now extinct Labrador duck (*Camptorhynchus*), scoter (*q.v.*), eider (*q.v.*), goldeneye (*q.v.*), harlequin duck (*Histrionicus*) and old squaw (*Clangula*). The stiff-tailed ducks comprise only a few species, the masked ducks and ruddy ducks (*Oxyura*) and Australian musk duck (*Biziura*). The torrent ducks, birds of rushing mountain streams of the Andes, comprise a single genus, *Merganetta*. For domestic breeds of ducks *see* POULTRY AND POULTRY FARMING.

See also references under "Duck" in the Index volume.

See J. C. Phillips, *A Natural History of the Ducks*, 4 vol. (1922–26); J. Delacour, *The Waterfowl of the World*, 4 vol. (1954–).

(HT. FN.)

DUCK, a plain fabric, made originally from tow yarns and subsequently from either flax or cotton. It is lighter than canvas or sailcloth, and differs from these in that it is almost invariably single in both warp and weft. The fabric, in its various qualities and colours, is used for an enormous variety of purposes, including tents, wagon and motor hoods, light sails, belting, bicycle tubes, mail and other bags and pocketings, and clothing; the plural form is used colloquially for trousers made of the material. Russian duck is a fine white linen canvas.

The term is probably derived from the Dutch *doeck*, a coarse linen material.

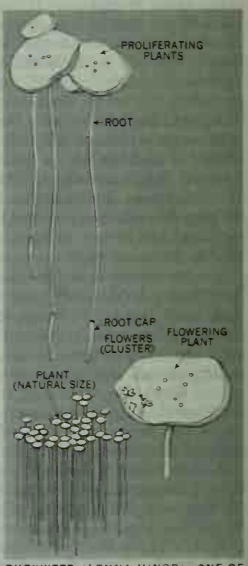
DUCKBILL: *see* PLATYPUS.

DUCKING STOOL, a chair for the punishment of scolds, witches and prostitutes, used in England as late as the beginning of the 19th century. It is sometimes confused with the ancient cucking stool or stool of repentance used by the Saxons. Seated on this stool the person, with head and feet bare, was publicly exposed or paraded through the streets. The cucking stool was used for both sexes and was especially the punishment for scolding women and dishonest brewers and bakers.

The earliest record of the use of the ducking stool is toward the beginning of the 17th century. It was a strongly made wooden armchair in which the culprit was seated, an iron band being placed around her so that she should not fall out during her immersion. The chair was fastened to a long wooden beam fixed as a seesaw on the edge of a pond or river, or was sometimes mounted on a pair of wooden wheels so that it could be wheeled through the streets.

In sentencing a woman, the magistrates ordered the number of duckings she should have. Another type of ducking stool was a chair on two wheels with two long shafts fixed to the axles. This was pushed into the pond and the shafts released, thus tipping the chair up backward.

DUCKWEED, the common name for species of *Lemna* (family Lemnaceae) and for related genera, which form a green coating on fresh-water ponds and ditches. The plants are of extremely simple structure and are the smallest and least differentiated of flowering plants. They consist of a so-called "frond"—a flattened, green, more or less oval structure which emits branches similar to itself from lateral pockets at or near the base. From the under surface a root with a well-developed sheath grows downward into the water. The flowers, which are rarely found, are developed in one of the lateral pockets. The inflorescence consists of one or two male flowers each comprising a single stamen, and a female flower comprising a flask-shaped pistil. The Lemnaceae are regarded as representing a very reduced type allied to the aroids (family Araceae; *q.v.*).



DUCKWEED (LEMNA MINOR), ONE OF THE SMALLEST FLOWERING PLANTS

Besides *Lemna*, other genera representative of the family are *Spirodela*, with several roots, and *Wolffia* and *Wolffiella*, with no roots. All of the following are distributed widely, nearly throughout the world: the lesser duckweed (*L. minor*), the gibbous duckweed (*L. gibba*), the ivy-leaved duckweed (*L. trisulca*) and the greater duckweed (*Spirodela polyrrhiza*). In North America 12 duckweeds occur, including many of the same ones found in Great Britain; three are species of *Wolffia* and one is a *Wolffiella*. *Wolffia punctata*, with fronds only $\frac{1}{50}$ in. to $\frac{1}{35}$ in. long, is one of the most minute of all flowering plants.

In Great Britain the family is further represented by *Wolffia arrhiza*, in which the rootless fronds are only $\frac{1}{20}$ in. long; it is the smallest of British flowering plants. (N. TR.)

DUCOMMUN, ÉLIE (1833–1906), Swiss writer and editor

who won the Nobel peace prize, was born at Geneva on Feb. 19, 1833. At the outset of his career he entered the service of the department of public instruction of his canton, where he rose to a responsible position. He worked also for the *Revue de Genève,* of which he became editor in chief. Later he removed to Berne where he edited *Der Fortschritt.* He became general secretary of the Jura-Simplon railway, retiring in 1903.

Ducommun's chief work lay in studying and preaching the principles of peace to which from an early age he devoted his leisure. He became famous both as an orator and a writer. Most noteworthy of his books were *L'Oeuvre de la paix* (1893), *Le Programme pratique des amis de la paix* (1897) and *Précis historique du mouvement en faveur de la paix* (1899). He took an active part in the movement for European union and conducted *Les États-Unis d'Europe,* the French periodical of the Ligue internationale de la paix et de la liberté, founded in 1867.

In 1889 Ducommun participated in the first of the regular peace congresses, and in 1891 when the International Peace bureau was established he became honorary general secretary. After 1895 he published the *Correspondance bi-mensuelle* relating to the peace bureau's activities. In 1902 he was awarded the Nobel peace prize. He died at Berne on Dec. 7, 1906. (G. P. Es.)

DUCTLESS GLANDS: *see* Endocrine Glands; Endocrinology; Hormones, Vertebrate; and separate articles on the various endocrine glands.

DUDEVANT, A. A. L.: *see* Sand, George.

DUDLEY, BARONS AND EARLS OF. The holders of these English titles are descended from John de Sutton (*c.* 1310–59) of Dudley castle, Staffordshire. His great-great-grandson John Sutton or Dudley (1400–87), 1st baron, was born on Dec. 25, 1400. He became lord lieutenant of Ireland (1428–30) and was summoned to parliament as a baron in 1440. He died on Sept. 30, 1487, and was succeeded by his grandson Edward (*c.* 1459–1532), 2nd baron, son of John's eldest son Sir Edmund Dudley (d. 1483). Other sons of the 1st baron included John Dudley, from whom the earls of Warwick and the Dudley earl of Leicester are descended, and William Dudley, bishop of Durham from 1476 to 1483. The 2nd baron's great-grandson, Edward (1567–1643), 5th baron, had several illegitimate children, including Dud Dudley (1599–1684), who in 1665 published *Metallum Martis,* describing a process of iron-making, but he died without a legitimate male heir and was succeeded in the barony by his granddaughter Frances (1611–97).

Frances married in 1628 Humble Ward (d. 1670), who was created Baron Ward in 1644. Their son Edward Ward (1631–1701), 7th Baron Dudley and 2nd Baron Ward, succeeded to both his father's and his mother's title, but after the death of his grandson William (d. 1740), 10th Baron Dudley and 5th Baron Ward, the baronies separated.

The Dudley barony passed to the 10th baron's nephew Ferdinando Dudley Lea (1710–57), 11th baron, but on his death on Oct. 21, 1757, the title fell into abeyance. It was revived in 1916 in favour of Ferdinando Smith (1872–1936), 12th baron, who was the great-great-grandson of the 11th baron's sister Anne. He was succeeded in 1936 by his only son Ferdinando (1910–), 13th baron.

The Ward barony, in 1757, passed to John Ward (d. 1774), who in 1763 was created Viscount Dudley and Ward. His grandson, John (1781–1833), 4th viscount, was foreign secretary in 1827–28 in George Canning's government and was created in 1827 Viscount Ednam and earl of Dudley. He died on March 6, 1833, when all his titles became extinct, except the barony of Ward which passed to his second cousin William Humble Ward (1781–1835) whose son William (1817–85) was made Viscount Ednam and earl of Dudley (in a new creation) in 1860. William's son William (1867–1932), 2nd earl of Dudley, was lord lieutenant of Ireland, 1902–05, and governor general of Australia, 1908–11. He was succeeded by his son William (1894–), 3rd earl.

DUDLEY, EDMUND (*c.* 1462–1510), English lawyer and minister of Henry VII, remembered, with Sir Richard Empson (*q.v.*), for his unpopular administration of the crown revenues, was the eldest son of John Dudley of Atherington, Sussex, of the baronial family of Sutton or Dudley. He studied law at Gray's Inn and gave two courses of lectures there. From 1496 to 1502 he was undersheriff of London and two years later was about to be made sergeant-at-law when he bought exemption and became speaker of the house of commons. By 1506 he was called "president of the king's council," but this seems to have been a small body of lawyers and household officials whose work was mainly administrative and financial. He and Sir Richard Empson are the best-known members of this group and became unpopular for their share in re-establishing the payment of the king's feudal dues and of the fines and other penalties of lawbreaking. Dudley was employed also in the Star Chamber, the duchy chamber of Lancaster and on the common-law side of chancery. He amassed a fortune and held land in 13 counties, but evidence of personal corruption or of defrauding the king cannot be proved. After Henry VII's death Empson and Dudley were arrested (April 1509). Dudley was tried at the Guildhall, London, and convicted on a charge of constructive treason on July 18, 1509. A bill of attainder apparently passed "onely the comen house," but the threat of it caused Dudley to plan an escape from the Tower of London. This was betrayed and he was executed on Tower Hill on Aug. 17, 1510.

In prison Dudley wrote *The Tree of Commonwealth* (ed., D. M. Brodie, 1948), which is based on the practice of Henry VII's administration and on the theories of the medieval schoolmen. In it Dudley preaches moderation in the use of royal powers as well as the punctual performance of political and social duties by all ranks. The prose is lively, and informed with the irony and wit of a great advocate.

Dudley was twice married. By his first wife, Anne, sister of Sir Andrew Wyndesore, he had a daughter, Elizabeth, who married William, Lord Stourton. His three sons, John, Jerome and Andrew, were born to his second wife, Elizabeth Grey, one of the sisters and coheirs of John, Viscount Lisle.

Bibliography.—D. M. Brodie, "Edmund Dudley, Minister of Henry VII," *Royal Historical Society Transactions,* 4th series, vol. xv (1932). *See* also articles by G. R. Elton and J. P. Cooper in *The Historical Journal,* vol. i, ii and iv (1958–61); Conyers Read (ed.), *Bibliography of British History, Tudor Period,* 2nd ed. (1959). (D. M. Be.)

DUDLEY, SIR ROBERT (1574–1649), English sailor and engineer, titular duke of Northumberland and earl of Warwick, and the author of a famous treatise on navigation, was the son of Robert Dudley, earl of Leicester, and of Lady Douglas Sheffield. He was born in Surrey on Aug. 7, 1574, and based his claim to legitimacy on an alleged marriage ceremony between his parents in 1573; this Leicester later denied, although he recognized Dudley as his heir, sent him to Oxford, and when he died in 1588 left his property to Dudley after the death of his brother, Ambrose Dudley, earl of Warwick, which occurred in 1590.

In 1594 Dudley made a voyage to Trinidad, proposing to explore Guiana, but beyond sending a boat some distance up the Orinoco, he accomplished little. In 1596 he was knighted for his part in the earl of Essex' expedition to Cadiz. On his return he married, as his second wife, Alice Leigh, and attempted to establish his legitimacy and claim to his father's titles. His failure and the disfavour he incurred for his part in the Essex rebellion led him to apply for leave to travel abroad, granted in 1605. He went to Italy, accompanied by his cousin Elizabeth Southwell, whom he afterward married, allegedly by papal dispensation. In 1607 Dudley was ordered to return home to meet charges of unlawfully assuming the titles; he refused and his estates were sequestrated for contempt. Alice, his deserted wife, was created duchess of Dudley for life in 1645. In Italy, Dudley entered the service of the grand duke of Tuscany, and was employed in draining the marshes behind Leghorn and in constructing the port. He was known there as duca di Nortombria and conte di Waruich, and in 1620 Ferdinand II, the Holy Roman emperor, confirmed these titles. He died near Florence on Sept. 6, 1649.

Dudley's chief claim to remembrance is the magnificent *Dell' Arcano del mare,* three volumes (1646–47), a treatise on navigation (particularly on the determination of longitude), ship construction, and naval organization and discipline. It is accompanied by many engraved charts and designs for instruments, often unsuitable for use at sea. Before he left England, Dudley had be-

come a practical navigator, and had learned something from mathematical friends. He clearly had an active and ingenious mind, but his expositions are involved and sometimes superficial. He appreciated the advantages of the Mercator projection, but gave an approximate graphical construction only. The *Arcano* is also remarkable for a scheme for the construction of a navy in five rates, or classes of ship.

See Vaughan Thomas, *The Italian Biography of Sir R. Dudley* (1861); J. T. Leader, *Life of Sir R. Dudley* (1895). (G. R. Ce.)

DUDLEY, THOMAS (1576–1653), colonial governor of Massachusetts, was born in Northampton, Eng., in 1576, possibly a member of the elder branch of the family to which Robert Dudley, earl of Leicester, belonged. He was the son of a country gentleman of some means and was captain of an English company in a French expedition of 1597. He eventually became the steward of the earl of Lincoln's estates, which he managed with great success for many years. Having been converted to Puritanism, he associated himself with other Lincolnshire gentlemen who in 1629 entered into an agreement to settle in New England provided they were allowed to take a charter with them. This proposal the general court of the Massachusetts Bay company agreed to, and in April 1630 Dudley sailed to America in the same ship with John Winthrop, the newly appointed governor. Dudley himself at the last moment had been chosen deputy governor in place of John Humphrey (or Humfrey), the earl of Lincoln's son-in-law, whose departure was delayed.

Dudley was for many years the most influential man in the Massachusetts Bay colony, save Winthrop, with whose policy he was more often opposed than in agreement. He was deputy governor in 1629–34, in 1637–40, in 1646–50, and in 1651–53, and was governor four times, in 1634, 1640, 1645 and 1650. Soon after his arrival in the colony he settled at Newton (later Cambridge), of which he was one of the founders. He was also one of the earliest promoters of the plan for the establishment of Harvard college. Winthrop's decision to make Boston instead of Newton the capital precipitated the first of the many quarrels between the two, Dudley's sterner and harsher Puritanism being in strong contrast to Winthrop's more tolerant and liberal views. He was an earnest and persistent heresy hunter. Not only the Antinomians, but even such a good Puritan as John Cotton, against whom he brought charges, felt the weight of his stern and remorseless hand. Dudley was an able man with business and managerial ability, and was devoted to the public interest. It was from him that New England Puritanism derived some of its harshest aspects. He was a strong believer in aristocracy and thought that the state should enforce religious conformity. He was dogmatic, prejudiced, austere and unlovable; he dominated the community by sheer strength of will. He died at Roxbury, Mass., on July 31, 1653.

His son Joseph Dudley (1647–1720), colonial governor of Massachusetts, was born in Roxbury on Sept. 23, 1647. He graduated from Harvard college in 1665, became a member of the general court, and in 1682 was sent by Massachusetts to London to prevent the threatened revocation of the colonial charter by Charles II. There, with an eye to his personal advancement, he secretly advised the king to annul the charter; this was done, and Dudley, by royal appointment, became president of the provisional council. With the advent of the new governor, Sir Edmund Andros (*q.v.*), Dudley became a judge of the superior court and censor of the press. Upon the deposition of Andros, Dudley was imprisoned and sent with him to England, but was soon set free. In 1691–92 he was chief justice of New York, presiding over the court that condemned Jacob Leisler (*q.v.*). Returning to England in 1693, he became lieutenant governor of the Isle of Wight and a member of parliament, and in 1702, after a long intrigue, secured from Queen Anne a commission as governor of Massachusetts, where he served until 1715. His administration was marked, particularly in the earlier years, by ceaseless conflict with the general court, from which he demanded a regular fixed salary instead of an annual grant. He was active in raising volunteers for the so-called Queen Anne's War. He was accused by the Boston merchants, who petitioned for his removal, of being in league with smugglers and illicit traders, and in 1708 a bitter attack on his administration was published in London, entitled *The Deplorable State of New England by Reason of a Covetous and Treacherous Governor and Pusillanimous Counsellors.* He was an able administrator and efficient servant of the crown, but neither of these attributes made for popularity in his turbulent period. He died at Roxbury on April 2, 1720.

Joseph Dudley's son Paul Dudley (1675–1751) graduated from Harvard in 1690, studied law at the Temple in London and became attorney general of Massachusetts (1702–18). He was associate justice of the superior court of that province from 1718 to 1745, and chief justice from 1745 until his death. He was a member of the Royal society (London), to whose Transactions he contributed several valuable papers on the natural history of New England, and was the founder of the Dudleian lectures on religion at Harvard.

See G. E. Koues, *Thomas Dudley, Governor of Massachusetts* (1914); Everett Kimball, *The Public Life of Joseph Dudley* (1911). (Ra. Mu.)

DUDLEY, a municipal, county and parliamentary borough of Worcestershire, Eng., forming an isolated enclave in Staffordshire, 9 mi. W.N.W. of Birmingham and 117 mi. N.W. of London by road. It is situated on the Birmingham, Stourbridge, and Staffordshire and Worcestershire canals. Pop. (1961) 61,748. Standing on a ridge 370–789 ft. above sea level in what was to become the Black Country, Dudley was conveniently placed over the "ten-yard" coal of the neighbourhood, which formed the richest seam worked in England, and also over limestone and ironstone. The site was of importance from about the 8th century when a Saxon castle was founded on the hill. In medieval times Dudley (Dudelei) depended on the castle. The earthworks of the Norman castle survive but most of the ruins are of the 16th-century castle built by Sir John Dudley, duke of Northumberland, and burned down in 1750. The first mention of Dudley as a borough occurs in 1272. Before that time it was governed by a high and low bailiff, appointed every year at the court leet of the manor. Roger de Somery held a market by prescription in Dudley before 1261. Two fairs, on Sept. 21 and April 21, were granted in 1684 to Edward, Lord Ward, lord of the manor. Dudley was represented in the parliament of 1295 but not again until the Reform act of 1832. It was incorporated in 1865.

Mines of sea coal are mentioned as early as the reign of Edward I, and by the beginning of the 17th century mining had become important. The industries of the area thus began early; woodlands were destroyed to supply charcoal for medieval iron smelting. Dud Dudley, a natural son of Lord Dudley, received in 1621 a patent for his method of smelting iron with coal, but no process is known to have been successful until Abraham Darby's method in the 18th century. Dudley played an important part in the Industrial Revolution. Local pig iron production reached a maximum about 1870. The older industries of nail making and glass blowing ceased, but chainmaking continued to prosper. Apart from the collieries, iron and brass founding, engineering and brickmaking predominate with local specialities such as clothing, scales and weights and leather goods. The whole district is set with chimneys, pit buildings and factories, and at night Dudley's glare of furnaces reveals the continuous activity of this "capital" of the Black Country. There are 159 mi. of canals in and around Dudley. An open market is held each weekday in the town.

Despite industry the town has many attractive features. The ruined castle stands above the woods on top of Castle hill, and a zoological garden was opened in the grounds in 1935. In the centre of the town are the ruins of a 12th-century priory (restored by the ministry of works), the grounds of which are a public park. The principal buildings are the council house (1935), the town hall (1928), the technical college (1935), the teachers' training college (1908–09), the Brooke-Robinson museum and the art gallery. The town is noted for its Silurian fossils from the limestone quarries of Dudley castle and Wren's Nest; a Silurian trilobite fossil is in the centre of the town's emblem.

DUDO (Dudon) of St. Quentin (*c.* 965—before 1043), French chronicler of the first dukes of Normandy, was a canon of St. Quentin in Picardy who was sent by Albert I, count of Ver-

mandois, on a mission to Richard I, duke of Normandy, and became a member of the duke's intimate circle. His *Historia Normannorum,* or *Libri iii de moribus et actis primorum Normanniae ducum,* is dedicated to Adalberon (*q.v.*), bishop of Laon. Written alternately in prose and verse, it tells the story of the Normans from the 850s to 996, but is of very dubious reliability, especially where Dudo refers to his own private information, which was poor. It is the only source of information on the events culminating in the "treaty of St. Clair-sur-Epte" (probably 911), whereby Charles the Simple authorized the Northmen under Rollo to settle in Normandy, but the narrative is cluttered with fabulous tales (such as that of Rollo's alleged marriage to Charles's daughter) and deserves credence only on a few points. The best edition of the work is by J. Lair (1865).

See J. C. M. R. Steenstrup, *Normannarne* (1876); H. Prentout, *Étude critique sur Dudon de Saint-Quentin et son histoire des premiers ducs normands* (1916). (J. De.)

DUDWEILER, a town of Saarland (*q.v.*), Ger., which in 1957 was incorporated in the Federal Republic of Germany, is situated in hilly country on the Sulz-bach, 7 km. (4 mi.) N.E. of Saarbrücken to which it is linked by rail and road. Pop. (1961) 28,854. Dudweiler is an industrial town with extensive coal mines and ironworks. Fireproof bricks, electrical equipment, precision instruments and clothing are made. Nearby is the "burning mountain," a coal vein which caught fire in 1648 and smouldered continuously from that time. There are traces of prehistoric and Celtic occupation. The town was the Roman Duodonisvillare.

DUEL, a combat between persons, armed with lethal weapons, which is held according to pre-arranged rules to settle a quarrel or a point of honour. It is an alternative to having recourse to the usual process of justice. Duels, in this sense, were practically unknown in the ancient world. The Greeks and Romans had a different conception of courage: Plato, for instance, defined courage as "the virtue of fleeing from an inevitable danger." Single combats, such as those between Hector and Achilles and between the Horatii and Curiatii, were mostly incidents in local wars.

The Judicial Duel.—The judicial duel or trial by battle was the earliest form of dueling. Caesar and Tacitus report that the Germanic tribes settled their quarrels by single combat with swords, and with the Germanic invasions the practice became established in western Europe early in the middle ages (it was recognized by the edict issued at Lyons in 501 by Gundobad of Burgundy). The judicial duel was adopted because solemn affirmation, or swearing of oaths, in legal disputes had led to widespread perjury and because the ordeal (*q.v.*) seemed to leave too much to chance or to manipulation by priests. If a man declared before a judge that his opponent was guilty of a certain crime and the opponent answered that his accuser lied, the judge ordered them to meet in a duel, for which he established the conditions as to place, time and arms; both combatants had to deposit sureties for their appearance. The throwing-down of a gauntlet was the challenge, which the opponent accepted when he picked it up. As it was believed that in such an appeal to the "judgment of God" the defender of the right could not be worsted, the loser was usually dragged from the lists by his heels and, if still alive, dealt with according to law. In criminal actions defeated men were hanged and women usually burned; in civil actions a hand might be cut off; and goods and arms were confiscated. Pope Nicholas I declared in 858 that trial by battle was "a just and legitimate combat," and church dignitaries resorted to it in disputes over church property or, in other cases, took their share of the goods seized from a defeated combatant.

This form of trial was open to all free men and even, in certain cases, to serfs. Only ecclesiastics, women, the sick, persons under 20 years of age and men over 60 could claim exemption. In certain circumstances, however, persons under trial could appoint professional fighters or "champions" to represent them, but the principal as well as his defeated champion was subjected to the legal punishment.

In most countries duels also served to decide impersonal questions. In Spain, for example, a duel was fought in 1085 to decide whether the Latin or the Mozarabic rite should be used in the liturgy at Toledo: the Mozarabic champion, Ruiz de Mastanza, won. The procedure of these duels was laid down in great detail. They took place in *champs clos* (lists), generally in the presence of the court and high judicial and ecclesiastical dignitaries. Before combat each participant swore on the cross and the Bible that his case was just and his testimony true and that he carried no weapons other than the stipulated ones and "no stone or herb of virtue, no charm, experiment or other enchantment by which the word of God might be diminished and the devil's power increased." Lest the spectators should influence the combat, strict silence was enforced under penalty, including the loss of a limb or even death. Combats never started before noon and might continue until the stars appeared; a defender who resisted until then won his suit. When one of the combatants was wounded or thrown, his opponent usually placed his knee on his chest and, unless he asked for mercy, drove his dagger through a joint in the armour.

England.—William I introduced the judicial duel or trial by battle to England. A notable early example was that in which Godfrey Baynard, count of Beaumont, defeated William of Eu (whom he had accused of treason against William II) on Salisbury plain in 1093. At first the duel was compulsory only for Normans, but this distinction lapsed, and by the reign of Henry II trial by battle was the only method for settling the issue of a writ of right in proprietary suits, though in practice combat rarely occurred. Henry II's reforms provided the alternative of the grand assize on trial by jury and encouraged the use of the jury in appeals of felony, in which trial by battle had also been used. Nevertheless there were later occasions when trial by battle was demanded; for instance in 1571, when a duel over disputed manorial rights was averted at Queen Elizabeth I's behest; and as late as 1818, in the case of *Thornton* v. *Ashford.* In this last case, Abraham Thornton, accused of murdering Mary Ashford, threw down a gauntlet in court and claimed his right to challenge his accuser, Mary Ashford's brother, to wager of battle. His suit was allowed, and as the challenge was refused Thornton escaped. After this, judicial duels were abolished by the law of 1819.

France.—French judicial duels became so frequent and fatal that from the 12th century attempts were made to reduce them. Louis VII decreed in 1168 that certain offenses should no longer be tried in this way, Louis IX *c.* 1254 tried to forbid duels in his domains. A duel which took place in 1385 in the presence of Charles VI profoundly affected the popular belief in the "judgment of God." A Norman gentleman, Jacques Legris, was accused by the wife of Jean de Carrouge of having seduced her when her husband was absent on crusade. The *parlement* ordered trial by battle, and Legris, who protested his innocence, was defeated by the husband and hanged. Later a man about to be executed for other crimes confessed that he was the seducer.

Thereafter the number of judicial duels decreased. The last one to be authorized by a French king took place on July 10, 1547, between Guy de Chabot de Jarnac and François de Vivonne de La Châtaigneraie—whose account of a gravely compromising statement by Jarnac was alleged by Jarnac to be untrue. Henry II authorized the duel out of affection for La Châtaigneraie, though his predecessor Francis I had refused to countenance it. In lists prepared with great pomp, the combatants, heavily armoured, met on foot with sword and buckler. When Jarnac felled his opponent with a sudden cut behind the knee (hence the phrase *"un coup de Jarnac"* meaning a sly, unforeseen blow), La Châtaigneraie, who had been confident of victory, was so mortified that he refused aid and died. Henry II now swore never to authorize another trial by battle.

The Duel of Honour.—Duels of honour were private encounters about real or imagined slights or insults. The practice, considerably facilitated by the fashion of wearing a sword as part of everyday dress, seems to have spread over the rest of Europe from Italy from the end of the 15th century. Italy in any case was the great centre of professional swordsmanship, and as the duel of honour became prevalent the nobility of Europe flocked to Milan to learn the secret strokes that fencing-masters had to teach.

Men would fight on the slightest pretext and often, at first, without witnesses, but as this secrecy came to be abused (*e.g.*, by ambushes) it soon became usual for duelists to be accompanied by friends or seconds. Later these seconds would also fight, to prove themselves worthy of their friends.

France.—Duels of honour became so prevalent that the estates-general of France at Orléans persuaded Charles IX to issue an ordinance in 1566 which applied the death penalty to anyone taking part in a duel. This ordinance became the model for later edicts against dueling. The rage for dueling persisted nonetheless. In the encounter at the Porte Saint-Honoré on April 27, 1578, between Charles de Balzac d'Entragues and Henry III's favourite, Jacques de Lévis, comte de Quélus, each with two seconds, four of the combatants were killed and the others severely wounded; and it was reckoned that between 1589 and 1608 more than 8,000 gentlemen were killed in duels. Duels, indeed, were fought by the highest in the land. In 1594, Charles de Lorraine, 4th duc de Guise, killed Antoine Montbéton de Saint-Pol in a duel in the streets of Reims after Saint-Pol had criticized his defection to Henry IV's side in the civil war.

It was Henry IV who issued the first strong edicts against dueling, under the influence of the great duc de Sully. The edict of 1602, which declared that those who fought unauthorized duels were guilty of treason, confirmed the powers of the courts of honour which had been set up under Louis XII. In these courts the marshals of France and the governors of the provinces, or their deputies, were to act for the king and to settle points of honour, allowing a duel as the last resort. The edict of 1609 graded punishments according to the degree of participation in a duel and included spectators. Henry's tendency to grant pardons to duelists counteracted this legislation.

Dueling under Louis XIII greatly increased. Lord Herbert of Cherbury, the British ambassador in Paris, reported that "there is scarce a Frenchman worth looking on who has not killed his man in a duel." Then the cardinal de Richelieu, through the edict of 1626, inaugurated a regime of greater severity, which was to be applicable also for duels fought in frontier territories or outside France. Richelieu moreover made no exceptions for any who flouted the laws, however exalted their family might be: when François de Montmorency, comte de Boutteville, fought his 22nd duel (with François d'Harcourt, marquis de Beuvron), Richelieu ordered their arrest and Boutteville was beheaded (June 22, 1627). The edicts against duels were republished in 1634, but after Louis XIII's death were for a time more laxly observed, as when the duc de Beaufort killed his brother-in-law, the duc de Nemours, in 1652. Louis XIV, however, eventually succeeded in putting the duel down through a series of edicts, one of which, in 1679, addressed a special appeal to the nobility. He also made the courts of honour effective and, in 1704, could record his satisfaction at seeing the virtual cessation of fatal duels. During the Regency there was a revival of dueling, which provoked the last royal edict to be issued against it (1723).

Dueling survived the *ancien régime* in France. Furthermore, from the Revolutionary period onward, it came to be a feature of political disputes. In Aug. 1790 Jean de Cazalès and Antoine Barnave fought a duel after a debate; and, in November, Charles Lameth fought Armand de La Croix, duc de Castries, after the duc had challenged all supporters of the Revolution. According to Barnave, the fact that the aggressors usually favoured the *ancien régime* caused some popular feeling against dueling. In spite of this there was no specific legislation against it. Napoleon's opinion was that a good duelist made a bad soldier, but the code of 1810 made no mention of dueling.

Political duels were frequent in the 19th century: Paul de Cassagnac was notorious for his duels; Pierre Napoléon Bonaparte shot the journalist Victor Noir when the latter was delivering a challenge to him in Jan. 1870; Léon Gambetta fought the minister of the interior, F. O. Bardy de Fourtou, in Nov. 1877, and Gen. Georges Boulanger came off the worse in a duel with Charles Floquet, president of the chamber of deputies, in July 1888.

In the 20th century duels still took place occasionally in France —often however for form's sake alone, with such precautions that neither sword nor pistol could prove fatal; or even for purposes of publicity. (*See* also *Women's Duels*, below.)

England.—Private dueling was never so prevalent in England as in France. Even so, some duels are recorded under Elizabeth I, for example those between the Holles and the Talbot families. Under James I dueling became, in Francis Bacon's words, an "unbridled evil," and, as solicitor-general, Bacon tried to enforce the proclamations against it. Duels were rare under the Commonwealth, but the Restoration brought an increase in their number, and in the 18th century they remained frequent. In George III's reign 172 duels were reported, in which 91 persons were killed, and the custom went on under George IV. Notable encounters were those between Richard Brinsley Sheridan and Maj. Thomas Matthews in 1772; between William Adam and Charles James Fox, who had spoken against Adam in the house of commons in 1779; between William Pitt and George Tierney in 1796; between Henry Grattan and Isaac Cory in 1800; between Sir Francis Burdett and James Paull in 1807; between Lord Castlereagh and George Canning in 1809; and between the duke of Wellington and the 10th earl of Winchelsea (George William Finch-Hatton) in 1829.

Up to the 1840s the British military code authorized dueling. Then two fatal encounters caused public opinion to react: first, the earl of Cardigan shot Capt. Harvey Tuckett on Sept. 12, 1840, for which he was tried by the house of lords and acquitted (Feb. 1841); next, Lieut. Alexander Munro shot his brother-in-law, Lieut. Col. David Fawcett, on July 1, 1843. An association against dueling was consequently formed by members of both houses of parliament and army and naval officers. It presented a memorandum to Queen Victoria and, with Prince Albert's support, succeeded in getting a debate in the house of commons in which Sir Henry Hardinge, the secretary for war, conveyed the Queen's desire for reform. There followed an amendment of the articles of war in 1844, to make dueling a military offense, and this was incorporated into the army act of 1881. Thenceforward duels had to be fought abroad; *e.g.*, at Calais or at Boulogne.

Germany.—In Germany duels of honour were authorized by the military code up to World War I: their conduct was controlled by a council of honour, and an officer who refused a challenge approved by his regiment was compelled to leave the service. Under the Weimar republic dueling was punishable with imprisonment, but after the advent of the Nazis to power it was legalized again (1936), under the control of special tribunals, wounds sustained being regarded in the same light as injuries in sport. Under an amendment of 1953 dueling was made punishable with imprisonment.

In a rather different category is the *Mensur*, the student duel still a feature of German university life. Most German universities have long-established *Verbindungen* (fighting corps) with strict rules, distinctive uniforms and great prestige. The meetings of the corps are held in strict secrecy. The *Schläger*, a heavy basket-hilted sabre is used, and the method of swordplay is quite different from that of normal fencing. In the *Mensur* the combatants take up a position on guard upright and quite close to each other with the sabre held above the head and the forearm in front of the face; it is a point of honour to remain immobile from the top of the head to the rear foot during a bout. The forearm is padded, the eyes are protected by steel glasses and the neck is also protected. Cuts are delivered almost exclusively at the head, inflicting severe wounds. Defense is limited to blocking the strokes with the forearm and the hilt, and the duel continues by timed rounds until loss of blood compels one of the duelists to retire. In this way students can obtain the scars on head and cheek which are prized as marks of courage.

Italy.—Private dueling flourished in Italy in the early 16th century and many books were written about it. Local laws were introduced against it in vain, and it was only after the Council of Trent had decreed against it in 1549 and in 1563 that it became less frequent. In the 19th century dueling became fashionable again (from 1879 to 1889 there were 2,759 duels recorded, but only 50 duelists were killed). Under the Fascist regime dueling was encouraged.

Women's Duels.—Duels have been recorded from time to time among women. Madame Maupin, née d'Aubigny (1673–1707), a singer at the Paris Opéra and the prototype of Theophile Gautier's Mademoiselle de Maupin, learned fencing from her lover and made herself formidable as a duelist. During the Regency in France the marquise de Nesle and the comtesse de Polignac are said to have fought a duel over the duc de Richelieu (L. F. A. du Plessis). In 1868 two young ladies fought a duel with pistols at Bordeaux: one was wounded in the thigh and the principals and seconds were condemned to 15 days imprisonment. In 1892 the princess Pauline Metternich and the Gräfin Kilmannsegg fought a duel in Liechtenstein.

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DUE PROCESS, a phrase principally associated with one of the basic guarantees of the U.S. constitution, but with roots in early English common law and constitutional history. The first concrete expression of the due-process idea in Anglo-American law appears in the 39th article of Magna Carta (1215) in the royal promise that "No free man shall be seized or imprisoned or outlawed, or in any way destroyed; . . . excepting by the legal judgment of his peers, or by the laws of the land." In subsequent English statutes purporting to re-enact, and in commentaries elucidating, the principles of Magna Carta, the references to "legal judgment of his peers" and "laws of the land" are treated as substantially synonymous with "due process of law." While American colonial documents frequently reflect the language of Magna Carta, the earliest use of the due-process phraseology in American constitutions occurs in the 5th amendment to the federal constitution, ratified in 1791, in the provision that "No person . . . shall be deprived of life, liberty or property without due process of law."

Since this amendment was held inapplicable to state, as distinguished from federal, action, it was not until the adoption of the 14th amendment in 1867 that a federal due-process clause became applicable to the states. Many state constitutions have similar provisions, but these are enforced only by state courts.

In its first elaboration of the meaning of due process, the U.S. supreme court directed attention to "those settled usages and modes of proceeding existing in the common and statute law of England before the emigration of our ancestors" (*Murray's Lessee* v. *Hoboken Land & Improvement Co.,* 18 How. 272 [1855]). This test was subsequently restated as embracing only those principles of justice which are "so rooted in the traditions and conscience of our people as to be ranked as fundamental" (*Snyder* v. *Mass.,* 291 U.S. 97 [1934]) or "implicit in the concept of ordered liberty" (*Palko* v. *Conn.,* 302 U.S. 319 [1937]). In determining the procedural safeguards that should be obligatory upon the states under the due-process clause of the 14th amendment, the supreme court has exercised considerable supervision over the administration of criminal justice in state courts, as well as occasional influence upon state civil and administrative proceedings. Its decisions have been vigorously criticized, on the one hand, for interfering unduly with state judicial administration, and on the other hand, particularly in dissenting opinions, for not treating all the specific procedural guarantees of the first ten amendments as equally applicable to state as well as to federal proceedings.

Even more controversial than its application to procedural rights has been the interpretation of the due-process clause to protect substantive rights against arbitrary governmental action, so as to subject to judicial review virtually every type of economic regulation. Perhaps the most famous example was a decision in 1905 invalidating, as an arbitrary interference with "liberty of contract," a New York statute limiting hours of work in bakeries; at least equally famous became the dissent of Justice Oliver Wendell Holmes that "a constitution is not intended to embody a particular economic theory, whether of paternalism . . . or of laissez faire" (*Lochner* v. *N.Y.,* 198 U.S. 45 [1905]). The view expressed by Justice Holmes eventually prevailed, as illustrated by a decision in 1934 sustaining state regulation of milk prices, in which Justice Owen Roberts stated the controlling principle that "a state is free to adopt whatever economic policy may reasonably be deemed to promote public welfare, and to enforce that policy by legislation adapted to its purpose" (*Nebbia* v. *N.Y.,* 291 U.S. 502 [1934]). Since that date the supreme court has rigorously adhered to this principle.

Somewhat later in development, but of more continuing vitality, has been the incorporation into the due-process clause of the 14th amendment of the freedoms of speech, assembly, press and religion which are explicitly protected by the 1st amendment against federal encroachment. Since the first acceptance of this principle of incorporation by the supreme court in 1925, there has been a steady stream of controversial decisions determining the validity of state governmental action regarding such topics as advocacy of violent overthrow of government, holding of mass meetings in public places, distribution of defamatory or salacious literature, newspaper comment upon judicial proceedings, and public support of religious teaching. The distinctions drawn between valid and invalid state action in these areas have frequently been quite technical and not always entirely consistent, but in general they reflect the assumption, though not without occasional questioning by individual justices, that 1st-amendment freedoms are entitled to a "preferred position" in constitutional adjudication, as compared with such economic freedoms as were formerly protected by the doctrine of "liberty of contract."

See also CONSTITUTION AND CONSTITUTIONAL LAW: *United States: The Guarantee of Individual Rights;* CIVIL LIBERTIES: *United States Bill of Rights;* POLICE POWER.

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DUET, a musical composition for two performers or singers. Unaccompanied vocal duets were common in secular music from the 14th to the 16th century. In 17th-century Italian cantatas the accompanied vocal duet was known as the chamber duet. Accompanied duets took on a variety of forms in 17th and 18th-century opera and also in the choral works of Bach and Handel. Unaccompanied instrumental duets, for string or wind instruments, known as duos, were written by French composers of the 18th century and by Haydn, Mozart and Beethoven, while the accompanied instrumental duet led to the development of the trio sonatas of Purcell, Bach, Handel and others. During a short period at the beginning of the 19th century harp duets were common and, when the harp went out of fashion as a domestic instrument, these were replaced in popularity by piano duets for four hands at one keyboard, notably those of Weber and Schubert. Piano duets, either for four hands at one keyboard or for two pianos, are also frequently arrangements of works for orchestra or organ. As orchestral works became more complex piano duet arrangements were particularly useful to students and amateurs, and much of the orchestral repertory became accessible in this form.

See Hans Engel, "Duett," in *Die Musik in Geschichte und Gegenwart,* ed. by F. Blume (1954); Alec Rowley, *Four hands—One piano. A list of works for duet players* (1940).

DUFAURE, JULES ARMAND STANISLAS (1798–1881), French statesman, one of the most notable supporters of Adolphe Thiers during the latter's presidency of the republic, was born at Saujon, Charente-Inférieure, on Dec. 4, 1798. He became a lawyer in Bordeaux and in 1834 was elected one of the deputies for his native *département.* Appointed minister of public works in Marshal Soult's ministry of 1839, he freed railway construction from the obstacles which had hampered it. In 1840 Dufaure became a leader of the opposition, and on the outbreak of the revolution of 1848 he sided with the republicans. On Oct. 13 he became minister of the interior in Gen. L. E. Cavaignac's government, but retired from office on the latter's defeat in the presidential election. During the second empire Dufaure practised at the Paris bar and in 1864 was elected to the Académie Française. In 1871 he was elected to the national assembly, and it was on his motion that Thiers was appointed head of the executive power of the state. Having been minister of justice under Thiers and under

Louis Buffet, he succeeded the latter as premier on March 9, 1876. He resigned office, however, on Dec. 12 but returned to power on Dec. 13, 1877. Early in 1879 Dufaure took part in compelling the resignation of Marshal MacMahon, but immediately afterward, on Feb. 1, he himself retired. He died at Rueil, near Paris, on June 28, 1881.

See G. Picot, *M. Dufaure, sa vie et ses discours* (1883).

DUFAY, GUILLAUME (*c.* 1400–1474), the greatest composer of his time, both of church music and the secular *chanson* (*q.v.*), was born about 1400, probably in Hainaut, which then was a part of Holland and now is a province of Belgium. He was a chorister at Cambrai cathedral (1409), entered the service of Carlo Malatesta of Rimini *c.* 1420 and composed a motet for the marriage of Cleophe Malatesta to Theodore Paleologus in 1421. He joined the papal singers in 1428 and composed motets to mark the election of Pope Eugenius IV (1431), and to celebrate the treaty of Viterbo between Eugenius and the emperor Sigismund (1433). In 1436 he wrote a motet for the dedication of Brunelleschi's dome for Sta. Maria del Fiore, Florence. In the same year he was made a canon of Cambrai. After seven years with the duke of Savoy, he lived mainly in Cambrai from about 1445, and supervised the music of the cathedral. In 1446 he became a canon of Mons. For Philip the Good's brilliant "Feast of the Pheasant" held at Lille in 1454, and intended to initiate a crusade to recapture Jerusalem, Dufay wrote a *"Lamentatio Sanctae Matris Ecclesiae Constantinopolitanae."* Following the ceremonial motets of his Italian period, he composed a series of masses, which, with those of John Dunstable (*q.v.*) and other English composers, laid the foundation for the rapid development of this form in the second half of the 15th century. For the *cantus firmi* of his masses he used both secular themes, such as his own ballade *"Se la face ay pale"* and *"L'Homme armé"* (which was used by many composers up to Palestrina), and sacred themes, such as *"Ave regina caelorum."* In these and other works of his Cambrai period he perfected the graceful and expressive style, the *contenance angloise*, which, according to Martin le Franc's *Le Champion des Dames* (*c.* 1440), he and Gilles de Binchois (*q.v.*) had adopted from Dunstable. He died at Cambrai Nov. 27, 1474.

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DUFF, ALEXANDER (1806–1878), Scottish missionary in India, who founded schools to promote European science and literature among Indians, was born on April 26, 1806, at Moulin, Perthshire. At St. Andrews university he came under the influence of Thomas Chalmers, and after being ordained (1829) he was sent out by the foreign mission committee of the general assembly as their first missionary to India. On the voyage he was twice shipwrecked and lost all his property before he reached Calcutta in May 1830. Up to this time Protestant missions in India had been successful only in reaching low-caste and outcaste peoples, particularly in Tinevelly and south Travancore. The Hindu and Moslem communities had been practically untouched. Duff therefore devised the policy of an educational mission. He first opened an English school in which the Bible was the centre of the schoolwork, and along with it all kinds of secular knowledge were taught from the rudiments up to university standard. The school soon began to expand into a missionary college, and a government minute was adopted on March 7, 1835, which gave official sanction to Duff's aims.

After six years' furlough in England, Duff returned in 1840 to India. In 1839 the earl of Auckland, governor general, had yielded to the "orientalists" who opposed Duff, and adopted a policy which was a compromise between the two. At the Disruption of 1843 Duff sided with the Free Church and had to give up the college buildings, with all their effects, but with unabated courage he set to work to provide a new institution. He had the official support of Sir James Outram and Sir Henry Lawrence, and the encouragement of seeing a new band of converts, including several young men of high caste. In 1844 Viscount Hardinge opened government appointments to all who had studied in institutions similar to Duff's foundation. In the same year Duff took part in founding the *Calcutta Review*, of which from 1845 to 1849 he was editor. In 1849 he returned to England. He was moderator of the Free Church assembly in 1851 and again in 1873.

In 1856 Duff returned to India, condemning the government's policy in *The Indian Mutiny: Its Causes and Results* (1858). He gave much thought and time to the University of Calcutta, which owes its examination system and the prominence given to physical sciences to his influence. In 1863 Sir Charles Trevelyan offered him the post of vice-chancellor of the university, but his health compelled him to leave India. He continued his work for foreign missions in different parts of the world, and was the first occupant of the chair of foreign missions at New college, Edinburgh. At his death, on Feb. 12, 1878, he left his personal property to found lectures on foreign missions at the college.

See his *Life*, by George Smith, 2 vol. (1879).

DUFFERIN AND AVA, FREDERICK TEMPLE HAMILTON-TEMPLE-BLACKWOOD, 1ST MARQUESS OF (1826–1902), British diplomat who distinguished himself in several important posts, including those of governor general of Canada and viceroy of India, was born at Florence, Italy, on June 21, 1826. His father, Price Blackwood, 4th Baron Dufferin, died in 1841. His mother, Helen, one of the three beautiful Sheridan sisters, lived till 1867, and influenced him profoundly. He was educated at Eton and Christ Church, Oxford, and married Hariot Rowan Hamilton, an Irish neighbour, in 1862. He held undersecretaryships in 1864–66 and was Gladstone's chancellor of the duchy of Lancaster, outside the cabinet, in 1868–72; he was created earl of Dufferin in 1871.

Dufferin was governor general of Canada from 1872 to 1878. Behind his appearance, at once romantic and stately, and his graceful oratory, lay shrewdness and readiness to accept responsibility. He did much to weld the newly formed dominion together. Then, after two years as ambassador to Russia, he was moved in 1881 to Constantinople, where he had to deal with the consequences of Arabi Pasha's rising in Egypt and the resultant British intervention. His diplomatic adroitness assisted British arms in securing a firm foothold in Suez and Cairo; and he spent the winter of 1882–83 in Egypt reporting on government reorganization. He succeeded Lord Ripon as viceroy of India in 1884, and pursued a domestic policy equally friendly to the Indians without antagonizing, as Ripon had done, the Anglo-Indian community. In foreign policy, he improved relations with Afghanistan and helped to settle the Panjdeh crisis, which resulted from a Russo-Afghan frontier incident in 1885. By the annexation of Burma in 1886 he consolidated British territories. For his services he was made marquess of Dufferin and Ava when, in 1888, he retired from India. He spent three years (1889–91) as ambassador in Rome, and then four in Paris, where he established unexpectedly friendly relations with the French. He retired to his estates in Ulster in 1896.

Dufferin's last years were clouded by his eldest son's death at Ladysmith in 1900 and by business troubles. He died at Clandeboye, his house near Belfast, on Feb. 12, 1902.

See Sir Alfred Lyall, *Life of the Marquess of Dufferin and Ava*, 2 vol. (1905); Harold Nicolson, *Helen's Tower* (1937). (M. R. D. F.)

DUFFTOWN, a small burgh of Banffshire, Scot., in the parish of Mortlach and on the Fiddich, 17 mi. S.S.E. of Elgin by road. Pop. (1961) 1,555. It dates from 1816 and bears the name of its founder, James Duff, 4th earl of Fife. Although planned in the shape of a cross, with a square and tower in the middle, the arms of the cross are not straight, the constructor holding that, in order to prevent little towns from being taken in at a glance, their streets should be crooked. The leading industry is distilling, the water being good for whisky making. The town is a health resort. The Stone of Mortlach is traditionally believed to have been erected to commemorate the success of Malcolm II over the Danes in 1010. There are also three large stones known as "The King's Grave," a hill-fort and cairns. A portion of old Balvenie castle, a ruin, is considered to be of "Pictish" origin, but most of it is of the Scots Baronial period.

Three miles southeast of Dufftown is the ruined castle of Auchin-

down, on a limestone crag 200 ft. high, of which three sides are washed by the Fiddich and the fourth was protected by a moat. It dates from the 11th century, and once belonged to the Ogilvies, from whom it passed in 1535 to the Gordons. The Gothic hall with rows of fluted pillars is in fair preservation.

DUFFY, SIR CHARLES GAVAN (1816–1903), Irish-Australian statesman, who was a leading nationalist agitator in Ireland until 1855, when he emigrated to Australia and there embarked on a more successful political career, was born in Monaghan, Ire., on April 12, 1816. Mainly self-educated, he became a vigourous exponent of Irish nationalist views. While studying law in Dublin he met John Blake Dillon and Thomas Davis, and the three decided to found a new Irish weekly journal to express the aims of young nationalists of all classes and creeds. The *Nation,* founded in Oct. 1842, had an immediate popular success. Davis as poet and essayist was its chief inspiration, but Duffy's organization was the basis of its success. The young editors of the *Nation* were largely responsible for arranging the "monster meetings" of Daniel O'Connell (*q.v.*) in 1843. Duffy was imprisoned with other nationalist leaders after the great meeting at Clontarf had been suppressed. After his release Duffy and his colleagues opposed O'Connell's increasingly cautious policy. Known as the "Young Ireland" party, they demanded active agitation. In the famine of 1845–47 they formed the Irish confederation to compel effective measures of relief by the government. They made an abortive attempt at insurrection in Aug. 1848; just before it, Duffy was arrested and the *Nation* suppressed. On his release in 1849 he revived the weekly, but limited his agitation to a program of land reform. He was elected member of parliament for New Ross in 1852, and proceeded to organize an independent opposition of some 50 Irish members at Westminster, which would obstruct any government that did not support the demands of the Irish Tenant league. His parliamentary tactics foreshadowed those of C. S. Parnell, but Duffy's efforts were frustrated by the ambitions of individuals and by ecclesiastical distrust of his political views.

Duffy retired from Irish politics in 1855, declaring that he left Ireland "as a corpse on a dissecting table." In Australia, he was warmly welcomed by Irish exiles in Melbourne, where he practised as a barrister. Elected to the Victoria house of assembly in 1856, he became minister of land and works in 1857, and promoted an important Land act. He was prime minister of Victoria in 1871–72, and was knighted in 1873. He was speaker of the Victoria house of assembly from 1877 to 1880, when he retired to the south of France to write his recollections, which form a principal source of Irish history. His publications include *Young Ireland, 1840–50,* 2 vol. (1880–83), *The League of the North and South, 1850–54* (1886), *Thomas Davis* (1870) and *My Life in Two Hemispheres* (1898). Duffy died at Nice on Feb. 9, 1903.

(D. G.)

DUFOUR, GUILLAUME HENRI (Wilhelm Heinrich) (1787–1875), Swiss army officer who was elected four times to the supreme command of the Swiss army and was noted as a civil engineer, was born at Constance on Sept. 15, 1787. He studied in Geneva, at the École Polytechnique in Paris and at the École de Génie at Metz, from which he graduated first in his class. He served in Napoleon's army, defending Corfu in 1813 and taking part in the campaigns in France in 1814. He resigned in 1817 and returned to Switzerland, where he was appointed *ingénieur cantonal* and supervised constructional works which greatly improved Geneva. He helped to form the military school at Thun in 1818, where he became chief instructor. He was appointed chief of staff of the Swiss army in 1831 and commanded a division sent to restore order in Basel in 1833. In the same year, he began his pioneer topographical survey of Switzerland (published 1842–64). Dufour was elected general of the federal army to act against the Sonderbund in 1847 (*see* Switzerland: *The Sonderbund War*) and displayed skill and moderation in its suppression. He was elected general for the second time in 1849 to maintain Swiss neutrality in the face of insurgents from Baden; again in 1856, during the conflict with Prussia over Neuchâtel; and finally in 1859, when the French were about to annex Savoy. He presided over the international congress in Geneva in 1864 which drew up the convention for the wounded in time of war and resulted in the creation of the Red Cross. He sat in the federal assembly as a Conservative. He died at Les Contamines, near Geneva, on July 14, 1875.

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DUFRESNOY, CHARLES ALPHONSE (1611–1665), French painter and writer on art, was born in Paris. He learned the rudiments of design under Perrier and Vouet. At the age of 21 he went to Rome, and there studied Raphael and the antique. He went in 1633 to Venice, and in 1656 returned to France. He died at Villiers le Bel, near Paris. His Latin poem, *De arte graphica,* written during his Italian sojourn, was translated into several languages.

DUFY, RAOUL (1877–1953), French painter and designer, known for his scenes of sailboats, bathers, the race course and other themes vibrating with colour juxtapositions, was born June 3, 1877, at the seaport of Le Havre, where he passed his childhood. In 1900 he went to Paris to attend the École des Beaux-Arts. But conventional museum art repelled him; rather he was fascinated by Impressionist and post-Impressionist art. The 1901 Van Gogh exhibition was a great influence on him as was the work of Henri Matisse in the famous 1905 Salon d'Automne exhibition. By 1907 Dufy had broken with the Impressionist idea of pure colour, moving toward the intensified tonalities of the *Fauve* (wild beast) school. During 1908–09 he worked with Georges Braque and Émile Othon Friesz. In 1911 he did a series of woodcut illustrations for Guillaume Apollinaire's *Le Bestiaire.* This, together with a new-found friendship with the fashion designer Paul Poiret, led him to do woodblock designs for textiles and set up his own factory. In 1920 Dufy began to produce pottery and the following year tapestries. His well-known paintings of Nice date from 1927; the Bois de Boulogne scenes from 1929 and those of Deauville from 1930. Although Dufy's life was marked by commercial and semicommercial projects, it is possible to disengage Dufy the sensitive painter from them. He died March 23, 1953, in Forcalquier.

(B. S. Ms.)

DUGDALE, SIR WILLIAM (1605–1686), English scholar and one of England's most distinguished antiquaries, was born at Shustoke, Warwickshire, on Sept. 12, 1605. He attended the Free school at Coventry and from an early age was encouraged by his father to study history and antiquities. At 17 he married Margery Huntbach, daughter of a Staffordshire gentleman, and settled as a small landowner at Blyth hall, Warwickshire.

At this time Dugdale became friendly with William Burton, author of a *Description of Leicestershire* (1622). Burton introduced him to Sir Simon Archer of Tanworth, Warwickshire, who was collecting material for a history of Warwickshire. The two subsequently worked together on this project and through Archer, Dugdale obtained access to the records of the Warwickshire gentry. Gradually he became the centre of a scholarly circle and, following an introduction to Sir Henry Spelman in London, he was persuaded to collaborate with Roger Dodsworth in the production of a *Monasticon Anglicanum,* a collection of records relating to monastic foundations. This was subsequently published under Dugdale's name in three separate volumes in 1655, 1661 and 1673. Dugdale's *Antiquities of Warwickshire* appeared in 1656 and was followed by *History of St. Paul's Cathedral* (1658); *History of Imbanking and Draining* (1662); *Origines Juridiciales* (1666); *Baronage of England* (1675–76); and *A Short View of the Late Troubles in England* (1681).

Dugdale was also a professional herald closely associated with the political events of his time. He was appointed a pursuivant extraordinary in 1638 and became Rouge Croix pursuivant in 1640. In 1641, at the instigation of Sir Christopher Hatton who foresaw the approaching Civil War, he undertook a survey of all the monuments and armorial glass in St. Paul's and Westminster abbey and at Peterborough, York, Lincoln and elsewhere. When war broke out he attended Charles I at York and subsequently sum-

moned various castles, including those of Banbury and Warwick, to surrender. He was at Oxford with the king and court from 1642 to 1646 and during his stay collected material for his books at the Bodleian and college libraries. He was admitted an M.A. of the university in Nov. 1642. He compounded for his estates, which had been sequestrated, in 1646 and subsequently resumed his researches in Warwickshire and London. He was created Norroy king of arms in 1660 and undertook a series of visitations to register the coats of arms and pedigrees of the local gentry during the following years. In 1677 he was created Garter king of arms and was knighted. He died at Blyth hall on Feb. 10, 1686.

In the course of a busy working life Dugdale came to be the foremost figure in a small group of medieval scholars whose correspondence, transcriptions and published works laid the foundations of modern English historical scholarship. Pre-eminently a student of charters and an exponent of their use, Dugdale excelled in the field of family history. Yet his interests in history and antiquities in the broadest sense were remarkably diverse. He was a pioneer in the technique of historical research and his work displays an accuracy and insight of an unusual order for his period.

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DUGHET, GASPARD (called GASPARD POUSSIN) (1615–1675), French painter, who called himself after his brother-in-law, Nicolas Poussin, was born and died in Rome. He worked chiefly in Rome and its vicinity throughout his life; but his father was French and it is usual to class him among the French school. His activity was exclusively in the field of landscape painting.

Though the chronology of his works is uncertain, his style is familiar, being composed mainly of elements derived in varying proportions from his brother-in-law and from Claude Lorrain. He tended sometimes toward the former's architectonic grandeur, sometimes toward the latter's more lyrical style, but as a rule produced a compromise between them. The landscapes of Paul Bril, Annibale Carracci and Domenichino must also be counted among the influences on his work. Most of his paintings express in an ideal, though not poetic, form, the character of the countryside round Rome. He also made a specialty of land storms. Important series of his works are to be found in the Colonna and Doria-Pamfili palaces in Rome. Many are still in England, where, in the 18th century, they were taken as models for the design of landscape gardens and parks. (M. W. L. K.)

DUGONG, one of the two existing genera of the order Sirenia (*q.v.*), herbivorous aquatic mammals of warm coastal waters. Dugongs (*Dugong*) are distinguished from their Atlantic-inhabiting ordinal relations the manatees (*q.v.*) by, among other anatomical features, their smaller size (7 to 9 ft. in the adult), broad crescent-shaped whalelike tail, fewer teeth (no more than six flat-surfaced molars on each side of either jaw), tusks in the upper jaw of the male and absence of nails on the well-developed fore flipper. The bones are hard and firm, and the generalized skeleton shows similarities with that of the elephant, though the hind limb bones are practically lost.

Dugongs frequent the shallow waters of far eastern tropical seas where, in small groups, they may be seen basking on the surface of the water, or browsing on submarine pastures of seaweed, for which the thick, fleshy lips and truncated snout pre-eminently fit them. When submerged during feeding the dugong surfaces every five to ten minutes for a fresh supply of air. Although it has poor eyesight, its hearing, despite the lack of external ears, is quite good. The female produces a single calf 12 months after mating, and is remarkable for its great maternal affection; the young is embraced with one flipper while it nurses on one of the two pectoral teats.

One species, with possibly several races, is known as *Dugong dugong*. This is distributed in the Red sea, the Indian ocean and east in the Pacific as far as the Solomon and Marshall Islands; it ranges south along the coast of northern Queensland, Austr., and north into the East China Sea. The islanders frequently hunt it with spears or harpoons, for its flesh is an esteemed delicacy. The oil obtained from its blubber has been of commercial value and a full grown dugong may yield from 10 to 12 gal. In recent years the dugong has been in special danger of extinction. For a discussion of evolutionary history, *see* UNGULATA.

DUGUAY-TROUIN, RENÉ (1673–1736), French privateer and naval officer who won a great reputation for daring during Louis XIV's wars, was born at St. Malo, on June 10, 1673. A younger son, he was destined for the church, but no college could discipline his turbulent spirit, and it was decided he should become a sailor. Serving on the "Trinité" at the age of 16 and commanding the "Danycan," equipped by his family for privateering, at 19, he had a hard apprenticeship. In 1694, his ship the "Diligente" was overcome by six enemy vessels and he was taken prisoner, but he escaped from Plymouth through the help of a young woman. During the next three years he fought a series of astonishing battles. Louis XIV gave him a sword of honour for the capture of the "Nonesuch" in 1695, and at 24 Duguay-Trouin received a commission as captain of a frigate.

The inferiority of the French navy during the War of the Spanish Succession and then the long period of peace after the treaties of Utrecht prevented Duguay-Trouin from showing the full extent of his ability: he commanded only small ships or small divisions. He attacked the Dutch whaling ships at Spitzbergen in 1703 and a rich fleet of Portuguese galleons in the Atlantic (1706) and, with Claude de Forbin, took part in the famous fight off the Lizard (1707). In 1709 he received letters patent of nobility. In 1711 the king lent several ships to the St. Malo privateers, and the squadron of Duguay-Trouin boldly entered the harbour at Rio de Janeiro and held the town to ransom. This success, although it came too late in the war to help French fortunes, did bring a ray of hope to France during a time of mourning and defeat. After the peace Duguay-Trouin was made a lieutenant-general in 1728. He led his last expedition, against the Barbary pirates, in 1731. He died in Paris on Sept. 27, 1736. His character was complex. Extravagant, prodigal, daring but at the same time calculating and prudent, forceful but kind-hearted, excitable, superstitious and outstandingly brave, he combined a tone of working detachment with a strong sense of honour and of duty: "I give my services only for the pleasure of serving." (L. Ni.)

DU GUESCLIN, BERTRAND (*c.* 1323–1380), Breton soldier and constable of France, an outstanding military leader on the French side in the first period of the Hundred Years' War, was born at the castle of La-Motte-Broons, near Dinan. Of his youth nothing is known except what is related in the poem about him by his contemporary Jean Cuvelier, much of which is of doubtful value as history. As a young squire, Du Guesclin learned the art of soldiering in the skirmishes of the War of the Breton Succession between Charles of Blois and John IV (Jean de Montfort). His real military career began when the English under Henry, duke of Lancaster, were besieging Rennes (Oct. 1356–July 1357); it was at this time that his famous duel with Sir Thomas Canterbury took place. Du Guesclin succeeded in forcing his way into Rennes and defended it for several months. He was, on Dec. 6, 1357, rewarded by the dauphin (the future Charles V) with a pension of 200 livres for this action. About the same time (by Dec. 13 at the latest), he was appointed captain of Pontorson for the dauphin's uncle, Philippe, duc d'Orléans. Henceforth he remained in the service of the French royal house of Valois.

Du Guesclin left Pontorson in June 1359 in order to take part in the siege of Melun, but was captured by Sir Robert Knollys on his way back. Set free after the treaty of Brétigny between France and England (1360), he fought against the pillaging *compagnies* (bands of mercenaries) in Normandy, Maine and Perche. He was again taken prisoner at Juigné.

In 1363 Du Guesclin was captain-general in the Norman *bailliages* of Caen and Cotentin, and by the beginning of 1364 his authority extended over the whole of Normandy and over Beauce. In April 1364 he took Mantes and Meulan from the forces holding them for Charles II of Navarre, and in May he defeated the Navarrese at Cocherel, taking prisoner the famous Jean de Grailly,

captal de Buch (*q.v.*). Appointed chamberlain by Charles V on his accession, he relinquished the position of captain-general in Normandy on being recalled to Brittany by Charles of Blois. At the battle of Auray (Sept. 29, 1364), in which Charles of Blois was killed, Du Guesclin was captured by Sir John Chandos. Having paid 40,000 gold francs for his ransom, Charles V entrusted Du Guesclin with the task of leading the *compagnies* into Spain to fight for Henry of Trastámara against Pedro I the Cruel. Du Guesclin set off in Sept. 1365, going via Avignon, and in 1366 Henry was proclaimed king of Castile. Edward the Black Prince, however, then intervened on Pedro's behalf and defeated and captured Du Guesclin at the battle of Nájera (April 3, 1367). Released after considerable difficulty and in exchange for an enormous ransom, Du Guesclin went to Provence to advance the designs of Louis of Anjou on that country (March–April 1368). He then led a second expedition to Spain, which resulted in Henry's final victory and Pedro's death at Montiel (March 1369). For his services Henry created him duque de Soria y Molina.

In 1370 Charles V recalled Du Guesclin and appointed him constable of France. The constable then defeated his old opponent Knollys at Pontvallain and occupied Poitou and Saintonge. Against the great cavalry raids across France by the English, he recommended careful tactics designed to contain and exhaust the enemy.

Expeditions against the English and against the mercenary bands occupied most of Du Guesclin's last years. It was against his advice that Charles decided, in 1378, to confiscate the duchy of Brittany from John IV, whom Du Guesclin had already effectively expelled from the country in 1373. Sent into Languedoc in 1380 to suppress disorders, Du Guesclin was taken ill while laying siege to the castle of Châteauneuf-de-Randon and died on July 13, 1380. After the death of his first wife, Tiphaine Raguenel, whom he had married in 1364, he had married Jeanne de Laval, dame de Tinténiac, in 1374.

See S. Luce, *Histoire de Bertrand du Guesclin et de son époque* (1876); R. Delachenal, *Histoire de Charles V*, 5 vol. (1909–32).

(R. Cs.)

DUGUIT, LÉON (1859–1928), French jurist, one of the most revolutionary legal thinkers of his generation, was born at Libourne, Gironde, Feb. 4, 1859. He studied law at the University of Bordeaux and was appointed professor in the faculty of law at Caen in 1883. In 1886 he returned as professor to Bordeaux, where he became dean of the faculty of law and remained until his death, Dec. 18, 1928. A brilliant teacher and an authority on constitutional law, he gained a world-wide reputation as a legal philosopher. Discarding the traditional theories of law and the state, he found the basis of law in the fact that man was a social animal endowed with a sense of social solidarity. Out of this sense came the recognition of certain rules of conduct as essential for life in society.

In his view the state had neither personality nor sovereign power; governments, like individuals, were bound by the rules of law derived from social necessity. Despite subsequent criticism, Duguit's work remains an important and original contribution to legal thought.

Duguit's more important works include: *Des Fonctions de l'état moderne* (1894); *Les Constitutions et les principales lois politiques de la France depuis 1789*, with H. Monnier, 3rd ed. (1915); *Les transformations générales du droit privé*, etc. (1912); *Traité de droit constitutionnel*, 5 vol., 2nd ed. (1921); *Jean Jacques Rousseau, Kant et Hegel* (1918); *Law in the Modern State* (Eng. trans., 1921).

(L. N. B.)

DUHAMEL, GEORGES (1884–), French author and novelist who sought to uphold traditional values and to safeguard individual liberties, was born in Paris on June 30, 1884. He took a science degree in 1908, and qualified as a doctor of medicine in 1909; his interest in science and medicine, and in music and the theatre, was reflected in his writings. Extensive travels provided a further source of material. He was a prolific writer on many subjects.

Duhamel began by writing poetry, plays and literary criticism, and as a critic was one of the first to draw attention to the works of Paul Claudel. In 1906, he joined in founding a small community at Créteil-sur-Marne, known as the Abbaye. It was there that he met Blanche Albane, an actress, whom he married in 1909. The members of this group hoped to earn their living as printers and to combine manual and intellectual pursuits, but the experiment proved unsuccessful, and after 14 months they went their separate ways. Nevertheless, this association promoted the sense of fraternity and social responsibility which several of them were to express, notably Duhamel himself, and Jules Romains (*q.v.*), who was connected with them.

Duhamel served as a front-line surgeon during World War I. He was deeply moved by the sufferings which he witnessed, and oppressed by the futility of war. His experiences were recorded in two notable books: *Vie des martyrs* (1917; Eng. trans. 1918) and *Civilisation* (1918; Eng. trans. 1920).

In 1920, he decided to make writing his career. Henceforth, he chiefly wrote novels, and a great variety of essays and miscellaneous works discussing social and moral issues. Duhamel was an agnostic, and based his philosophy on human values, particularly moderation, tolerance and kindliness. He sought to preserve what was best in civilization, and to maintain individual freedom in an age of growing standardization. His distrust of mechanical or material progress, his misgivings about the future of mankind and his compassion for human misfortunes inspire much of his writing. His views were expressed in such works as *La Possession du monde* (1919); *Le Voyage de Mascou* (1927); *Scènes de la vie future* (1930), describing his impressions of the United States; *Défense des lettres* (1937); *Civilisation française* (1944); *Problèmes de l'heure* (1957). He also wrote memoirs, records of World War II (*Lieu d'asile*), stories for or about children and works expressing his feeling for nature (*Les Plaisirs et les jeux, Fables de mon jardin*).

His reputation as a novelist rests mainly on two novel-cycles. Both contain many reflections of his own experiences. The first, entitled *Vie et aventures de Salavin*, 5 vol. (1920–32; Eng. trans. *Salavin*, vol. i–iv, 1936), describes the frustrations and perplexities of a "little man" of the 20th century, trying to work out his own salvation with no religious faith to sustain him. In the second cycle, *Chronique des Pasquier*, 10 vol. (1933–44; Eng. trans. 1937–46), Duhamel relates the history of a French middle-class family, from the 1880s to the 1920s. His gifts of humour, sympathy and observation are here particularly apparent. Other novels include *La Pierre d'Horeb* (1926); *Le Voyage de Patrice Périot* (1950); *Le Complexe de Théopile* (1958).

Duhamel became a member of the Académie Française in 1935. He was president of the *Alliance française* from 1937 to 1949, and subsequently its first honorary president.

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(S. C. Go.)

DÜHRING, EUGEN KARL (1833–1921), German philosopher and political economist, standing with Ernst Mach and Richard Avenarius as one of the most notable German positivists, was born at Berlin on Jan. 12, 1833. After practising as a lawyer (until 1859), he turned to free-lance studies because of incipient blindness and became *Privatdozent* at Berlin university in 1864; but in 1877 his licence to teach was withdrawn in consequence of a quarrel with the professors there. His work includes histories and systematic treatises in the fields of mathematics, physics and literature, but he is chiefly remembered for his contributions to philosophy and economics.

Dühring's most important books are: *Kapital und Arbeit* (1865); *Der Wert des Lebens* (1865); *Natürliche Dialektik* (1865); *Carey's Umwälzung der Volkswirtschaftslehre und Sozialwissenschaft* (1865); *Kritische Geschichte der Philosophie* (1869); *Kritische Geschichte der allgemeinen Principien der Mechanik* (1873), one of his most successful works; *Cursus der National- und Sozialökonomie* (1873–92); *Sache, Leben und Feinde* (1882), an autobiography; and *Der Ersatz der Religion durch Vollkommeneres* (1883). Dühring died at Nowawes (Potsdam) on Sept. 21, 1921.

In his theory of knowledge Dühring proceeds from a concept of

reality expressed in strongly scientific terms: our intellect is capable of comprehending the whole of reality, since the laws of the intellect and those of reality are the same. In his early work Dühring concerned himself with the analysis of the epistemological problems raised by this thesis, but in his later writings his concept of reality stiffened into a dogmatic materialism. In the place of the mystical metaphysics current in his day Dühring sought to erect a world system characterized by the antagonism of different powers, with a "law of difference" ruling both the physical world and the consciousness. Yet he held that nature aims generally at a combination of powers. Dühring maintained this optimistic view in his ethics: the origins of morality lie in our naturally "sympathetic" instincts. Individualism and socialism belong inevitably together.

As an economist Dühring placed sociological factors above economic ones. He rejected the Darwinian struggle for existence and put in its place the idea of a "free society" in which all relations based on power are abolished and all human relations are socialized. Following H. C. Carey and F. List, he emphasized the "national" character of economics.

Friedrich Engels, in his famous textbook of Marxism, *Herrn Eugen Dührings Umwälzung der Wissenschaft* (1878; later and more familiarly known as *Anti-Dühring*); Eng. trans. by E. Burns, ed. by C. P. Dutt (1943), dissociated himself from Dühring's "vulgar materialism" and from his utopian socialist ideas: whereas Dühring had contested the importance of Hegel, Engels argued that Hegel's "revolutionary side" had always been misjudged and that the discovery of dialectic was an immortal service distinguishing Hegel from all "metaphysicians." Nevertheless, Engels' own position with regard to the theory of knowledge does not differ from Dühring's naïve realism.

See E. Döll, *Eugen Dühring* (1893); Gerhard Albrecht, *Eugen Dührings Wertlehre* (1914) and *Eugen Dühring* (Jena, 1927); and H. Lamberz, *Carey und Dühring* (1926). (M. O. G.)

DUIKER (DUIKERBOK, DUIKERBUCK), small African antelopes of forest and brush country. The popular names (derived from the Dutch) allude to the animal's habit of diving into and threading its way through thick bush. *See* ANTELOPE: *Subfamily Cephalophinae;* BOVIDAE.

DUILIUS (DUELLIUS), **GAIUS** (3rd century B.C.), Roman general during the First Punic War. In 260 B.C., when consul in command of the land forces in Sicily, he superseded his colleague Gnaeus Cornelius Scipio Asina, who was captured, as commander of the fleet. Recognizing that for the unskilled Romans the best chance of victory lay in fighting under conditions as similar as possible to those of a land engagement, he invented boarding bridges with grappling irons (*corvi*), and gained a brilliant victory over the Carthaginian fleet off Mylae on the north coast of Sicily. He was granted the first naval triumph in Rome's history, and a memorial column adorned with the beaks of the captured ships (*rostra*) was set up in the forum. In 258 he was censor. *See* also PUNIC WARS.

See *Corpus, Inscriptionum Latinarum,* 2nd ed., vol. 1, part 2, no. 25 (1918); Polybius, *History,* i, 22–23.

DUISBURG, an industrial town of Germany which after partition of the nation following World War II was located in the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. It stands at the junction of the Rhine and the Ruhr. One of Germany's great iron and steel towns, and one of the largest inland ports in the world, Duisburg is connected with the north German ports by the Rhine-Herne canal which links it with Dortmund and thus with the Dortmund-Ems canal. Pop. (1961) 502,993.

The present town was formed by the incorporation of a number of other centres—Ruhrort (which includes the harbour) and Meiderich in 1905 and Hamborn (the chief industrial area), Hochfeld, Neudorf and Düssern in 1929. From 1929 until 1934 it was called Duisburg-Hamborn. It is divided into three main districts. The heart of the town lies south of the Rhine-Ruhr junction, with suburbs and a garden city spreading up the surrounding wooded hills and well-planned industrial areas. To the north is the port area, and to the northwest the sprawling industrial area of Hamborn. There are a number of bridges over the river. The centre of the town is formed by three shopping streets near which lie the Burgplatz, site of the 8th-century Frankish court and of a foundation (1253) of the Teutonic order (*q.v.*). Although many of Duisburg's medieval buildings were destroyed in World War II, the 13th-century Gothic Salvatorkirche (which contains the grave of Mercator) and the 12th-century Romanesque Premonstratensian abbey in Duisburg-Hamborn are still standing. There are a Municipal Arts museum and a local history museum. The zoo contains the largest aquarium in western Germany.

Duisburg is connected by helicopter with Brussels, Belg., and thus with international air services. Its port has 23 docks, over 31 mi. of quays and one of the biggest grain-loading conveyors in Europe, handling an average of 10,000 tons a day. In the mid-1950s Duisburg produced about 25% of the German Federal Republic's steel and 30% of its iron. It is also a centre of coal mining, and manufactures foodstuffs, textiles, wood and metal products and chemicals.

Known to the Romans as Castrum Deutonis and to the Franks as Diuspargum, Duisburg became a free imperial city in the 12th century. In the 17th century it was acquired by Brandenburg, and the elector Frederick William founded a Protestant university in 1655, which flourished until 1802. Its most important period of development came with increasing industrialization after 1880. It was occupied by Belgian troops during 1921–25, and was heavily bombed during World War II.

DUJARDIN, FÉLIX (1801–1860), French biologist and pioneer in cytology, was born at Tours on April 5, 1801, and died at Rennes on April 8, 1860. He forsook art and engineering for natural science, and in 1839 was appointed professor of mineralogy at Toulouse. He was subsequently dean and professor of zoology at Rennes university.

In 1835 Dujardin distinguished protoplasm from other viscid substances, designating it "sarcode" and assigning to it all the qualities of life. He made detailed studies of rhizopods and of oceanic foraminifera and was the first to recognize Infusoria as a special unicellular group.

Dujardin's writings include *Histoire Naturelle des zoophytes infusoires* (1841), *Manuel de l'observateur au microscope* (1843) and *Histoire naturelle des helminthes* (1844). (W. J. BP.)

DUJARDIN, KAREL (1622–1678), Dutch painter and etcher, best known for his spirited representations of Italian peasants and shepherds with their animals. Born in Amsterdam in 1622, he was a son of the painter Guilliam Dujardin and a pupil of Nicolaes Berchem. After a trip to Italy, he worked in Amsterdam and The Hague from 1652 until 1674; after that he returned to Rome where he stayed until shortly before his death in Venice on Nov. 20, 1678. He also painted religious, mythological and allegorical subjects, various genre scenes and a number of excellent likenesses, notably a large group portrait (Rijksmuseum, Amsterdam). (W. Sw.)

DUKAS, PAUL ABRAHAM (1865–1935), French composer whose fame and popularity rest on a single orchestral work, *L'Apprenti sorcier,* was born in Paris on Oct. 1, 1865, and studied at the Paris conservatory under T. Dubois, G. Mathias and E. Guiraud. After winning a second Grand Prix de Rome with his cantata *Velléda* (1888), he established his position among the younger composers with the overture to Corneille's *Polyeucte,* first performed in 1892, and the Symphony in C major (1896). The remainder of his output (never large because of his own strict censorship of his works) consisted mainly of dramatic and program music and compositions for piano. Dukas, who was a master of orchestration, was from 1910 to 1913 professor of the orchestral class at the Paris conservatory and, from 1913 till his death in Paris on May 17, 1935, professor of composition there. Dukas also contributed musical criticism to several Paris papers and his collected writings, *Les Écrits de Paul Dukas* (1948), include some of the best essays ever published on Rameau, Gluck and Berlioz.

Dukas' *L'Apprenti sorcier* (1897, based on Goethe's *Der Zauberlehrling*) was a piece of descriptive music written at the same time and in much the same style as Richard Strauss's *Till*

Eulenspiegel. Yet Dukas' musicianship was of a considerably wider range than this brilliant period-piece attests. His *Sonate* (1901) is one of the last great works for piano that prolong the tradition of Beethoven, Schumann and Liszt; his *Variations, Interlude et Finale pour piano sur un thème de Rameau* (1903) represent an elegant translation into French musical idiom and style of Beethoven's formidable *Diabelli Variations,* op. 120. The ballet, *La Péri* (1912), on the other hand, displays consummate mastery of impressionist scoring; and in Dukas' opera *Ariane et Barbe-Bleue* (1907), on the play of Maurice Maeterlinck, poetic atmosphere and perfection of musical texture make up for lack of dramatic impact.

After 1912 Dukas ceased publishing his compositions—except for a piano piece written in memory of his admirer Claude Debussy (d. 1918), the evocative *La Plainte au loin du Faune* (1920), and a song setting, the charming *Sonnet de Ronsard* (1924)—and a few weeks before his death, he destroyed all his musical manuscripts. Dukas collaborated with the Paris publishing firm of Durand in preparing modern editions of some of the works of Rameau, Couperin and D. Scarlatti and of the piano works of Beethoven.

An admirable pedagogue (Manuel de Falla was among his disciples and Oliver Messiaen was one of his pupils), a shrewd observer of the musical scene, a tireless reader of every score ancient and modern and of every literary work he could lay hands on, Dukas was that rare man among modern musicians: a 20th-century humanist.

See G. Favre, *Paul Dukas, sa vie, son oeuvre* (1948). (F. E. G.)

DUKE, JAMES BUCHANAN (1856–1925), U.S. tobacco manufacturer and philanthropist, was born on a farm near Durham, N.C., on Dec. 23, 1856. His father, Washington Duke, entered the tobacco business after the Civil War. James, who with his brother Benjamin Duke (1855–1929) entered the business at an early age, became president in 1890 of a combination of major cigarette manufacturers, the American Tobacco company. He also came to control several other tobacco manufacturing combinations. In 1911 the United States supreme court ordered the dissolution of the American Tobacco company, and James Duke bore the chief responsibilities in arranging the dissolution. The Duke family contributed heavily to Trinity college in Durham, which was expanded into a university and named Duke university under provisions of a fund created by James Duke (Dec. 1924). By the indenture of 1924 and by his will, James also provided funds for other educational and charitable purposes in North and South Carolina. He died on Oct. 10, 1925. (H. J. Sg.)

DUKE, a European title of nobility: Lat. *dux* (cf. *ducere,* "to lead"), It. *duca,* Fr. *duc,* Sp. and Port. *duque,* Ger. *Herzog.*

Origins.—Under the early Roman empire, when the regular army groups were commanded by the governors (*legati Augusti pro praetore*) of the provinces in which they were stationed, the title *dux* was normally applied only to generals of special expeditionary forces; the title was followed by a description of the force and often of the campaign for which it had been assembled. When Diocletian and Constantine I separated the military command of a province from its civil administration, they gave to the military commander the title of *dux.* The *Notitia Dignitatum* records 25 *duces,* distinguished by their provinces, all round the frontiers of the empire from the *dux Britanniarum* to the *dux Armeniae.* Some district commanders were dignified with the then higher title of *comes* (*see* Count); *e.g.,* the *comes Aegypti* and, in Britain, the *comes littoris Saxonici,* or "count of the Saxon shore."

The title of *dux* was taken over in the Visigothic, Ostrogothic and Merovingian kingdoms that succeeded the Roman empire in the west: a *dux provinciae* is recorded in Spain, a *dux Raetiae* in Italy, and *duces* commanding a group of *civitates* or municipalities in Gaul. As the title *comes* was in these kingdoms normally given to the military governors of a single *civitas,* a duke came naturally to rank higher than a count.

Tacitus, in his account of the ancient German tribes in the 1st century A.D., states that they chose "their kings for their noble lineage, the leaders [*duces*] for their prowess." These early Germanic dukes, then, were "leaders of the host" (Old Ger. *herizogo; cf. Heer,* "army"), elected originally by their tribes for the conduct of a campaign but ready when occasion arose to establish themselves permanently—as for instance when the Lombard dukes of Benevento and Spoleto made themselves independent of the Lombard kings in Italy from the end of the 6th century. In Merovingian France likewise in the 7th and 8th centuries dissident and outlying peoples such as the Basques (Gascons) and the Aquitanians set up tribal dukes of their own.

The early Carolingian sovereigns in France and in Germany continued to appoint dukes, but their weaker successors found themselves constrained to free the dukes more and more from royal control in the areas that they had to defend.

Germany.—Franconia, Swabia, Bavaria and Saxony (*qq.v.*), originally the homes of distinct tribes, emerged as the great "stem-duchies" of Germany as the dukes appointed by the Carolingians as military governors made themselves increasingly independent. In the first 100 years of the post-Carolingian period the tribal character of these duchies disappeared: in Franconia from 939, when the emperor Otto I took that duchy into his own hands. They retained their old boundaries, however, even when new men took advantage of the political turmoil to set themselves up as dukes.

The earlier emperors of the 11th century, especially Henry III, were able to assert their authority over the dukes, but the Investiture contest weakened this control (*see* Investiture Controversy). In the 12th century the Hohenstaufen emperors, who created the new duchies of Austria (1156) and Styria (1180) and even deposed such a magnate as Henry the Lion of Saxony, seemed likely to succeed in building a strong central authority around the growing royal principality of Franconia and in reducing the dukes to genuinely obedient vassalage; and at the same time the lesser noble families began to consolidate their own holdings and their ancient allodial jurisdiction at the expense of the ducal authority, gradually acquiring various new rights such as criminal jurisdiction and direct taxation. The growth of these smaller territorial principalities (countships, etc.) naturally diminished the real prestige of the dukes. Despite the collapse of the Hohenstaufen design after 1250 and the success of the dukes in securing their independence in their own principalities, their title came to denote no longer greater power under the king, but only a higher rank than that of the princely counts. By the end of the 15th century Brunswick (1235), Mecklenburg (1348), Jülich (1356), Berg (1380), Cleves (1417), Holstein (1474) and Württemberg (1495) had been raised to the rank of duchies. Furthermore, with the extensive privileges accorded the electors (only one of whom was a duke) by the Golden Bull of 1356, the duke had ceased even in theory to be the highest-ranking of the princes of the empire; the Austrian dukes indeed assumed the new title of archduke (*q.v.*), claiming equal rights with electors.

In the 16th, 17th and 18th centuries, therefore, the Habsburg emperors were ready to accord the title of duke quite readily for honorific purposes to the lords of comparatively small territories. In 1805, the year before the Confederation of the Rhine and the dissolution of the Holy Roman empire, there were ten sovereign dukes in the empire (apart from duchies held by the Habsburgs or by the electoral princes); namely those of Oldenburg, of Brunswick, of Mecklenburg-Strelitz, of Mecklenburg-Schwerin, of Saxe-Weimar, of Saxe-Gotha-Altenburg, of Saxe-Coburg-Saalfeld, of Saxe-Hildburghausen, of Arenberg and of Croy-Dülmen; and there were also the "dukes in Bavaria," as the Wittelsbachs of the Birkenfeld-Gelnhausen line were styled from 1799. The counts of Nassau took the ducal title in 1806, the princes of Anhalt in 1807. The Napoleonic grand duchy of Berg disappeared at the Restoration settlement, but Oldenburg, the two Mecklenburgs, Saxe-Weimar (as the grand duchy of Saxony), Baden and Hesse-Darmstadt were grand duchies (*see* Grand Duke) and Anhalt, Brunswick, Saxe-Altenburg, Saxe-Meiningen and Saxe-Coburg and Gotha sovereign duchies till the end of the German empire in 1918.

France.—The dukes of Normandy, Aquitaine and Burgundy (*qq.v.*) were practically independent of the French crown in the early feudal period, as also was the duke of Brittany, though the

French royal chancellery at first accorded him only the style of count. Gradually, however, these great fiefs were reunited to the French crown. Thereafter they were granted only in appanage, as *duchés-pairies,* or peerage duchies, to princes of the blood royal. The first authentic list of "the 12 peers" of France (1257) cites three ecclesiastical dukes (the archbishop-duke of Reims and the bishops-dukes of Langres and Laon) and three lay dukes (Normandy, Aquitaine and Burgundy). In 1297, however, Brittany was "erected" into a *duché-pairie.* Thereafter these erections became frequent. At first reserved for legitimate princes of the blood, *duchés-pairies* were accorded from the 16th century onward to bastard princes of the blood, to foreign princes and to other noble subjects of the French king. The royal letters erecting a *duché-pairie* had to be registered in one of the *parlements,* after which the holder could sit and vote in the *parlement* of Paris (bitter quarrels about precedence might arise through delays between erection and registration, where one duchy's letters antedated those of another that had been registered earlier). *Duchés-pairies* were hereditary, but there were also hereditary duchies which were not peerages, as well as life duchies (*à brevet* or *par lettres*). By an edict of 1711, succession to hereditary duchies was confined to male descendents; for succession by marriage to duchies already created with female succession in default of males, royal approval had to be obtained. Apart from those in the royal house of France, there were 34 ducal titles dating from the *ancien régime* still being borne in the 1960s, the premier duchy of France being that of Uzès (1565; registered 1572).

After the Revolution, Napoleon I bestowed 35 ducal titles (with names nearly all taken from outside France proper), the Restoration monarchy 17, the July monarchy 4 (one of them not ratified) and Napoleon III 14.

Italy.—The great territorial duchies of Italy which survived into modern times were those of Milan, Florence (as the grand duchy of Tuscany), Lucca, Mantua, Modena and Parma-Piacenza (*qq.v.*); the use of the title of doge (*q.v.*) for the head of the Venetian and Genoese republics is a different matter. The popes, the emperors and the kings of Naples, however, could all bestow the ducal title as they wished and did so often enough, with the consequence that it is now fairly widespread. The kings of the house of Savoy gave the title of *duca* occasionally to their offspring: apart from the titles in that house before the formation of the Italian kingdom (Savoy, Aosta, Genoa, etc.), four such duchies were conferred on members of the royal house in 1904 (Puglia, Spoleto, Pistoia and Bergamo) and one more in 1906 (Ancona).

Spain.—The Visigothic duchies of Spain disappeared under the Muslims. During the Christian reconquest the title *duque* was revived for honorific purposes. The duchy of Gerona (1351), created by Peter IV of Aragon for the future John I, provided a regular title for the heir apparent to the Aragonese throne. Apart from the Castilian duchy of Soria y Molina, created in 1370 for Bertrand du Guesclin, the title was at first usually reserved for royal princes, but from the middle of the 15th century onward it was accorded more and more frequently to other nobles. Of these latter creations, the premier surviving is that of Medina Sidonia (1445). The Spanish kings also created duchies very liberally in their Neapolitan and Sicilian dominions. As a result of female succession many ducal titles may be accumulated by one person (in the 1960s the duque de Medinaceli, for instance, had seven other ducal titles), and the practice of "rehabilitating" titles long in abeyance (on payment of a fee) makes the number of existing duchies very fluid. In fact the importance of the title depends on the number of *grandezas* attached to it (*see* GRANDEE); hence the use of the style *conde-duque* for the Benavente and the Olivares titles, as the countships of Benavente and of Guzman were already of conspicuous *grandeza* when their holders were raised to ducal rank. By virtue of the right accorded to him by the *Cortes,* General Franco created three duchies in 1948: those of Calvo Sotelo, of Mola and of Primo de Rivera.

Portugal.—John I of Portugal created the duchies of Coimbra and of Viseu for his sons Dom Pedro and Dom Henrique after their capture of Ceuta from the Moors (1415), and in 1442 the duchy of Braganza was created for his illegitimate son Afonso. Six more duchies were created for branches of the royal house before the Spanish annexation of Portugal. Thereafter duchies were accorded outside the royal house, but the total number of creations was far less than in Spain.

The British Isles.—In Anglo-Saxon times an ealdorman was sometimes described in Latin as *dux* till his function was equated with that of earl (*q.v.*). Thereafter there were no English ducal titles (the duchies of Normandy and Aquitaine held by the English kings being of course French fiefs) until 1337, when Edward III erected the county of Cornwall into a duchy for his son the Black Prince. There followed the duchies of Lancaster (1351), Clarence (1362), York (1385), Gloucester (1385), Bedford (1st creation; 1413) and Somerset (1st creation; 1443), all for descendents of the royal house in the male line. In 1444, however, Humphrey Stafford, of royal blood only through his mother, was made duke of Buckingham (1st creation). From the creation of the dukedom of Norfolk (1483) onward, the ducal title was quite regularly bestowed outside the royal house, though creations were not frequent.

In Scotland the title was first bestowed in 1398 by Robert III on his eldest son David, who was made duke of Rothesay, and on his brother Robert, duke of Albany.

In the 1960s, apart from royal dukedoms, there were ten dukedoms in the peerage of England (Norfolk, 1483; Somerset, 1546; Richmond, 1675; Grafton, 1675; Beaufort, 1682; St. Albans, 1684; Leeds, 1694; Bedford, 1694; Devonshire, 1694; and Rutland, 1703); eight in that of Scotland (Hamilton, 1643; Buccleuch, 1663; Lennox, 1675; Queensberry, 1684; Argyll, 1701; Atholl, 1703; Montrose, 1707; and Roxburghe, 1707); six in that of Great Britain (Marlborough, 1702; Brandon, 1711; Portland, 1716; Manchester, 1719; Newcastle, 1756; and Northumberland, 1766); two in that of Ireland (Leinster, 1766; and Abercorn, 1868); and six in that of the United Kingdom (Wellington, 1814; Sutherland, 1833; Westminster, 1874; Gordon, 1876; Argyll, 1892; and Fife, 1900). However, the duke of Richmond was also duke of Lennox and duke of Gordon; the duke of Buccleuch was also duke of Queensberry; the duke of Hamilton was also duke of Brandon; and the dukedom of Argyll belonged to two peerages. Thus the 32 peerages provided only 27 dukes. *See* further PEERAGE; PROTOCOL AND PRECEDENCE; also ADDRESS, FORMS OF.

DUKE UNIVERSITY, a privately operated coeducational institution of higher learning, established in 1924 at Durham, N.C., and built around Trinity college (1851), founded as Union institute in 1838. *See* DURHAM.

DUKHOBORS, "spirit wrestlers," a Russian peasant religious sect first known in the 18th century. The majority (about 20,000) now live in Canada. They are distinguished by the rejection of all external authority, even that of the Bible. Dukhobors believe in direct individual revelation, supplemented by a growing body of canticles and proverbs called the "Book of Life," which is handed down orally. They hold that men's souls fell before the creation of the material universe; some believe in reincarnation. Priesthood and sacraments they despise, their only ceremony being the meeting (*sobranya*), at which they chant round a table laid with bread, salt and water. The leader, often hereditary, is regarded as a reincarnation of Christ. Egalitarian and pacifist, the Dukhobors have varied their attitude to communal ownership and resistance to government with their leaders. The intermittent persecutions they suffered under the tsars were due to their rejection of authority in church and state, to their proselytizing activities and to their refusal to accept conscription. In Canada their clashes with the government turn on their noncompliance with land, tax and education laws. (The Dukhobors strive to avoid schooling on the ground that "the letter killeth" and that "schools teach war.")

Numerous sects of mystical—orgiastic or rationalist—evangelical type sprang up in Russia after the great 17th-century schism (*see* NIKON) and the opening of the country to western influences by Peter the Great. The Dukhobors, combining features of both types, lived mainly in southern Russia. They were sporadically persecuted from 1773 onward, but in 1801 the majority (about

4,000) was settled by the tsar Alexander I on the Molochnaya river near the Sea of Azov. Prosperous for a time, the sect degenerated on the death of its leader, S. Kapustin (*c.* 1820). A government investigation of 1834 revealed a state of corruption (admitted by the Dukhobors themselves), and in 1840–41 they were nearly all deported to the Caucasus.

Under the leadership of Kapustin's descendants, the Kalmykovs, the Dukhobors, abandoning their earlier communism, enjoyed 40 years of prosperity and peace. On the death in 1886 of the last Kalmykov (a woman), a so-called "large party" followed a fanatical young leader, Peter V. Verigin, who claimed Kalmykov descent. Banished to Siberia in 1887, he instructed his followers in the Caucasus, on principles derived from Tolstoian fellow exiles, to adopt vegetarianism and stricter pacifism and to return to communism. A "small party" of moderates retained individual ownership of property. After disturbances culminating in a solemn burning of arms in 1895 the "large party" was deported to scattered villages in Georgia.

Tolstoi successfully petitioned the tsar to allow the persecuted Dukhobors (renamed in 1886 the Christian Community of Universal Brotherhood) to emigrate. Funds were collected by English Quakers, and after an unsuccessful attempt at settlement in Cyprus about 7,500 reached Canada by 1899; 12,000 remained in Russia. The Canadian government granted land on easy terms in Saskatchewan and exemption from conscription. Some settled well, but a group of fanatics, who thought to have escaped all government, started a series of nudist protest pilgrimages. Verigin, arriving in 1903, restored order. In 1908 he founded a communal settlement of 6,000 in British Columbia which prospered until his death in 1924. The incompetence of his son, P. P. Verigin, allowed to emigrate from the U.S.S.R. in 1927, and the depression of the 1930s ruined the communal enterprises, which were not restarted. Verigin, who had given the sect the new name of Union of Spiritual Communities of Christ, died in 1939. The leadership of his nephew, J. J. Verigin, was not fully accepted until 1958, on confirmation of the death of an uncle in the U.S.S.R.

With the demand for labour and the rise in prices after World War II, the Union of Spiritual Communities of Christ became more prosperous, but a certain spiritual disorientation led some to join the extremists, who came to form a distinct group known as Sons of Freedom. The Sons of Freedom has continued nudist parades, arson, dynamiting, etc. (to show contempt for material goods they burn their own property as well as that of their neighbours and the government). A third group of Dukhobors, known as independents, are generally well assimilated to life in Canada.

Bibliography.—O. Novitsky, *Dukhobortsy* (1882); Aylmer Maude, *A Peculiar People* (1904); J. F. C. Wright, *Slava Bohu* (1940); H. B. Hawthorn (ed.), *The Doukhobors of British Columbia* (1955).

(B. Br.)

DULAC, EDMUND (1882–1953), British illustrator, was born at Toulouse, Fr., on Oct. 22, 1882, and became a British subject in 1912. His best-known illustrations were for traditional fairy tales, but his work also included pictures for *The Tempest* (1908), *The Rubaiyat of Omar Khayyam* (1909), *Treasure Island* (1927) and *The Marriage of Cupid and Psyche* (1951). He designed stamps for the coronation of King George VI and bank notes and stamps for the French government in exile during World War II. He was a successful portraitist. Dulac died in London on May 25, 1953.

DULCIMER, a musical instrument with strings stretched over a flat, shallow soundbox. In Britain, the word denotes the beaten form of the instrument, known in European folk music as the Alpine *Hackbrett*, the Hungarian *cimbalom* (*q.v.*), the Rumanian *tsambal* and the Greek *santouri*. These have a trapeze-shaped soundbox and two or more metal strings for each note; the notes are sounded by striking the strings with a pair of light beaters, often made of cane. There are two long bridges, which are perforated so that the strings bearing on one bridge can pass freely under the other, which they do on alternate sides. Thus the strings slope alternately to right and left, and are struck where they rise toward their respective bridges. This greatly facilitates rapid technique. Tunings vary regionally, being fully chromatic

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TURKISH SANTIR OR DULCIMER INLAID WITH MOTHER-OF-PEARL, 19TH CENTURY

in the elaborate concert *cimbalom* of Hungarian gypsy orchestras; these instruments are built on legs and fitted with a damper pedal. The simpler varieties are placed on a table or carried on a sling. They are used chiefly to accompany the violin or other instruments. Historically, these dulcimers appear to be beaten versions of the plucked psaltery and to have entered central Europe from Persia about the 15th century A.D.

The "Appalachian" or "mountain" dulcimer of the United States is different, being a true zither (*q.v.*) with stopped melody strings running over a fretted fingerboard. (A. C. Ba.)

DULLES, JOHN FOSTER (1888–1959), U.S. secretary of state in the Republican administration of Pres. Dwight D. Eisenhower, also held diplomatic positions under three Democratic presidents, Woodrow Wilson, Franklin D. Roosevelt and Harry S. Truman. His grandfather John W. Foster and his uncle Robert Lansing had both served as secretaries of state.

Born in Washington, D.C., Feb. 25, 1888, Dulles attended Princeton university and George Washington university law school, graduating with highest honours in both, and studied at the Sorbonne in Paris. While he was a student at Princeton he attended the second Hague conference with his grandfather. Entering the international law firm of Sullivan and Cromwell in 1911, he became a partner in 1920 and head of the firm in 1927.

A Republican, Dulles was legal counsel at the Versailles conference at the end of World War I and President Wilson appointed him a member of the reparations commission. In World War II he helped prepare the United Nations charter at Dumbarton Oaks and served as a senior adviser at the San Francisco UN conference. In 1949, while Dulles was attending a Paris conference of foreign ministers, Gov. Thomas E. Dewey named him senator for New York, to fill an unexpired term.

Appointed a state department consultant in 1950, he was assigned to negotiate the peace treaty with Japan. He traveled 125,000 mi. to the various capitals to avoid calling an international conference. The result was a brilliant diplomatic success.

Named secretary of state in 1952 and sworn into office in Jan. 1953, Dulles determined to lead rather than follow public opinion. He stood against Communist China in defending Quemoy and Matsu. When France vacillated in accepting the European Defense community he declared that the U.S. must make an "agonizing reappraisal" of its policies and France compromised. He refused to support France, Great Britain and Israel in attacking Egypt in violation of the UN charter.

His insistence helped to bring about an Austrian peace treaty and a settlement of the Trieste problem. In the Berlin crisis Dulles was adamant against Communist dictation. His determination not to yield to U.S.S.R. or Chinese threats was widely attacked in the U.S. and abroad as "inflexible" and "stubborn"; he was also sharply criticized when he wrote in a magazine article in Jan. 1956 that "the ability to get to the verge [of war] without getting into the war is the necessary art. . . . If . . . you are scared to go to the brink, you are lost." Many leading statesmen of the non-Communist nations, however, credited his firmness with having checkmated Communist "cold war" strategy.

Seriously ill with cancer, Dulles resigned April 15, 1959, and died May 24. President Eisenhower characterized him as "one of the truly great men of our time."

Dulles wrote *War, Peace and Change* (1939) and *War or Peace* (1950).

See John Robinson Beal, *John Foster Dulles* (1957). (G. H. S.)

DULONG, PIERRE LOUIS (1785–1838), French chemist and physicist who helped formulate the Dulong-Petit law of specific heats, which subsequently proved useful in determining atomic weights although it is now known to be only approximate (*see* QUANTUM MECHANICS: *Specific Heats;* LOW-TEMPERATURE PHYSICS: *Energy Levels and Order*). Dulong was born at Rouen on Feb. 12 (or 13), 1785. After acting as assistant to Berthollet, he became successively professor of chemistry at the faculty of sciences and the normal and veterinary schools at Alfort, and then (1820) professor of physics at the École Polytechnique, of which he was appointed director in 1830. He died in Paris on July 18 (or 19), 1838.

His earliest work was chemical in character. In 1811 he discovered nitrogen trichloride. Dulong's important research work in physics was carried out in conjunction with Alexis Thérèse Petit (1791–1820), professor of physics at the École Polytechnique. Their first published research (1816) dealt with dilatation and with the exact measurement of temperature, and it was followed by one in 1817 in which they showed that Newton's law of cooling was only true for small differences in temperature, and one in 1818 on the measurement of temperature and the transference of heat, which was crowned by the French academy. In another, "On some important points in the theory of heat" (1819), they stated the "law of Dulong and Petit" dealing with atomic weights. Subsequent papers by Dulong were concerned with "New determinations of the proportions of water and the density of certain elastic fluids" (1820, with Berzelius); the property possessed by certain metals of facilitating the combination of gases (1823 with Thénard); the refracting powers of gases (1826); and the specific heats of gases (1829). In 1830 he published a research, undertaken with François Arago for the Academy of Sciences, on the elasticity of steam at high temperatures. In his last paper, published posthumously in 1838, Dulong gave an account of experiments made to determine the heat developed in a chemical reaction, together with a description of the calorimeter he employed.

DULSE (*Rhodymenia palmata*), one of the red seaweeds or algae, consisting of flat solitary or tufted purplish-red fronds, fan-shaped in general outline and divided into numerous segments, which are often divided in a forked manner. It varies much in size and degree of branching, ranging from 5 to 12 or more inches long. It grows on rocks, shellfish or larger seaweeds, and is used by the poor in Scotland and Ireland as a relish with their food. It is commonly dried and eaten raw, the flavour being brought out by long chewing. In the Mediterranean dulse is used cooked in ragouts and other dishes. *See* also ALGAE: *Rhodophyta.*

DULUTH, a city of Minnesota, U.S., the most western terminus of the St. Lawrence seaway, seat of St. Louis county, is situated on Lake Superior at the mouth of the St. Louis river opposite Superior, Wis. Elevation is abrupt, rising 600 to 800 ft. above the level of the lake in high rock bluffs, once the shore line of glacial Lake Duluth. Along the crest a 30-mi. sky-line boulevard commands an excellent view of both city and harbour. The combined Duluth-Superior harbour results from a natural breakwater formed by deposits left where river and lake meet. This resulting 9-mi. strip, Minnesota point, or Park point, extends toward Wisconsin point, separating St. Louis bay from Lake Superior. The narrow channel between the two points forms the Superior harbour entrance, and a dredged 300-ft. ship canal across Minnesota point, spanned by an aerial lift bridge, forms the Duluth harbour entrance.

The combined harbour ranks second only to New York, among U.S. ports, in tonnage handled. Through it is shipped in order of importance: iron ore from the Mesabi, Cuyuna and Vermilion ranges, coal from Lake Erie ports, grain from the Red river valley, Manitoba and the Dakotas, and crude oil from Canada refined at Wrenshall, Minn., and at Superior. Harbour facilities include coal docks, grain elevators and iron-ore docks, which receive ore and taconite arriving from processing plants in northeastern Minnesota. Main industries include a steel and wire mill, a blast furnace, a cement plant, an oriental food processing plant, and the manufacturing of electrical appliances, paint, beer, wood and dairy products.

Duluth is the centre for a branch of the University of Minnesota, established in 1947, the Benedictine College of St. Scholastica, founded in 1912, the St. Louis County Historical society, Chisholm museum, Tweed Art gallery and a locally supported symphony orchestra and playhouse. Added attractions are the zoological park, Enger Memorial tower, the scenic North Shore drive and the Jay Cooke State park.

The Duluth area, occupied originally by the Sioux and then by the Chippewa Indians, was visited about 1660 by the French *coureurs de bois:* Pierre Esprit, Sieur de Radisson; Médart Chouart, Sieur de Groseilliers; and in 1679 by Daniel Greysolon, Sieur du Lhut (sometimes spelled Dulhut, Derhaut and du Luth), for whom Duluth was named. The fur-trading post of Fond du Lac, on the banks of the St. Louis river, was controlled by the Hudson's Bay company in 1692, the Northwest company in 1793 and by John Jacob Astor's American Fur company from 1817 until 1854. Another post on Minnesota point was established in 1852 by George R. Stuntz, surveyor of the Minnesota-Wisconsin boundary. The following year brought many settlers to the north shore area in search of copper deposits. Duluth was platted in 1856 and incorporated as a city on March 5, 1870, with a population of 3,131; was relegated to a village in 1877; and was reincorporated in 1887. The extension of railways into the northwestern wheat region, increased lake commerce following the cutting of the Duluth ship canal in 1871, and the development of the Vermilion and Mesabi ranges brought increasing prosperity. Pop. (1960) 106,884. The population of the Duluth-Superior standard metropolitan statistical area, comprising St. Louis county in Minnesota and Douglas county in Wisconsin, was 276,596 in 1960. For comparative population figures *see* table in MINNESOTA: *Population.*

(E. F. GR.)

DULWICH, a residential suburb in the metropolitan borough of Camberwell (*q.v.*), London, Eng. Pop. (1951) 54,736. It comprises most of the southern end of the borough from Denmark hill, Peckham, Nunhead and Peckham Rye to the boundary. West Dulwich, in which the college is situated, with its toll gate and its wooded lanes descending from Sydenham hill, is on one side; on the other is Dulwich park (75 ac.), given by the governors of the college for a public park in 1885. The district retains much of its rural character and is spoken of as Dulwich village. The manor, which Henry I gave to the Cluniac monks of Bermondsey, passed through various hands to Edward Alleyn (*q.v.*) in 1605. His foundation of the College of God's Gift, commonly called Dulwich college, was opened with great state on Sept. 13, 1619, in the presence of Lord Chancellor Francis Bacon, Inigo Jones and other distinguished men. According to the letters patent a master, a warden, 4 fellows, 12 poor scholars, 6 poor brethren and 6 poor sisters were to be chosen equally from the parishes of St. Giles (Camberwell), St. Botolph without Bishopsgate, St. Luke's (Old street) and St. Saviour's (Southwark). The master and the warden were to be unmarried and were always to be of the founder's surname. In 1857 the foundation was entirely reconstituted. It now comprises three schools, called respectively Dulwich college, Alleyn's school and James Allen's Girls' school. Dulwich college was built in 1866–70 by Charles Barry in the north Italian Renaissance style. Among many famous pupils was Ernest Shackleton. The college possesses one of the leading private picture galleries in the country, the bequest mainly of Sir Francis Bourgeois, a member of the Royal Academy, in 1811, with later additions and a separate endowment. The Dutch and Flemish schools in particular are well represented, together with some fine examples of the Spanish, French and British. Dickens' Mr. Pickwick, after his retirement to Dulwich village, was "frequently seen, contemplating the pictures in the Dulwich Gallery." The Dulwich library was founded in 1896 in memory of Edward Alleyn.

DUMA (properly GOSUDARSTVENNAYA DUMA; *i.e.*, "state deliberative assembly"), the lower house in the imperial Russian legislature during the brief constitutional era (1906–17; *see* RUSSIA: *History*). The product of one revolutionary upheaval, it perished in another. The duma always had enemies to the right and left; its very existence was resented by the champions of unlimited autocracy, while democrats objected to its inadequate

powers and indirect unequal franchise. Despite its many failings, however, it acted as a check on arbitrary rule and helped to familiarize a section, at least, of Russian society with constitutional ideas and practices. Liberals in particular valued it as a symbol of Russia's progress toward parliamentary government on the western model.

The promise of a legislative assembly was contained in the October manifesto reluctantly granted by the tsar Nicholas II on Oct. 30 (new style; 17, old style), 1905. The duma's constitutional status was formally established by the revised fundamental laws of May 6 (N.S.; all dates N.S. henceforth), 1906, and certain supplementary acts; the electoral procedure was determined by a decree of Dec. 24, 1905, issued by Count S. Y. Witte, the prime minister, but was subsequently revised (June 1907; *see* below). The majority of deputies were elected at provincial conventions of "electors" chosen by the voters, who were segregated into four *curias:* landowners (subdivided into two categories), peasants, townspeople and industrial workers. Lesser landowners and townspeople elected deputies in two stages, peasants in three; of the workers, only those employed in larger enterprises in certain industrial areas were represented.

In general the duma enjoyed autonomy in matters of internal organization, although the duration of its sessions was prescribed by the emperor; deputies had personal inviolability; debates were public, and were reported in the press. The duma could not control ministers, who were responsible only to the emperor; it could address questions to them, but ministers were entitled to delay for one month before replying. The duma's rights of budgetary control were limited by the exclusion of certain items, such as the imperial court and the armed forces (except additional estimates); expenditure which it did not approve automatically continued at the previous rate. The duma could initiate legislation, but to take effect this required the assent of the state council (the upper house, a partly elective and partly nominated body with a standing conservative majority) and the sovereign; in practice no bill from the duma surmounted both these hurdles. According to the constitution no law was valid without the duma's assent; but the emperor still called himself an autocrat and retained extensive prerogatives. Under art. 87 of the fundamental laws he could issue decrees while the duma was not in session, subject to its subsequent approval; but this loophole, designed for use only in a genuine emergency, was in practice frequently used by the administration to circumvent the assembly.

Composition of the Four Dumas

Parties	First	Second	Third*	Fourth*
Right	—	10	49	64
Moderate right and Nationalist	—	23	95	88
Centrist	—	—	—	33
Octobrist	—	19	148	99
National minorities	60†	94	26	21
Progressive, etc.	32	2	25	47
Constitutional Democratic (Kadet)	179	99	53	57
Trudovik (Labour)	101†	98	14	10
Populist Socialist	—	52	—	—
Social Democratic	6	66	19	14
Nonparty and miscellaneous	100†	57	—	4
Total	478	520	429	437

*First session. †Approximate

First Duma.—The first duma, which met from May 10 to July 21, 1906, expressed the popular mood of frustrated revolutionary turbulence. The numerous peasant deputies, whom the authorities had hoped would prove a moderating force, supported, or even stood to the left of, the Constitutional Democrats (Kadets), who dominated the assembly (*see* Table). The Kadets sought to use the duma as a platform from which to appeal for popular support, thereby forcing the government to grant a constituent assembly. But the prime minister, I. L. Goremykin, rejected outright their bold declaration of legislative intentions, particularly their plan for compulsory expropriation of estates where necessary to assuage peasant land hunger. After exploratory talks for a Kadet ministry had broken down, the duma was charged with having exceeded its powers, and was dissolved.

Second Duma.—Despite administrative interference in the elections, the second duma, meeting from March 5 to June 16, 1907, was from the government's viewpoint even more intractable than the first. The Socialists, most of whom had hitherto boycotted the duma, were strongly represented, and there was a vociferous anticonstitutional right wing. The Kadets, who held the balance between the extremes, vainly tried to preserve the duma by scrupulous adherence to the law. P. A. Stolypin, the new prime minister, was readier than his predecessor to collaborate with the assembly, but only on his own terms; once convinced that it would not support his policies, above all his scheme for agrarian reform, he too resolved on dissolution.

Dissolution was announced on June 16, 1907, and simultaneously, in violation of the constitution, the electoral law was revised to the detriment of socially underprivileged groups and non-Russian minorities. In most provincial conventions the number of landowners' electors was arbitrarily augmented to give them an overall majority, and they were also enabled to influence the choice of peasant deputies. The proportion of deputies elected by landowners rose from 34% to 51%, while those elected by peasants declined from 43% to 22%, and by workers from 3% to 2%; representation of national minorities was cut by two-thirds.

Third Duma.—The virtual *coup d'état,* justified by Stolypin on grounds of expediency, yielded an assembly which, though grossly unrepresentative, had a workable majority. The left was much reduced; power lay with the Octobrists, a conservative constitutionalist party, which at first allied with the right but later, resenting administrative obstruction, adopted a more liberal position. The third duma (Nov. 14, 1907, to June 22, 1912) survived for its full five-year term and accomplished much solid legislative work, particularly in the fields of agrarian reform and army reorganization.

It often reacted sharply to bureaucratic abuses, so that its relations with the government were far from cordial. Nicholas II was still at heart unreconciled to the constitutional regime, and in 1912 revelations in the duma about Rasputin (*q.v.*) earned it the lasting enmity of the empress Alexandra.

Fourth Duma.—Administrative pressure in the elections to the fourth duma (Nov. 28, 1912, to March 11, 1917) helped the right-wing parties to increase their strength at the Octobrists' expense, but did not create a stable majority upon which the government could rely. When World War I broke out all parties rallied to the regime; but soon public dissatisfaction became widespread at the incompetence and negligence shown by the administration, particularly in supplying the army, and at the suspicious hostility with which it greeted efforts by duma members to mobilize the country's resources for the efficient prosecution of the war. In Aug. 1915 all groups except the extreme left and right united in a Progressive bloc, demanding the formation of "a ministry enjoying public confidence" and other essential reforms. The emperor replied on Sept. 16 by proroguing the assembly till Feb. 1916. Capable ministers responsive to the pressure of public opinion were dismissed and replaced by worthless creatures of Rasputin and the court camarilla; the duma was convoked only at infrequent intervals and could exercise no influence over policy. Though its inherent conservatism made it shrink from a bold effort to seize power, its debates attracted nation-wide attention; by the autumn of 1916 the duma—somewhat unexpectedly, in view of its unrepresentative character—found itself the focal point of opposition to the discredited regime. On Nov. 14 the Kadet leader P. N. Milyukov (*q.v.*) threw down a challenge to the government by suggesting that those in power were guilty of treason. The empress urged dissolution. When the order for dissolution (as from March 11, 1917) was finally given, Petrograd was already in the grip of a revolution which quickly swept away the imperial regime and the duma as well. The collapse of the monarchy deprived the duma of its legal authority; generally condemned as an undemocratic anachronism, it lapsed into oblivion. (J. L. H. K.)

DUMAS, ALEXANDRE (Alexandre Davy de la Pailleterie) (1802–1870), French novelist and dramatist, author of *The Count of Monte Cristo, The Three Musketeers* and other famous romances, was born at Villers-Cotterêts (Aisne) on July 24, 1802. His father, General Dumas (Alexandre Davy de la

Pailleterie), the natural son of Antoine Alexandre Davy, marquis de la Pailleterie, and Marie Cessette Dumas, a Negress of San Domingo, offended Napoleon by his staunch republicanism and left his family in straitened circumstances on his death in 1806. Alexandre received the rudiments of education from a priest, and in July 1816 entered the office of a local solicitor. His chief friend was Adolphe de Leuven, the son of an exiled Swedish nobleman, and the two collaborated in various vaudevilles and other pieces which never saw the footlights. Leuven returned to Paris and Dumas became a junior clerk in the office of a solicitor at Crépy, where, however, he did not remain long. He visited Leuven in Paris and was received by the actor F. J. Talma. He then determined to seek his fortune in Paris. An introduction to General Foy procured for him a place as clerk in the service of the duc d'Orléans. He has left jocular and humorous memories of his mishaps as a record keeper in the service of the future king. At the same time, he began to collaborate with Leuven in the production of vaudevilles and melodramas. Mme Dumas presently joined her son in Paris, where she died in 1838. Soon after his arrival Dumas had entered on a liaison with a dressmaker, Marie Catherine Labay (1794–1868), and their son, the famous Alexandre Dumas *fils* (*q.v.*), was born in 1824. Dumas acknowledged his son in 1831 and obtained the custody of him after a lawsuit with the mother.

His Plays.—The first piece by Dumas and Leuven to be staged was *La Chasse et l'amour* (Ambigu-Comique, Sept. 22, 1825), and in this they had help from other writers. Dumas had a share in another vaudeville, *La Noce et l'enterrement* (Porte Saint-Martin, Nov. 21, 1826). It was under the influence of the Shakespeare plays produced in Paris by William Charles Macready, Harriet Smithson (later Mme Berlioz) and an English company that the romantic drama of *Christine* was written. The subject was suggested by a bas-relief of the murder of Giovanni Monaldeschi exhibited at the Salon of 1827. The piece was accepted by the Comédie Française, but its production was deferred. Meanwhile Dumas had written, in prose, *Henri III et sa cour,* which was immediately accepted by the Comédie Française and produced on Feb. 11, 1829. It was the first great triumph of the romantic drama. The brilliant stagecraft of the piece and its admirable historical setting delighted an audience accustomed to the decadent classical tragedy, and brought him the friendship of Victor Hugo and Alfred de Vigny. His patron, the duc d'Orléans, now gave him the librarianship of the Palais Royal. *Christine* was recast as a romantic trilogy in verse in five acts with a prologue and epilogue, with the title of *Stockholm, Fontainebleau, Rome,* and was produced by F.-A. Harel at the Odéon in March 1830.

The revolution of 1830 temporarily diverted Dumas from writing. The account of his exploits should be read in his *Mémoires,* in which it is difficult to sift the truth from the boasts of the author. The pages where Dumas tells how he took possession all by himself of the Soissons powder-magazine are an amusing specimen of preposterousness and ingenuity. He finally alienated himself from the Orléans government by being implicated in the disturbances which attended the funeral of General Lamarque in June 1832 and he received a hint that his absence from France was desirable. A tour in Switzerland furnished material for the first of a long series of amusing books of travel. Dumas remained, however, on friendly and even affectionate terms with the young duc d'Orléans until the duke's death in 1842. Meanwhile he had produced *Napoléon Bonaparte* (Odéon, Jan. 10, 1831), his unwillingness to make a hero of the man who had slighted his father having been overcome by Harel, who put him under lock and key until the piece was finished. His next play, *Antony,* had a real importance in the history of the romantic theatre. It was put in rehearsal by Mlle Mars, but so unsatisfactorily that Dumas transferred it to Pierre-François Bocage and Mme Dorval, who played it magnificently at the Porte Saint-Martin theatre on May 3, 1831. The Byronic hero Antony was a portrait of himself in his relations with the authoress Mélanie Waldor, except of course in the extravagantly melodramatic *dénouement,* when Antony, to save his mistress' honour, kills her and exclaims, *Elle me résistait, je l'ai assassinée.* He produced a score more plays alone or in collaboration before 1845, as well as dramatizations from his novels. *Richard Darlington* (Porte Saint-Martin, Dec. 10, 1831), the first idea of which was drawn from Sir Walter Scott's *Chronicles of the Canongate,* owed part of its great success to the admirable acting of Frédérick Lemaître. *La Tour de Nesle* (Porte Saint-Martin, May 29, 1832), announced as by MM. X X X and Gaillardet, occasioned a duel and a law-suit with the original author, Frédéric Gaillardet, whose manuscript had been revised, first by Jules Janin and then by Dumas. In rapidity of movement and in the terror it inspired, the piece surpassed *Henri III* and *Antony.* A lighter drama, *Mademoiselle de Belle-Isle* (Théâtre Français, April 2, 1839), long held the stage. Of the 91 plays for which Dumas was wholly or partially responsible, 67 have appeared in successive collective editions.

In 1840 Dumas married, for ill-defined reasons, the actress Ida Ferrier (1811–59), whose liaison with him was eight years old, about whom he had few illusions and whom he had imposed on stage-managers who produced his plays. The couple soon parted and Mme Dumas went to Italy to live.

His Novels.—Dumas' happy collaboration with Auguste Maquet, which began in 1839, led to the admirable series of historical novels in which he proposed to reconstruct the whole course of French history. In 1844 he produced, with Maquet's help, that most famous of "cloak and sword" romances, *Les Trois Mousquetaires,* the material for which was discovered in the *Mémoires de M. d'Artagnan* (1700–01) by Giles de Courtilz de Sandras. The adventures of d'Artagnan and the three musketeers —the gigantic Porthos, the clever Aramis and the melancholy Athos, who united to defend the honour of Anne of Austria against Richelieu and the machinations of "Milady"—are brought down to the murder of Buckingham in 1628. Their admirers were gratified by two sequels, *Vingt ans après* (1845) and *Dix ans plus tard, ou le vicomte de Bragelonne* (1848–50; Eng. trans., *The Man in the Iron Mask*), which opens in 1660, showing a mature d'Artagnan, a respectable captain of musketeers, and contains the magnificent account of the heroic death of Porthos. The three musketeers are as famous in England as in France. Thackeray, who could read about Athos from sunrise to sunset with the utmost contentment of mind, was one of those who have paid tribute to the band. Before 1844 was out Dumas had completed a new great romance, *Le Comte de Monte-Cristo,* in which he had help from P. A. Fiorentino as well as from Maquet. The idea of the intrigue was suggested by J. Peuchet's *Mémoires . . . de la police de Paris* and the stress laid on the earlier incidents, Dantès, Danglars and the Château d'If, is said to have been an afterthought. Almost as famous as these romances is the set of Valois novels of which Henry IV is the central figure, beginning with *La Reine Margot* (1845), which contains the history of the struggle between Catherine de Medicis and Henry of Navarre; the history of the reign of Henry III is told in *La Dame de Monsoreau* (1846), generally known in English as *Chicot the Jester,* from its principal character; and in *Les Quarante-cinq* (1847–48), in which Diane de Monsoreau avenges herself on the duke of Anjou for the death of her former lover, Bussy d'Amboise.

The Valois novels and the musketeers series brought French history down to 1672. Contributions to later history are: *La Dame de volupté* (1864), being the memoirs of Mme de Luynes, and its sequel *Les Deux Reines* (1864); *La Tulipe noire* (1850), giving the history of the brothers De Witt; *Le Chevalier d'Harmental* (1853) and *Une Fille du régent* (1845), the story of two plots against the regent, the duc d'Orléans; two books on Mme du Deffand, *Mémoires d'une aveugle* (1856–57) and *Les Confessions de la marquise* (1857), both of doubtful authorship; *Olympe de Clèves* (1852), the story of an actress and a young Jesuit novice in the reign of Louis XV; five books on the beginning of the Revolution down to the execution of Marie Antoinette: the *Mémoires d'un médecin,* including *Joseph Balsamo* (1846–48), in which J.-J. Rousseau, Mme du Barry and the dauphiness Marie Antoinette figure, with its sequels; *Le Collier de la reine* (1849–50), in which Balsamo appears under the alias of Cagliostro; *Ange Pitou* (1852; Eng. trans., *The Taking of the Bastille*); *La Comtesse de Charny* (1853–55), describing the attempts to save the monarchy and the

flight to Varennes; and *Le Chevalier de Maison-Rouge* (1846), which opens in 1793 with the hero's attempt to save the queen. Among the numerous novels dealing with the later revolutionary period are *Les Blancs et les bleus* (1868) and *Les Compagnons de Jéhu* (1857). *Les Louves de Machecoul* (1859) deals with the rising in 1832 in La Vendée. Other famous stories are: *Les Frères corses* (1845); *La Femme au collier de velours* (1851); *Les Mohicans de Paris* (1854–55), detective stories with which may be classed the series of *Crimes célèbres* (1839–41), which are however, of doubtful authorship; and *La San Félice* (1864–65), in which Lady Hamilton played a prominent part, with its sequels *Emma Lyonna* and *Souvenirs d'une favorite*.

Of his numerous historical works other than fiction the most important is his *Louis XIV et son siècle* (1845). *Mes Mémoires* (1852–54; annotated edition by P. Josserand, vol. i–ii, 1954–57), fascinating in spite of some padding and rigmaroles, is the account of his life until about 1832, with important chapters on the life of General Dumas, his father. There are abridged English translations by A. F. Davidson (2 vol., 1891) and J. E. Goodman (*The Road to Monte Cristo;* 1956).

His Collaborators.—Much has been written about the exact share which Dumas had in the novels which bear his name. Equivocating maliciously on his fecund productivity and on the number of his collaborators (or *"nègres"*), Charles Hugo once said: "No one has ever read the whole of Dumas, not even himself." August Maquet was his chief collaborator; others were Paul Lacroix (the bibliophile "Jacob"), Paul Bocage, J. P. Mallefille and P. A. Fiorentino. The Dumas-Maquet series is undoubtedly the best, but Maquet alone never accomplished anything to approach them in value. The manuscripts of the novels still exist in Dumas's handwriting, and the best of them bear the unmistakable stamp of his unrivaled skill as a narrator. The chief key to his enormous output is to be found in his untiring industry and amazing fertility of invention, not in the system of wholesale collaboration which was exposed with much exaggeration by J.-M. Quérard in *Les Supercheries litteraires dévoilées* (1845–60) and by "Eugène de Mirecourt" (C. J. B. Jacquot) in his misleading *Fabrique de romans, Maison Alexandre Dumas et Cie* (1845). His assistants, in fact, supplied him with outlines of romances on plans drawn up by himself and he then rewrote the whole thing. That this method was never abused it would be impossible to say. Before passing judgment, an exhaustive study of the work is necessary; thus *Les Deux Diane,* a prelude to the Valois novels, which was said to have been written entirely by Paul Meurice, although Dumas's name appears on the title-page, is in all probability by Dumas, as Aksel J. Nielsen, the compiler of a bibliography of Dumas's works translated and printed in Scandinavia, has shown.

Later Years.—The latter part of Dumas's life is a record of excessive toil to meet prodigal expenditure and accumulated debts. His disasters began with the building of a house in the Renaissance style, with a Gothic pavilion and an "English" park, at Saint Germain-en-Laye. This place, called Monte-Cristo, was governed by a crowd of hangers-on of both sexes, who absorbed his large earnings and left him penniless. He also founded the Théâtre Historique, chiefly for the performance of his own works, under the patronage of the duc de Montpensier. Dumas had never changed his republican opinions and greeted the Revolution of 1848 with delight, but the change was fatal to his theatrical enterprise, for the failure of which in 1850 he was made financially responsible. His son, Alexandre Dumas, was at that time living with his mother Mlle Labay, who was eventually reconciled with the elder Dumas. Father and son, though always on affectionate terms when they met, were too different in their ideas to see much of one another. After the *coup d'état* of 1851 Dumas crossed the frontier to Brussels, not as an exile, as he cleverly pretended, but in order to escape from his creditors. Two years of rapid production, and the economy of his secretary, Noël Parfait, restored something like order to his affairs. On his return to Paris at the end of 1853 he established a daily paper, *Le Mousquetaire,* for the criticism of art and letters, wherein he published the final chapters of his *Mémoires,* of which over two-thirds had already seen the light in *La Presse* while he was in Brussels. It survived until 1857 and was succeeded by a weekly paper, the *Monte-Cristo* (1857–60), with a revival in 1862. In 1868, he launched another paper, *Le Dartagnan, journal d'Alexandre Dumas,* which died five months after its birth.

In 1858 Dumas journeyed through Russia to the Caucasus, and in 1860 he joined Garibaldi in Sicily. After an expedition to Marseilles in search of arms for the insurgents, he returned to Naples, where Garibaldi nominated him keeper of the museums. After four years' residence in Naples he returned to Paris. In 1866 he visited the battlefields of the Austro-Prussian War and published the novel *La Terreur prussienne.* But his powers were beginning to fail and in spite of the 1,200 volumes which he boasted he had written, he was at the mercy of his creditors. During this period he also fell a prey to adventuresses and minor theatrical ladies in quest of crude publicity. His liaison with Adah Menken, an American circus girl, created a great scandal. Now and then, an unexpected visit of Dumas *fils* would, for a time, restore a normal state of things. He was finally rescued by his daughter, Mme Petel, who came to live with him in 1868; and two years later, on Dec. 5, 1870, he died in his son's house at Puys, near Dieppe.

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(M. Bt.; P. Jo.)

DUMAS, ALEXANDRE (DUMAS FILS) (1824–1895), French dramatist and novelist, chiefly remembered for the dramatized version of his first novel, *La Dame aux camélias,* was the natural son of Alexandre Dumas (*q.v.*). He was born in Paris on July 27, 1824. Like his father, he early turned to letters. *La Dame aux camélias,* written in 1848, and another novel, *Diane de Lys* (1851), from both of which he extracted plays, first performed in 1852 and 1853 respectively, drew largely on his own experience; the former, which paints an idealistic picture of his mistress, Marie Duplessis (Marguerite Gautier in the play), won him instant success and became one of the best known plays of the 19th century, fortunate in having for its interpreters such renowned actresses as Sarah Bernhardt, Eleonora Duse and, later, Edwige Feuillère. Nor was this play merely lucky in attracting such actresses: it contains intrinsic merits—the humanity of the central figure, the courtesan, and the authenticity of the picture of contemporary Parisian life. A modified version served Verdi as a libretto for his opera *La Traviata* (1853).

A steady stream of plays and novels followed, the novel *L'Affaire Clémenceau* (1866) containing a bitter account of his sufferings at school. But it was the plays that kept his name alive: *Le Demi-monde* (1855), in which he defended the institution of marriage against the assault of adventuresses, provided the language with a name for the class it portrayed; *Le Fils naturel* (1858) was irreverently called by some *"Le Fils surnaturel,"* because it showed how society went out of its way to recognize a gifted young man, despite the stigma of his irregular birth; *Un Père prodigue* (1859) contained a fine picture of the dashing Dumas *père; L'Ami des femmes* (1864) showed how helpless women are without the assistance of a disinterested man; *Les Idées de Mme Aubray* (1867) was based on the parable of the lost sheep; *Une Visite de noces* (1871) exposed the shabbiness of free love; *Monsieur Alphonse* (1874) described the regeneration of an

unmarried mother by marriage. The two so-called "symbolist" plays, the hysterical *La Femme de Claude* (1873), showing how France was suffering from the depredations of impure women, and the extravagant *L'Étrangère* (1876), warning against the lure of an exotic adventuress in the highest circles of French society, were failures. But Dumas returned to the subject of unfortunate women in *Denise* (1885) and *Francillon* (1887), which brought him much success. From 1867 onward he wrote long and often tedious prefaces to all his plays, coupled with pamphlets on the questions of the day, such as *L'Homme-femme* (1872), *Les Femmes qui tuent et les femmes qui votent* (1880). He had warned against prostitutes and impure women generally and now he became the champion of all honourable women by proclaiming their right to divorce and to vote.

He was nothing if not categorical. He attacked the creed of *"l'art pour l'art"* ("three words utterly devoid of meaning"), and he naïvely believed that a dramatist, by punishing wickedness and rewarding virtue, could contribute to social health: "To save from transgression, to attempt to reform, that has been the eternal theme for which I have been reproached and of which I am proud." This formula, despite its sincerity and even nobility, has not preserved his plays (with the exception of *La Dame aux camélias*) from oblivion. Nonetheless, Dumas counts as one of the most successful dramatists of the 19th century. He was admitted to the Académie Française in 1875 and received many other honours. He died at Marly-le-Roi on Nov. 27, 1895.

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DUMAS, JEAN BAPTISTE ANDRÉ (1800–1884), French chemist who pioneered in organic chemistry and particularly in organic analysis, was born at Alais (now Alès) on July 16, 1800. He was apprenticed to an apothecary and when he moved to Geneva in 1816 he worked in a pharmacy there. In Geneva he attended the lectures of Raoul Pictet (physics), Charles de la Rive (chemistry) and Augustin Pyrame de Candolle (botany). Before he was 21 he engaged in original work on problems of biochemistry and embryology. In 1818 Dumas and Charles Coindet introduced the use of iodine for the treatment of goitre. As a result of other work done in his early years, Dumas, together with J. L. Prévost, published a paper in 1826 describing segmentation in the frog ovum.

In 1823 Dumas moved to Paris, where he lived the rest of his life. He joined the faculty of the École Polytechnique and founded a research laboratory there in 1832; in the same year he became professor at the University of Paris and the College of France. In Paris, Dumas completed a series of chemical triumphs that made him one of the world's leading chemists by 1840. He originated a method for determining the nitrogen content of organic compounds (1830); isolated anthracene from coal tar (1831); discovered the formula for camphor (1832); showed that halogens could replace hydrogen in organic compounds (1834); conducted, with E. M. Peligot, experiments on the methyl radical and isolated methyl alcohol (1834); obtained and named chloroform (1834); presented a classical paper, together with Justus von Liebig, to show that in organic chemistry groups of elements (radicals) can act as single elements (1837). By using vapour densities, Dumas demonstrated that the atomic weights of certain elements differ from those previously established by J. J. Berzelius, whose theories came to be replaced by the ideas of Dumas and Liebig. Dumas' method is still valid for determining the molecular weights of gases and low-boiling liquids.

Although Dumas continued to be active in chemistry throughout his life, his interests between 1848 and 1870 were in politics. He became a member of the national legislative assembly in 1849, acted as minister of agriculture and commerce for a few months in 1850–51 and later became a senator, president of the municipal council of Paris and master of the French mint. He died at Cannes on April 11, 1884.

DU MAURIER, GEORGE LOUIS PALMELLA BUSSON (1834–1896), an eminent British illustrator and caricaturist who, in late middle life, wrote three successful novels based on vivid memories of his early years, was born on March 6, 1834, in Paris. His happy childhood at Passy is recalled in *Peter Ibbetson* (1891). His full-blooded enjoyment of student life in the Latin quarter of Paris is reflected in *Trilby* (1894). In *The Martian* (1897), there is a poignant episode based on his own tragic experience of losing the sight of his left eye. This misfortune, which occurred in Antwerp during his student days, obliged him to abandon painting and devote himself to drawing. In 1860 he came to London where, thanks to his skilled draftsmanship and engaging personality, he quickly established himself. In a notable period of English illustration, du Maurier's achievement was considerable. His "society pictures" in *Punch* were acute commentaries on the Victorian scene, but his many beautiful illustrations for books and for such periodicals as *Once a Week* and *The Leisure Hour* were the truer measure of his artistic qualities. He died in London on Oct. 6, 1896. His younger son was Sir Gerald du Maurier (*q.v.*).

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DU MAURIER, SIR GERALD HUBERT EDWARD BUSSON (1873–1934), British actor-manager, a son of the artist and novelist George du Maurier (*q.v.*), was born at Hampstead, London, on March 26, 1873. He was the chief British exponent of an exactly and delicately realistic style of acting, which sought to imitate the surface of life and to suggest rather than to state the deeper emotions. He won immense popularity, but the fact that he presented characters in terms of his own personality, in contemporary plays, led many to underrate him. Among the plays in which he appeared were: *The Admirable Crichton, Raffles, Peter Pan, Dear Brutus* and *Bulldog Drummond*. He joined in the management of Wyndham's theatre in 1910, and then of the St. James's in 1925 with *The Last of Mrs. Cheyney*. He was knighted in 1922. Du Maurier died in London on April 11, 1934. His daughter Daphne du Maurier (1907–), a successful novelist and playwright, published a life of her father, *Gerald; A Portrait*, in 1934. (W. A. Dn.)

DUMBARTON, a royal, large and parliamentary burgh, seaport and the county town of Dunbartonshire, Scot., on the river Leven, near its confluence with the Clyde, 14 mi. W.N.W. of Glasgow by road. Pop. (1961) 26,335. The Alcluith ("hill of the Clyde") of the Britons, and Dunbreatain ("fort of the Britons") of the Celts, it was the capital of the district of Strathclyde. There the Romans are said to have had a naval station. The history of the town, however, practically centres in the successive fortresses on the Rock of Dumbarton, a twin-peaked hill, 240 ft. high and a mile in circumference at the base. The rock, of basalt with a tendency to columnar formation, overlooks the Clyde as well as the Leven. The higher of the two peaks is called Wallace's seat. The Picts seized the hill in 736 and the Northmen in 870. It was the chief stronghold of the earl of Lennox in the time of William the Lion and as a royal fortress it was alternately in the hands of the Scottish and the English for many years. Sir William Wallace (*q.v.*) was in 1305 imprisoned there before he was removed to London. Thomas Crawford of Jordanhill on the night of March 31, 1571, in the interests of James VI scaled the walls and seized the castle from Lord Fleming who had held it for Queen Mary for nearly three years.

Dumbarton was of old the capital of the earldom of Lennox, but was given up by Earl Maldwyn to Alexander II, by whom it was made a royal burgh in 1222 and declared to be free from all imposts and burgh taxes. Later sovereigns gave it other privileges, and all were finally confirmed by a charter of James VI. It had the right to levy customs and dues on all vessels on the Clyde between Loch Long and the river Kelvin. "Offers dues" on foreign ships entering the Clyde were also exacted. In 1700 these rights were transferred to Glasgow by contract, but were afterward

vested in a special trust created by acts of parliament.

Most of the town lies on the left bank of the Leven, but there is communication with the suburb of Bridgend on the right bank by a five-arched stone bridge. The Glencairn Greit house, which dates to 1623 and has fine dormer windows, was acquired by the town council and scheduled as an ancient monument in 1923. The principal industries are shipbuilding, engineering, distilling and the manufacture of tubes, aircraft and aluminum houses. The old staple trade of the making of crown glass, begun in 1777, lapsed some 70 years afterward when the glass duty was abolished. There are quays, docks and a harbour at the mouth of the Leven, and a pier for river steamers runs out from the Castle rock, but is not used. The first steam navigation company was established in Dumbarton in 1815, when the "Duke of Wellington" (built in the town) plied between Dumbarton and Glasgow. But it was not till 1844, consequent on the use of iron for vessels, that shipbuilding became the leading industry. The famous clipper "Cutty Sark" was completed by a Dumbarton firm in 1869.

DUMBARTON OAKS CONFERENCE, a meeting of diplomatic experts of the "big four" powers (U.S., U.K., Soviet Union and China) held during World War II (1944) at Dumbarton Oaks, an estate in Washington, D.C. Newspapers named it the World Security conference, for it was called to draw up basic proposals for a postwar security organization to succeed the League of Nations. The discussions were officially designated "conversations" to indicate that they were held below the foreign ministers' level and would constitute recommendations only, not binding commitments. They constituted the first important step taken to carry out paragraph 4 of the Moscow Declaration of 1943, which recognized the need for a general international organization to maintain world peace and security.

Because the Soviet Union was still neutral in the war with Japan, it would not meet with China. The talks were therefore arranged in two phases: (1) from Aug. 21–Sept. 28, the U.S., the U.K. and the Soviet Union drafted "Proposals for the Establishment of a General International Organization," known as the Dumbarton Oaks proposals); (2) from Sept. 29–Oct. 7, the British and U.S. experts considered the proposals with the Chinese, who then endorsed them.

Unfortunately, the proposals did not represent a complete plan of organization, the U.S. and the U.K. being stalemated with the Soviet Union on two essential points: first, on the voting system of the proposed Security council, which later became famous as the "veto problem"; second, on membership, because the Soviet Union demanded seats in the general assembly for all of its 16 constituent republics. Roosevelt, Churchill and Stalin finally resolved these two issues at the Yalta conference (*q.v.*), and the Dumbarton Oaks proposals then formed the basis for negotiations at the San Francisco conference, which drafted the charter of the United Nations in 1945. The text of the Dumbarton Oaks proposals was published in the department of state *Bulletin,* XI, no. 276, Oct. 8, 1944. *See* SAN FRANCISCO CONFERENCE.

(R. B. Ru.)

DUM-DUM, a town in Twenty-four Parganas district, West Bengal, India, lies 7 mi. N.E. of Calcutta. It is divided into three municipalities, North Dum-Dum (pop. [1961] 38,451), South Dum-Dum (pop. [1961] 111,507) and Dum-Dum cantonment (pop. [1961] 20,159). North Dum-Dum still contains large rural enclaves. South Dum-Dum forms the northern fringe of the built-up area of Calcutta and has a college. Founded in 1783, Dum-Dum cantonment was the headquarters of the Bengal artillery until 1853. It is now an industrial suburb of Calcutta, having an ammunition factory (where the dumdum expanding bullet was first made) and a large number of engineering concerns. It contains a college affiliated to Calcutta university and a Protestant church (St. Stephen's). The airport of Calcutta is also located there.

(S. P. C.)

DUMDUM BULLET (or DUM-DUM), the name applied (about 1897), from its manufacture at Dum-Dum arsenal, Bengal, to a modification (Mark IV) of the Lee-Metford bullet. Its peculiarity consisted in its expanding on impact and thus causing an ugly wound, and it was adopted in Indian frontier fighting because of the failure of the ordinary bullet, making a clean perforation, to stop the charges of fanatical tribesmen. In the dumdum, expansion was obtained by leaving the lead core exposed at the tip and weakening (by making thin) the cupronickel casing round the shoulder of the bullet. Improvised forms of expanding bullets were used in India and the Sudan, the commonest method of securing expansion being to file down the point until the lead core was exposed and to make longitudinal slits in the nickel envelope. All these forms of bullets came to be described colloquially, and even in diplomatic correspondence, as "dumdum bullets." The "soft-point" or "soft-nose" bullet for medium and large game works on the same principle as the dumdum.

An international declaration was made at the second Hague conference, July 29, 1899, forbidding the use of expanding bullets. The United States, however, did not subscribe to this declaration. The alleged use of dumdums by the British in South Africa (1899), by the Russians against the Japanese (1904–05) and by both sides in World War I formed the substance of accusations and protests.

DUMESNIL, MLLE (MARIE FRANÇOISE MARCHAND) (1713–1803), French actress, was born in Paris on Jan. 2, 1713, and made her debut in 1737 at the Comédie Française as Clytemnestre in Racine's *Iphigénie en Tauride.* She played Cléopâtre in Corneille's tragedy *Rodogune* and Racine's Phèdre, Athalie and Hermione with great effect. When she created Voltaire's Mérope (1743), he said that she kept the audience in tears for three successive acts. She retired in 1775 and died on Feb. 20, 1803.

She authorized in 1800 the publication of a *Mémoire de Marie Françoise Dumesnil,* in reply to an attack by her rival, La Clairon (*q.v.*).

DUMFRIES (*Dum Fres,* "the fort of the Frisians"), a royal and large burgh and the county town of Dumfriesshire, Scot., on the left bank of the Nith, 8 mi. from the Solway firth and 33 mi. W.N.W. of Carlisle by road. Pop. (1961) 27,275. Dumfries is an attractive border town, picturesquely situated, with mild climatic conditions. On the crest of the main street stands the Mid Steeple, built in 1705–08 by Tobias Bachup. Formerly the town hall, it is occupied by shops but its dignity still forms an appropriate background for traditional ceremonies, particularly those of Guid Nychburris day celebrated annually in June, during which the marches are ridden by the cornet (cavalry officer carrying the standard) and his cavalcade and a schoolgirl is crowned "queen of the south." A competition for "the siller gun" (a small silver gun originally presented as a trophy by James VI [James I of Great Britain] to encourage the use of firearms) which took place annually until 1831 has now been revived as part of the annual Guid Nychburris celebrations. The Theatre Royal, which dates from 1787, was frequently attended by Robert Burns. The Nith is crossed by four bridges and a railway viaduct: of the two bridges used for vehicular traffic, the New bridge dates from 1790–94 and St. Michael's bridge from 1927. The Old bridge, built of nine arches (later reduced to six) in the early 15th century and traditionally known as Devorguila's bridge, is used for foot passengers only, as is the suspension bridge erected in 1875. Maxwelltown, on the opposite side of the Nith, was amalgamated with Dumfries in 1929. World Wars I and II changed the character of the burgh's industry. The traditional occupations, hosiery and knitwear, continued to absorb a proportion of female labour and to command a rich export market, but the weaving of tweed, which fell victim to the depression following World War I, was totally superseded by large-scale industries including the processing and manufacture of articles from rubber, the production of nitrocellulose and man-made fibre, and the dehydration and canning of milk. In Dumfries are the Dumfries academy; Crichton Royal, an extensive hospital for the treatment of mental disorders; the Gracefield arts centre (1950); and the Dumfries Burgh museum, formerly a windmill, which contains a camera obscura.

Although Dumfries was the site of a camp of the Selgovian Britons, nothing is known of its early history. William the Lion (d. 1214) made it a royal burgh, but the oldest existing charter was granted by Robert II in 1395. The town became embroiled in the struggles that ended in the independence of Scotland. It

favoured the claims to the throne, first of John de Baliol and then of John Comyn (d. 1306) called the "red", as against those of Robert the Bruce, who drew his support from Annandale and who reputedly murdered "red Comyn" in the chapel of Greyfriars. Until the close of the 16th century the burgh was exposed to frequent raids, both from freebooters on the English side and from partisans of the Douglases, Maxwells and Johnstones. In Covenanting times the martyr roll of Dumfries was heavy and is commemorated by the martyrs' monument in St. Michael's churchyard. There also stands the mausoleum to Robert Burns, who lived in Dumfries (his house is now a museum) from Dec. 1791 until his death on July 21, 1796, and whose remains were reinterred on this site in 1815. The union with England was so unpopular that not only did the provost vote against the measure in the Scottish parliament, but the articles were burned (Nov. 20, 1706) at the market cross by a body of Cameronians. In the Jacobite rebellions of 1715 and 1745 Dumfries remained apathetic.

Lincluden abbey, the ruins of which lie 1½ mi. N.W., was founded in the 12th century and later converted into a collegiate church by Archibald, earl of Douglas; it enshrines the tomb of Princess Margaret, daughter of King Robert III. Caerlaverock castle, 8 mi. toward the estuary of the Nith, is one of the finest examples of early 15th-century military architecture in Scotland.

(M. D. McL.)

DUMFRIESSHIRE, the second largest county of southern Scotland, is bounded on the north by the shires of Lanark, Peebles and Selkirk, west by Ayrshire and Kirkcudbrightshire, east by Roxburghshire and south by the Solway firth and Cumberland.

Physical Features.—The county's 1,075 sq.mi. occupy a roughly oval area facing the Solway firth between Dumfries and Gretna and with a rather irregular, high northern boundary including most of Nithsdale in the west, all of Annandale in the centre and all of Eskdale in the east (with a small part of lower Liddesdale). The northern boundary belt includes many high points like White Coomb (2,696 ft.), Hart Fell (2,652 ft.) and the isolated cone of Queensberry (2,286 ft.); it is largely a watershed: the south-flowing streams are relatively short and vigorous, flowing only 40–80 mi. to the sea, and therefore gouge deep into the Ordovician and Silurian slaty shales, grits and greywackes of the Southern uplands dissected plateau, as in the spectacular Devils's Beef Tub north of Moffat, and extend their basins at the expense of the less vigorous headwaters of Clyde and Tweed, sometimes by actual river capture. These northern heights look south across lower dissected plateaus planed across similar rocks, with summit planes successively at about 1,500, 1,000 and 500 ft.

To the south, Carboniferous lavas and tuffs give a belt reaching about 900 ft. as in Birrenswark. There is a gradual change to the coastal lowlands of the Solway, planed across Carboniferous rocks, and red Triassic sandstones, all usually drift-covered. Of the three major river-basins, the Nith and the Annan particularly carry pockets of lowland into the heart of the upland, gorgelike stretches alternating with partly structural basins in softer, more recent rocks, Carboniferous or Permian. At the maximum glaciation the valleys and lowlands were swept by glaciers from the major centre of ice dispersal just south of the headwaters of the Nith. Valleys were smoothed and a few rock-basin lakes carved, like Loch Skene; lower hillsides and lowlands were plastered with boulder-clay, often in the drumlin pattern; pre-glacial drainage was upset, as in the diversion of the lower Nith to its present course past Dumfries from a broad valley now occupied by Lochar Moss. During retreat phases the hills were notched by drainage channels marginal to standing ice in the Solway area; meltwater gave many valleys a flat gravel floor and spread kames and deltas perhaps with kettlehold lakes, as around Lochmaben; and the higher sea level of post-glacial times left raised beaches at 50 and 25 ft. of which latter the lower Lochar Moss was an embayment, with its peats over shelly gravels.

The climate is mild and genial, the strongest prevailing wind being westerly. Rainfall varies from 35 in. in the south to 60 in. in the north. Because of the nature of the soil, peat plants are largely represented. There are some fine planted beechwoods, often on glacial sands flanking the dales.

(A. T. A. L.)

History.—The early populations have left hill forts in the north, stone circles (as in Dunscore and Eskdalemuir), camps (Dryfesdale), tumuli and cairns (Closeburn) and sculptured stones (Dornock and Hoddom). At Holywood, which derives its name from a grove of sacred oaks, is a stone circle known locally as "the twelve apostles." The British inhabitants were called Selgovae by the Romans who built many forts in the upper basin of the Annan. There are traces of Roman roads which ran by Dalveen pass into Clydesdale and up the Annan to Tweeddale, and at Birrens is a well-preserved Roman camp. Roman altars, pottery and coins have been found in many places and much important material on excavations carried out at Milton near Beattock, Dalswinton, and other sites is recorded in the *Transactions* (3rd series, Dumfries, 1913 *et seq.*) of the Dumfriesshire and Galloway Natural History and Antiquarian society. Upon the withdrawal of the Romans, the Selgovae were conquered by Scots from Ireland. In the parish church of Ruthwell (pron. Rivvel; the "rood," or cross, "well") is preserved an ancient cross which tells in Runic characters the story of the Crucifixion. The Saxon conquest of Dumfriesshire does not seem to have been thorough, the people of Nithsdale and elsewhere maintaining their Celtic institutions up to the time of David I (1084–1153). Edward I besieged Caerlaverock castle, and the factions of the second Robert Bruce (who was lord of Annandale), John Comyn and John de Baliol were at constant feud. The border clans were continually at strife until the 18th century. In 1680, persecuted Covenanters published at Sanquhar their declaration against the king. Although Prince Charles Edward Stuart passed through Dumfries in 1745, at no time were Jacobite sympathies particularly marked. Robert Burns farmed at Ellisland on the Nith for three years and spent the last five years of his life at Dumfries where he is buried. Thomas Carlyle was born at Ecclefechan, in a house still standing, and is buried in the churchyard. Among other famous men of Dumfriesshire were Thomas Telford, civil engineer, and William Paterson, founder of the Bank of England.

Population and Administration.—The population enumerated in the 1961 census was 88,423. The chief towns are Dumfries (*q.v.*), the only large burgh (pop. [1961] 27,275), and the small burgh of Annan (pop. [1961] 5,572). The other small burghs, which have populations of less than 2,800, are Langholm, Lockerbie, Moffat, Sanquhar and Lochmaben. The last two, together with Dumfries and Annan, are royal burghs. Gretna Green (*q.v.*), once famous for runaway marriages, is near the Cumberland border. There are eight county districts.

The county returns one member to parliament. Dumfries forms a sheriffdom with the shires of Kirkcudbright and Wigtown and there is a resident sheriff-substitute at Dumfries. Senior secondary education is provided at Dumfries academy and by the early 1960s was extended to Annan. There is a farm school at the Barony, Parkgate, and a technical college at Dumfries.

Agriculture and Industry.—Dumfriesshire is essentially an agricultural county. During the 18th century farmers began to raise stocks for southern markets and within 100 years 20,000 head of cattle, formerly Galloways, later mostly shorthorns and Ayrshires, were sent annually to England. Cheviots are bred in the hill country, the richer pastures of the Solway plain being reserved for half-bred lambs, mainly a cross of Cheviots with Leicesters or Suffolks. Horse-breeding has declined. Poultry rearing and pig-keeping are carried on. Agricultural holdings occupy about 85% (more than half of which is rough grazing or woodland) of the total area of the county. Oats is the largest crop followed by turnips, barley and potatoes. A big afforestation scheme was established around Ae village in 1947.

Sandstone and to a lesser degree limestone are quarried and coal mining is carried on at Kirkconnel. The oldest-established industries of Dumfriesshire are hosiery and tweed manufacture, at Dumfries and Langholm respectively. Modern industries near Dumfries include plants for the dehydration and canning of milk; the manufacture of flooring and footwear from rubber; the production of nitrocellulose for industrial and military use; and the manufacture of plastics and cellulose ethers. At Annan, in addi-

tion to hosiery and engineering works, is a factory for the manufacture of chip boards; and at Chapelcross, near Annan, is a plutonium and nuclear power generating plant. The salmon fisheries of the Nith and Annan and the Solway firth are of value.

The main railway line between Glasgow and Carlisle runs through Nithsdale and lower Annandale over the border and another line from Edinburgh to Carlisle passes through Beattock and Lockerbie. From Dumfries westward there is also rail communication with Castle Douglas, Kirkcudbright, Newton Stewart and Stranraer. (M. D. McL.)

DUMKA, a musical term of Ukrainian origin borrowed by Dvořák from popular literature as a title for some of his compositions. The Dumka and Furiant, Op. 12, and the Dumka, Op. 35, are the two examples from his piano works. The term signifies a lament in slow tempo of passionate character. Dvořák's piano trio, Op. 90, known as the "Dumky" trio (*dumky* is the plural of *dumka*), consists of a series of short movements in this form.

DUMONT, the name of a family of prominent French artists. François Dumont (1688–1726), a sculptor, best known for his figures in the church of St. Sulpice, Paris, was the brother of the painter Jacques Dumont, known as "le Romain" (1701–81), whose chief success was gained with a great allegorical composition for the Paris *hôtel de ville* in 1761. François's son Edme (1720–75), the latter's son Jacques Edme (1761–1844) and the son of the last named, Augustin Alexander (1801–84), were famous sculptors. Jean Joseph Dumons (1687–1779), sometimes called Dumont, is best known for his designs for the Aubusson tapestries.

DUMONT, FRANÇOIS (1751–1831), one of the greatest miniature painters of France, was born at Lunéville (Meurthe), studied for a time under Jean Girardet, and in 1788 was accepted as an academician and granted an apartment in the Louvre. He married the daughter of Antoine Vestier, the miniature painter, and had two sons, Aristide and Bias, both of whom became painters. He painted portraits of Louis XVI and Marie Antoinette, Louis XVIII and Charles X, and of almost all the important persons of his day. His own portrait was engraved both by Audouin and by Tardieu. He spent the greater part of his life in Paris, and there he died. A younger brother, known as Tony Dumont, was also a miniature painter, a pupil of his brother, a frequent exhibitor and the recipient of a medal from the Academy in 1810. Each artist signed with the surname only, and there is some controversy concerning the attribution to each of his own canvases. Many of Dumont's finest paintings came into the collection of J. Pierpont Morgan, but others are in the Louvre, presented by the heir of Bias Dumont.

DUMONT, JEAN (1666–1726), French writer, author of *Corps universelle diplomatique du droit des gens; contenant un recueil des traitez d'alliance, de paix,* etc. *faits en Europe depuis le regne de Charlemagne jusques à present,* 8 vol. (1726–31), continued after his death by J. Rousset. Before settling in the United Provinces of the Netherlands, where his early works included a number of pamphlets attacking the government of Louis XIV, he had been a soldier and had traveled in Europe and Turkey. Subsequently he was appointed historiographer to the emperor and became baron de Carlscroon. He died in Vienna.

Dumont's books include *Mémoires Politiques . . . de l'histoire de la paix de Ryswick,* 4 vol. (1699); *Recherche modeste des causes de la presente guerre* (1703); *Nouveau recueil de traitez . . . depuis la paix de Munster,* 2 vol. (1710). He was founder-author (1692–1710) of the periodical *Lettres Historiques; contenant ce qui se passe de plus important en Europe;* it was continued until 1736 by H. Basnage and others.

DUMONT, PIERRE ÉTIENNE LOUIS (1759–1829), Swiss writer and statesman, was author of the valuable *Souvenirs de Mirabeau* and literary collaborator with Jeremy Bentham. He was born in Geneva, July 18, 1759, and ordained pastor in 1783; but after the hostile reception of his first sermon, he went to St. Petersburg. In 1786 he arrived in London as tutor to the sons of Lord Lansdowne. Of many later travels the most interesting was the period from Jan. 1789 until March 1790 when he was in Paris, taking part in Revolutionary events by assisting Mirabeau with the journal *Courier de Provence* and with his speeches. In 1814 Dumont returned to Geneva and later became leader of the representative council. He died in Milan, Sept. 29, 1829. Dumont's relationship with Jeremy Bentham was unusual in kind and far-reaching in effect. Shortly after their first meeting (1788) at Bowood, Bentham agreed that Dumont should take Bentham's chaotic papers to prepare a French edition of his work: during 40 years' intermittent work, Dumont made a compilation, using Bentham's ideas and illustrative material but abridging, arranging, interpreting and translating them into readable French. *Traités de législation civile et pénale,* 3 vol. (1802; Eng. trans., *Theory of Legislation,* by R. Hildreth, 1864; ed. by C. K. Ogden, 1931) was drawn from Bentham's *Introduction to the Principles of Morals and Legislation* (1789) and other manuscripts and made Bentham's reputation, particularly outside England. *Tactique des assemblées législatives,* 2 vol. (1815), drew upon *Essay on Political Tactics* (1791); and *De l'organisation judicaire et de la modification* (1828) upon many writings, including the *Codification Proposal* (1822); but *Théorie des peines et des recompenses,* 2 vol. (1811; Eng. trans., 1825–30), and *Traité des preuves judiciares,* 2 vol. (1823; Eng. trans., 1825), first appeared in French. Bearing in mind Bentham's lack of interest in publication and his turgid style, Sir Samuel Romilly's comment on his two friends may be justifiable: "But for Mr. Dumont Bentham's reputation might never have emerged from obscurity."

BIBLIOGRAPHY.—Bentham's *Oeuvres,* 2 vol. (1829–30); Dumont's *Souvenirs de Mirabeau* (1832; new ed. by J. Bénétruy, 1951; Eng. trans., 1832 and 1904). *See* also biography by J. Martin (1942); B. Gagnebin, *Jeremy Bentham et Étienne Dumont* (1948).

DUMONT D'URVILLE, JULES SÉBASTIEN CÉSAR (1790–1842), French navigator who made a notable voyage of discovery to the antarctic, was born at Condé-sur-Noireau, Calvados, on May 23, 1790. He went to sea in 1807 as a *novice* on board the "Aquilon." During the next 12 years he gradually rose in the service, and added a knowledge of botany, entomology, English, German, Spanish, Italian and even Hebrew and Greek to his professional studies. In 1820, while engaged in a hydrographic survey of the Mediterranean, he was fortunate enough to recognize the Venus of Milo (Melos) in a Greek statue recently unearthed and to secure its preservation by his report to the French ambassador at Constantinople. In 1822 he served in the circumnavigating expedition of the "Coquille"; on its return in 1825 he was promoted *capitaine de frégate* and commissioned to discover traces of the lost explorer, J. F. La Pérouse, in which he was successful. The "Astrolabe," as he renamed the "Coquille," left Toulon on April 25, 1826, and returned to Marseilles on March 25, 1829, having traversed the South Atlantic, coasted the Australian continent from King George's sound to Port Jackson, charted various parts of New Zealand and visited the Fiji Islands, the Loyalty Islands, New Caledonia, New Guinea, Amboina, Van Diemen's land (Tasmania), the Caroline Islands, Celebes and Mauritius. In 1829 D'Urville was promoted *capitaine de vaisseau* and in Aug. 1830 he conveyed the exiled king Charles X to England. On Sept. 7, 1837, he set sail from Toulon with "L'Astrolabe" and "La Zélée" on a voyage of exploration in the south polar regions, with the object of passing the "furthest south" (74° 15′ S.) reached by James Weddell in 1823. After surveying in the Strait of Magellan, D'Urville's ships reached the ice pack in 63° 29′ S., 44° 47′ W., on Jan. 22, 1838. Ill-equipped for ice navigation, they failed to penetrate the pack, which they coasted for 300 mi. to the east. Returning westward they visited the South Orkney Islands and part of the New Shetlands, and discovered Joinville Island and Louis Philippe land, but were compelled by scurvy to seek succour at Talcahuano in Chile. Thence they proceeded across the Pacific and through the Asiatic archipelago, visiting the Fiji and the Pelew (Palau) islands, coasting New Guinea and circumnavigating Borneo. In 1840 they returned to the antarctic region, hoping to discover the magnetic pole in the unexplored sector between 120° and 160° E., and in Jan. 1841 discovered Adélie Coast in 140° E., 66° 30′ S. Nov. 6 found them at Toulon. On May 8, 1842, D'Urville was killed, with his wife and son, in a railway accident near Meudon. An island (also called Kairu) off the north coast of New Guinea and a cape on the same coast bear his name.

BIBLIOGRAPHY.—D'Urville's principal works are *Enumeratio plantarum quas in insulis Archipelagi, aut littoribus Ponti Euximi*, etc. (1822); *Voyage de la corvette "l'Astrolabe," 1826–1829* (1830–35) and *Voyage au pôle sud et dans l'Océanie, 1837–1840* (1841–54), in each of which his scientific colleagues had a share; *Voyage autour du monde: résumé général des voyages de Magellan*, etc. (1834 and 1844). *See* also G. Day, *Dumont d'Urville* (1947). (R. A. SN.)

DUMORTIERITE, an uncommon aluminum borosilicate, is one of the aluminum silicate minerals important in the manufacture of refractories. It is an especially desirable raw material because it transforms into the crystalline substance mullite (*q.v.*) at a lower temperature (approximately 1,200° C.) and with a smaller volume change than most other aluminum silicates. The resulting mullite body has a high degree of thermal, mechanical and chemical stability at high temperatures. Dumortierite is used chiefly for spark-plug and laboratory-ware porcelain. The only known commercial deposit in the world is one near Oreana, Nev.

Dumortierite occurs in aluminum-rich metamorphic rocks such as schists and gneisses and in pegmatites associated with such rocks. In addition to the deposit near Oreana some of the best-known localities are: near Lyons, France, where it was discovered; near Schmiedeberg, Silesia; the Island of Madagascar; near Rio de Janeiro, Braz.; near Vallenar, Chile; Nacozari, Mex.; near Quartzite, and Yuma, Ariz.; and at Dehesa, Calif.

Small amounts of ferric iron (Fe^{3+}) generally are present in dumortierite in solid solution in place of some of the aluminum, the chemical formula being represented by $(Al,Fe)_7BSi_3O_{18}$. The mineral occurs most characteristically in fibrous to columnar aggregates of orthorhombic crystals. The colour ranges through blue, greenish blue, violet and pink. The specific gravity is approximately 3.3. The mineral is difficult to identify with certainty except by careful optical, X-ray or chemical determinations.

(D. M. H.)

DUMOURIEZ, CHARLES FRANÇOIS DU PÉRIER (1739–1823), French general and statesman who deserted the cause of the Revolution after winning for it the victories of Valmy and Jemappes, was born at Cambrai on Jan. 25, 1739. The son of a war commissary, he followed his father to Hanover during the Seven Years' War and volunteered for service in a cavalry regiment (1758). Twice wounded, he was promoted captain in 1761 and made a knight of St. Louis in 1763. Having been discharged from the French army in 1762, he went to fight first for the Genoese against the Corsican rebels, then for Pasquale Paoli and the Corsicans against the Genoese. After a secret mission to Madrid (1767), he took part in the French expedition to Corsica (1768) and was promoted *mestre de camp* in the cavalry (1769). In 1770 he was sent on a mission to the Poles of the Confederation of Bar (*q.v.*). Recalled in 1772, he was next entrusted with a mission to Gustavus III of Sweden in connection with Louis XV's secret diplomacy (1773), but was arrested in Hamburg on the orders of the duc d'Aiguillon and imprisoned first in the Bastille, then in Caen. On his release he was sent to Lille with the rank of colonel (1775). In 1778 he was appointed commandant at Cherbourg, where for 11 years he supervised the development of the port. In 1788 he was promoted *maréchal de camp*.

The Revolution opened a new career to Dumouriez. On a visit to Paris he came to terms with La Fayette and with Mirabeau, whom he had previously opposed. He joined the Jacobin club in 1790. In 1791, he was appointed to the command of the 12th military division at Nantes, where he co-operated with Armand Gensonné, the future Girondin, but at the same time made overtures to Louis XVI. He favoured the scheme for declaring war against Austria so that after a short and successful campaign the army could be brought back to Paris to restore the king's power and set up a government in his name. Appointed minister of foreign affairs, on March 15, 1792, in a government that included Girondin ministers, he was largely responsible for the declaration of war (April 20).

Dumouriez's hopes of an early victory were disappointed, as the French sustained a number of reverses at the start of the campaign. He was made minister of war on June 12, 1792, but resigned on June 15, fearing impeachment by the Legislative Assembly. He then took La Fayette's place as commander in chief of the army of the North (Aug. 16). Together with F. C. Kellermann, he defeated the Prussians in the battle of Valmy (*q.v.*) on Sept. 20, but he then allowed the enemy to withdraw. As commander in chief in Belgium, he next defeated the Austrians in the battle of Jemappes (*q.v.*) on Nov. 6, which delivered Belgium into his hands, but again allowed the enemy to withdraw.

Dumouriez resumed command of the army of the North on Feb. 2, 1793, to direct the invasion of Holland. This began on Feb. 26, but an enemy thrust toward Liège (March 1) forced him to retreat from Holland, and he was defeated at Neerwinden on March 18. He then made two agreements with the Austrian colonel, Karl Mack: under the first, he was to evacuate Belgium; under the second, he was to march on Paris, with Austrian support. Dumouriez failed to take Lille, Condé or Valenciennes, which he had meant to give as pledges to the Austrians, but he did deliver the Convention's war commissaries and the marquis de Beurnonville (Pierre de Ruel), minister of war, into the enemy's hands on April 2, 1793. Outlawed by the Convention and deserted by his troops, he went over to the Austrian army on April 5, 1793.

After living in Germany and Switzerland, Dumouriez went to England, where he enjoyed a pension of £1,200 from 1800. He went to Spain to advise the Spaniards on guerrilla warfare in 1808. Wellington also consulted him—in particular before the invasion of southwestern France (1814). Louis XVIII, however, refused to let Dumouriez return to France. Dumouriez died at Turville Park, in Buckinghamshire, on March 14, 1823.

See A. Chuquet, *Dumouriez* (1914). (A. So.)

DUNANT, JEAN HENRI (1828–1910), Swiss humanitarian, founder of the Red Cross and one of the founders of the World's Young Men's Christian association, was born in Geneva, Switz., May 8, 1828. An eyewitness of the battle of Solferino, in June 1859, where there were nearly 40,000 casualties, Dunant organized emergency aid services for Austrian and French wounded. In the book *Un Souvenir de Solférino* (1862) he proposed the formation in all countries of voluntary relief societies, for the prevention and alleviation of suffering in war and peace without any distinction of race or creed, and an international agreement regarding those wounded in war. In 1864 the first societies and the first Geneva convention came into being.

Because of bankruptcy, arising from neglect of business affairs, Dunant left Geneva in 1867 and spent most of the remainder of his life in poverty and obscurity, though he fought unceasingly to promote interest in the treatment of prisoners of war, the abolition of slavery, international arbitration, disarmament and a Jewish homeland. In 1895, after being "rediscovered" by a newspaperman at Heiden, Switz., Dunant received many honours and annuities, including, in 1901, the first Nobel peace prize (with Frédéric Passy). He died on Oct. 30, 1910, at Heiden. *See* also RED CROSS.

See Ellen Hart, *Man Born to Live* (1953). (R. C. Dw.)

DUNASH, the name of two Jewish scholars of the 10th century.

1. DUNASH BEN LABRAT, grammarian and poet, belonged to the brilliant circle attracted to Cordóva by Hasdai, and took a large share in promoting the Jewish "golden age" under the Moors in Andalusia.

Dunash not only helped in the foundation of a school of scientific philology, but adapted Arabian metres to Hebrew verse, and thereby gave an impulse to the neo-Hebraic poetry, which reached its highest level in Spain.

2. DUNASH IBN TAMIM was, like the preceding, a leader in the critical study of language among Arabic-speaking Jews. Bacher says of him: "In the history of Hebrew philology Ibn Tamim ranks as one of the first representatives of the systematic comparison of Hebrew and Arabic."

DUNBAR, PAUL LAURENCE (1872–1906), U.S. author, whose reputation rests upon his verse and short stories written in Negro dialect, was born in Dayton, O., June 27, 1872, the son of an escaped slave. He was a popular student in high school, where he was the only Negro enrolled, and was the editor of the school paper.

While earning his living in various occupations, including work as an elevator boy in Dayton and later as an assistant in the Library of Congress (1897–98), he continued to write, publishing some poems in Dayton newspapers. His first two volumes of verse, *Oak and Ivy* (1893) and *Majors and Minors* (1895), were privately printed. A favourable notice of the latter by William Dean Howells in *Harper's Weekly* made it a considerable success. Howells also wrote a sympathetic introduction to *Lyrics of Lowly Life* (1896), and Dunbar was established as a popular poet.

In 1898 he married Alice Ruth Moore, also a writer, and began to devote his full time to writing. With *The Uncalled* (1898) he turned his attention to the novel form, and produced three other novels in rapid succession: *The Love of Landry* (1900), *The Fanatics* (1901) and *The Sport of the Gods* (1902). His health began to fail at the turn of the century and he finally succumbed to tuberculosis in Dayton on Feb. 8, 1906. His *Complete Poems* was published in 1913.

With charm and simplicity, Dunbar succeeded in portraying both the essence of the old plantation life and the new restlessness of the emancipated Negro in his poems and short stories in Negro dialect. His novels and verse in literary English, however, are generally artificial and unconvincing.

See Benjamin Brawley, *Paul Laurence Dunbar* (1936); V. Cunningham, *Paul Laurence Dunbar and His Song* (1948).

DUNBAR, WILLIAM (*c.* 1460–*c.* 1520), Scottish poet at the court of James IV. He came probably of the family of the earls of Dunbar and March, and may have been the William Dunbar who graduated B.A. in 1477 and M.A. in 1479 at St. Andrews. His life between 1480 and 1500 is without record. It has been suggested on the unsatisfactory evidence of possibly autobiographical allusions in his poems that he was a Franciscan novice, and traveled into England and France as a preaching friar and later in the king's service. In 1501 he was certainly in England, probably in connection with negotiations of the marriage between James IV and Margaret Tudor which took place in 1503. (The poem associated with this Scottish embassy, "London, thou art the flour of cities all," cannot safely be ascribed to Dunbar.) In 1500 he was granted a life pension of £10 by the king, to be paid "quhil he be promouit be oure soverane lord to a benefice of xl lib. or abone." By 1504 he was in priest's orders. By 1507 his pension had been increased to £20, and in 1510 he received a clear mark of royal esteem in a pension of £80. In 1511 he accompanied the queen to Aberdeen, and celebrated in verse the entertainments provided by the city. It seems unlikely that he went with the king to Flodden (1513); but it is likely that he survived into the new reign and received the benefice for which he had so often asked in verse, as there is no record of his pension after 1513.

With few exceptions, the 100 and more poems attributed to Dunbar are short and occasional, written out of personal moods or events at court. His long pieces are *The Goldyn Targe* (an allegory of love) and *The Thrissil and the Rois* (an allegorical prothalamium for the marriage of James IV); his *flyting* (abuse) of his professional rival Walter Kennedy; the alliterative *Tretis of the tua mariit Wemen and the Wedo*, a dramatic *débat* on love which exposes selfish and insatiable sexuality in women against a background of natural beauty and grace; and (if it is his) the comic tale of *The Freiris of Berwik*, the finest *fabliau* after Chaucer. Dunbar's versatility is astonishing. He handles a great variety of stanza forms, the couplet and the old alliterative measure, with assurance. He is splendidly at ease in hymn and satire, morality and obscene comedy, panegyric and begging complaint, elegy and lampoon. His poetic vocabulary ranges from "anamalit termis celicall [divine]"—the Latinate language of the *rhétoriqueur* tradition—through the alliterative abuse of the *flyting* (verbal artifice of a different sort) to colloquial Scots of tavern and street, and he moves freely from one level of diction to another for satiric effect. He is strikingly individual, not only in the expression of his personality in everything he writes with (for his time) uncommon frankness and wit, but in the originality with which he manipulates old themes, devices and forms. Dreams, tournaments, allegorical processions, love dialogues in the tradition of the *chanson d'aventure*, complaint and satire in the tradition of the *chanson à mal mariée*, verse testament, romance and even the offices of the church, are all turned to fresh account. Like other Scots poets after him—notably Robert Burns—he is a vigorously creative traditionalist. Too much has been made of his whimsicality and daftness. He shows the fantastic humour common among pre-Reformation Scots poets, but he has a superb sense of form, a control of his medium and of himself, which set him apart. In sheer artistry and range, though not in humanity, he is the finest of Scotland's poets.

BIBLIOGRAPHY.—*Manuscripts:* Dunbar's poems are preserved in 16th-century prints and mss. The prints, mainly the work of the Edinburgh printers Walter Chepman and Andrew Myllar *c.* 1508, survive in apparently unique copies in the National Library of Scotland. The manuscripts collections containing poems ascribed to Dunbar are: (1) the Asloan manuscript (written in the reign of James V) in the possession of the Talbot de Malahide family in Dublin; (2) the Bannatyne manuscript (1568) in the National Library of Scotland; (3) the Maitland Folio manuscript (*c.* 1580) in the Pepysian library, Magdalene college, Cambridge—with the Bannatyne manuscript preserving most of Dunbar's extant work; (4) the Aberdeen Minute Book of Seisins, vol. ii and iii; (5) the Reidpeth manuscript (1622), a transcript of the Maitland manuscript preserving a number of pieces lost from the original and in Cambridge university library; (6) the Howard manuscript (16th century) in the British museum, London (Arundel manuscript 285); (7) an early 16th-century collection of songs in the British museum (appendix to royal manuscripts 58).

Editions: The Bannatyne manuscript was edited by W. T. Ritchie in four volumes (1928–34), the Maitland Folio manuscript by W. A. Craigie in two volumes (1919–27), the Asloan manuscript by W. A. Craigie in two volumes (1923–25), all for the Scottish Text society. A facsimile of the Chepman and Myllar prints was edited with a note by W. Beattie for the Edinburgh Bibliographical society (1950). The standard edition of the poems is by J. Small and others, 3 vol., Scottish Text society (1884–93); others are by W. M. Mackenzie (1932) and J. Kinsley (1958).

Biography and Criticism: Full accounts of Dunbar's life and work are in J. Schipper, *William Dunbar. Sein Leben und seine Gedichte* (1884) and J. W. Baxter, *William Dunbar: a Biographical Study* (1952). For the political and social background *see* R. L. Mackie, *King James IV of Scotland* (1958). Critical discussions are: R. A. Taylor, *Dunbar: the Poet and his Period* (1931); A. M. Mackenzie, *An Historical Survey of Scottish Literature to 1714* (1933); J. Kinsley (ed.), *Scottish Poetry: a Critical Survey* (1955); C. S. Lewis, *English Literature in the Sixteenth Century* (1954). *See* also E. Morgan, "Dunbar and the Language of Poetry," *Essays in Criticism*, ii (1952); J. Kinsley, "The tretis of the tua mariit wemen and the wedo," *Medium Ævum*, xxiii (1954). (J. Kv.)

DUNBAR, a royal burgh and seaport in East Lothian, Scot., lies on the southern shore of the entrance to the Firth of Forth, 36 mi. E.N.E. of Edinburgh by road. Dunbar (Gaelic, "the fort on the point") is a favourite vacation town, with a sand and pebble beach and a golf course. Pop. (1961) 4,003.

A castle was built on the cliffs at least as early as 856. The fortress was an important bulwark against English invasion, and the town, which was created a royal burgh by David II, grew up under its protection. The castle was taken by Edward I and it afforded shelter to Edward II after Bannockburn. In 1336 it was besieged by the English, but was successfully defended by "Black Agnes" of Dunbar, countess of March. In 1479, after his escape from Edinburgh castle, the duke of Albany concealed himself there before sailing for France, and Mary Queen of Scots (*q.v.*) sheltered there in two crises. The regent Moray dismantled it in 1568. The remains of the castle, on the hill above Victoria harbour, are a nesting place for kittiwakes. A Franciscan monastery founded in 1218 stands in ruins at the west end of the town. The early 16th-century Town house, with a heeling clock steeple and massive doors to the police cells, is still in use. Lauderdale house, a Georgian mansion in High street, was formerly a residence of the earls of Lauderdale.

There are two harbours, the Old harbour, extended by Oliver Cromwell before the battle of Dunbar, and the Victoria harbour; both are difficult of access because of sunken rocks and reefs. As part of the redevelopment of the ancient part of the town, which is the harbour area, cottage-type dwelling houses were built after 1951 to the special design of Basil Spence, the architect of the new Coventry cathedral.

Apart from tourism the chief industries are fishing, agriculture, and brewing and malting. (X.)

Battle of Dunbar.—This battle was fought on Sept. 3 (Sept.

13), 1650, between the English army under Oliver Cromwell and the Scots under David Leslie, afterward Lord Newark. It took place about 3 mi. southeast of the town, on a plain between the hills and the sea, through which runs the road from Dunbar to Berwick. Plain and road are crossed at right angles by the Spott water (Brocks burn or Broxburn), which at first separated the hostile armies. Rising from the right bank of the Spott is Doon hill (582 ft.), overlooking the whole field. For the events preceding the battle *see* CIVIL WAR, ENGLISH.

Cromwell, worsted by Leslie in a war of manoeuvre near Edinburgh, was compelled by want of supplies to withdraw to Dunbar; Leslie pursued him and occupied Doon hill, commanding the English line of retreat toward Berwick. Cromwell's situation was perilous, and some officers were for attempting to withdraw by sea. He chose to hold his ground, though sickness had weakened his forces and he estimated the Scots numbers as double his own. Leslie, however, likewise short of provisions and perhaps subject to pressure from the civil and ecclesiastical authorities, descended from the heights on Sept. 2 in order to confront and attack his opponent. With the Spott water on their left, his forces now occupied the forward slopes of Doon and the plain below it.

If Leslie had thus placed himself on Cromwell's line of retreat, he had also placed Cromwell on his own; all would then depend on the skill of the commanders and, still more, on the discipline and fighting qualities of the troops. In the evening Cromwell disposed his army along the ravine and issued orders for a dawn attack on Sept. 3. His advance troops crossed the ravine very early and without meeting much opposition. His artillery was posted on the Dunbar side of the burn, to engage and pin down the Scottish left, while the infantry and cavalry, having made the crossing, deployed in a line south of and roughly parallel to the Berwick road.

Attacked on their right, the Scots at first repulsed both the horse and the foot, but soon Cromwell himself came up with his reserve, and the whole English line advanced again. The fresh impetus enabled it to break the Scottish resistance, and Leslie's line of battle was quickly rolled up from right to left. Oliver was heard to exclaim, "Now let God arise, and let His enemies be scattered," and, in a little while, "I profess they run."

Driven into the broken ground between Doon hill and the ravine, where their left wing was useless, the Scots "routed one another after we had done their work on their right wing," wrote one English officer. Cromwell reckoned that the Scots lost 3,000 killed and 10,000 prisoners, while he put his own casualties as low as 20.

BIBLIOGRAPHY.—C. H. Firth, "The Battle of Dunbar" in *Trans. Royal Hist. Soc.*, new ser., vol. XIV (1900), and *Oliver Cromwell and the Rule of the Puritans in England* (1900); Thomas Carlyle, *Oliver Cromwell's Letters and Speeches* (1845 *et seq.*); S. R. Gardiner, *History of the Commonwealth and Protectorate*, vol. i (1894); W. S. Douglas, *Cromwell's Scotch Campaigns* (1898). (G. S. P.)

DUNBARTONSHIRE, a county of western Scotland, is bounded north by Perthshire, east by Stirlingshire, southeast by Lanarkshire, south by the Clyde and its estuary, and west by Loch Long and Argyll. The detached parishes of Kirkintilloch and Cumbernauld, which are enclosed between the shires of Stirling and Lanark, formed part of Stirlingshire until the 14th century when the earl of Wigtown, to whom they belonged, became heritable sheriff of Dunbartonshire. Excluding fresh and sea water as well as foreshore, the area of Dunbartonshire is 241.2 sq.mi.

Physical Features.—The Highland boundary faults traverse the country northeastward from Kilcreggan through Loch Lomond near Luss. To the north and west lie heavily glaciated block mountains with a summit plane at about 2,200 ft. above which rises the highest hill, Ben Vorlich (3,092 ft.); this tract is mainly of Dalradian schists and grits, but there is a large granite intrusion straddling the county boundary west of Ben Vorlich. The mean annual rainfall exceeds 120 in. in the north; with snow evident for 10–30 days in the winter. This was doubtless an area of high precipitation during the Ice Age and it was a major centre of ice dispersal of which the rock-basin lakes of Loch Sloy and Loch Lomond (*q.v.*) and the fiord of Loch Long bear witness. There is much bare rock. Acid grassland (fescue-purple moor grass with bracken on deeper well-drained soils) dominates the vegetation with birch on protected slopes, oak in the valleys and alder by the streams. The area is within the range of the golden eagle, capercaillie, ptarmigan, great spotted woodpecker, red deer and wild cat.

South and east of the fault line the other half of the county lies in the mid-lowland but includes much hill country. First comes the Old Red Sandstone giving some conglomerate foothills and islands in Loch Lomond, then Carboniferous rocks over the rest of the county; first the Calciferous Sandstone series in which are intercalated basalt lavas especially in the Kilpatrick hills with a summit plane at about 1,200 ft., while Dumbarton Castle rock is a volcanic plug. The east of the county, including the detached portion, is on the Carboniferous Limestone series which as elsewhere in Scotland contains important coal seams, though broken by dolerite dykes which cross the whole of this tract from east to west. The lowland areas are largely covered by boulder clay dumped by the Highland glaciers and including many schistose rocks. The post-glacial rise in sea level which drowned the Clyde estuary and the sea-lochs caused an arm of the estuary to run north from Dunbarton into what is now Loch Lomond, and there are many raised beach deposits of sand and gravel on coastal shelves as also in this tract, along with recent silts of the river Leven meander-belt. The hills have over 50 in. mean annual rainfall, with peat-bog vegetation and wet flying bent grassland (used for sheep grazing), sedges, etc. The true lowlands, with under 50 in., present a landscape of whitewashed dairy farms where oats, turnips and kale are grown, and short leys (pastures) to feed Ayrshire cattle in pleasant rolling country with planted woodlands for amenity and shelter. (A. T. A. L.)

History.—Prehistoric peoples have left rude forts and tumuli, and there are several remains of the wall of Antoninus, built from Forth to Clyde and running along the north of the detached portion of the shire and through the southeastern corner of the county to Kilpatrick (*see* ANTONINE WALL). Other Roman relics have been found at Duntocher, Cumbernauld and elsewhere. The shire formed part of the old Scottish territory of Lennox (Levenachs, "fields of the Leven") which embraced the vale of the Leven and the basin of Loch Lomond, or all modern Dunbartonshire, most of Stirling and parts of the shires of Renfrew and Perth. It gave its title to the earldom created in 1174 by William the Lion and of the dukedom conferred by Charles II on his natural son, Charles, duke of Richmond and Lennox. Robert Bruce is said to have mustered his forces at Dullatur before the battle of Bannockburn, and died in the county at Cardross castle in 1329. In 1603 Glen Fruin was the scene of the conflict between the Macgregors and the Colquhouns in which the latter were almost exterminated. This encounter led to the proscription of the Macgregors, including Rob Roy. The Covenanters in their flight from the field of Kilsyth, where in 1645 the marquess of Montrose had defeated them, made their way through the southern districts. The clans of Macgregor and Macfarlane made their home in this highland fastness and raided their lowland neighbours.

Population and Administration.—The population in 1961 was 184,546; Gaelic and English were spoken by 1,190 persons. The principal towns are Clydebank (pop. [1961] 49,654) and Dumbarton (26,335; a royal burgh and the county town), both large burghs, the small burghs Helensburgh (9,605), Cove and Kilcreggan (877), Milngavie (8,894), Bearsden (17,022) and, in the detached portion of the county, Kirkintilloch (18,257). There are five county districts. The county returns two members to parliament, one representing East Dunbartonshire and one West Dunbartonshire. Dunbartonshire forms a sheriffdom with the counties of Stirling and Clackmannan, and a resident sheriff-substitute sits at Dumbarton.

Industries and Communications.—The arable lands extend chiefly along the Clyde and the Leven and are composed of rich black loam, gravelly soil and clay. Farmers have markets on the Clyde for all kinds of stock and produce, and high farming and dairying prosper. Black-faced sheep and Highland cattle are pastured on the hilly lands and Border Leicesters and Ayrshires

on the low grounds. Oats is the principal crop; potatoes, turnips, swedes and some wheat are also grown.

Agriculture, orientated to the Glasgow market, is altered locally by intensification in the shape of market gardening (including rhubarb-growing) with considerable areas of glasshouses, and also by the spread of suburban and week-end residences from Glasgow. The great quantities of pure water in the Leven, traditionally used by textile trades and by dye-works and cleaners, are associated with new industrial development including some in the Vale of Leven industrial estate. The Clyde shores, lined at first with shipyards and engineering works, including the sewing-machine works at Clydebank, give sites downstream for suburban and resort development as at Helensburgh and Garelochead, while beyond lies tourist country, naval developments and the new oil port at Finnart. Manufactures include office equipment, elastic garments, alarm clocks, lenses and textile finishing.

The more populous districts are served by British railways. From Craigendoran to Inverarnan, the West Highland line runs through beautiful scenery. Portions of the Forth and Clyde canal, connecting with the Clyde at Bowling, and opened for traffic in 1790, pass through the shire. There is a regular steamer communication between Craigendoran, Kilcreggan, and the south side of the Firth. During the summer months a steamer service on Loch Lomond operates from Balloch. (Rt. C.)

DUNBLANE, a small burgh of Perthshire, Scot., mainly on the left bank of Allan water, a tributary of the Forth, 6 mi. N.W. of Stirling by road. Pop. (1961) 2,922. It is a place of great antiquity, with narrow streets and old houses and a 15th-century bridge, later widened. The chief industry is wool spinning and there is also silk dyeing. The agricultural area around Dunblane traditionally produced beef, but dairy farming now predominates while on the arable land seed potatoes are mostly grown. There is good fishing in the Allan. A large hydropathic hotel stands on a hill. The cathedral by the side of the river, now the parish church, escaped injury at the Reformation. The first church is said to have been erected by St. Blane in the 6th century, but the cathedral, founded by David I, was almost entirely rebuilt about 1240 by Bishop Clemens. The tower is early Norman. The building was neglected for a long period after the decline of episcopacy, but there was extensive restoration in the 19th century. In the cathedral are 15th-century carved oak stalls and an old Celtic cross, 6½ ft. high. Of the bishop's palace only a few ruins remain. Leighton library, built in 1687 to house Bishop Robert Leighton's books, was expanded in the following centuries. Queen Victoria school for the sons of Scottish servicemen was opened in 1908. The battlefield of Sheriffmuir (*q.v.*) lies about 2½ mi. E. of Dunblane.

DUNCAN, the name of two Scottish kings.

Duncan I (d. 1040), king of the Cumbrians, and king of the Scots from 1034 to 1040, was the son of Bethoc, daughter of King Malcolm II, by her husband Crinan, lay abbot of Dunkeld (in whose family the name Duncan probably ran). Malcolm II made him king of Strathclyde when that kingdom ceased to be independent, probably not long before 1034, when he succeeded his grandfather as king of Scotland. He besieged Durham in 1039, and in 1040 "at an immature age" was killed by Macbeth, mormaor of Moray. Two of his sons, Malcolm III and Donaldbane, became kings of Scotland.

Duncan II (d. 1094) was king of Scotland for a few months in 1094. He was the son of Malcolm III and his first wife Ingibiorg, who were related, so that Duncan's legitimacy was later questioned. He was a hostage in England from 1072 to 1087. He went north as William II's vassal in April 1094, and drove out King Donaldbane; but he was forced to dismiss his Anglo-Norman following and fell victim to Donald in Nov. 1094. The earliest known Scottish charter runs in his name and bears his seal; in it he styles himself, like John Balliol, but unlike all other Scottish kings, *rex Scotie* not *rex Scottorum*. Claims to the Scottish throne were made by his descendants until 1215. (A. A. M. D.)

DUNCAN, ADAM DUNCAN, 1st Viscount (1731–1804), British admiral, who gained a famous victory over the Dutch at Camperdown in 1797, was born on July 1, 1731, at Lundie, Scot. He entered the navy in 1746 and served under Augustus (later viscount) Keppel in the Seven Years' War. He became lieutenant in 1755, captain in 1761 and rear-admiral in 1787. He was present with Adm. George (later Lord) Rodney at the relief of Gibraltar (1780) and at the battle of the Saints (1782). On the outbreak of war with France in 1793 he was made vice-admiral. In 1795 he was appointed admiral in command of the North sea fleet to blockade the Dutch in the Texel. Though in May 1797 all his ships except two joined the mutiny at the Nore, Duncan maintained his blockade by deluding the enemy with signals to imaginary ships over the horizon. That summer Gen. Lazare Hoche planned an invasion of Ireland with the assistance of the Dutch fleet under Adm. Johann Wilhelm De Winter. On the former's death in September the troops disembarked, but the Batavian government (contrary to the advice of the admiral) ordered the fleet to sea. Duncan was informed by his cruisers that 16 line-of-battle ships had left the Texel on Oct. 7. On Oct. 11, as De Winter tried to regain his base, Duncan attacked with 15 ships five miles off Camperdown. In order to engage before the enemy had time to reach shoal water, he bore up in two groups without waiting to form line of battle. The enemy line was broken in two places, De Winter himself surrendering to Duncan's flagship, "Venerable." After a particularly hard-fought action, nine ships (excluding frigates) were captured. The remainder, which escaped under cover of darkness, surrendered to Duncan in 1799, when he covered the landing of an Anglo-Russian force under Frederick, duke of York, at the Helder. For his services at Camperdown Duncan was created a viscount in 1797. In 1800 he retired because of ill-health and died at Cornhill, Northumberland, on Aug. 4, 1804. A man of imposing build, 6 ft. 4 in. tall, he had a modest and genial temperament that made him universally popular. His resolution in adopting tactics similar to those used later at Trafalgar was rewarded by one of the most complete victories in naval history.

See Earl of Camperdown, *Admiral Duncan* (1898). (C. C. L.)

DUNCAN, ISADORA (1878–1927), U.S. dancer, was a great revolutionary of the dance who repudiated artificial technical restrictions; she returned to nature itself for her inspiration, seeking a form of dance as natural as the rhythmic movement of the waves. She liberated the dance from dependence on worn-out formulas, paving the way for the development of modern expressive dance.

Born in San Francisco, Calif., May 27, 1878, she danced as a child, but, after a few lessons in ballet, determined to study only natural movement. She toured with Augustin Daly and gave her first tentative concerts in Chicago and New York before persuading her family (mother, sister Elizabeth and brother Raymond) to accompany her to Europe in a cattle boat.

Her first substantial success followed a concert in Paris in 1902. Appearances in Budapest, Berlin and Bayreuth focused serious attention on her art. When she visited Russia in 1905, Michel Fokine (*q.v.*) was profoundly impressed by her dancing. She made several American tours, the last in 1922–23. She founded schools in Germany, Russia and the United States, but none survived.

One of the first dancers to interpret symphonic music, Duncan was deeply influenced by Gluck, Brahms, Wagner and Beethoven. Her dancing barefoot in a loose tunic, suggested by Greek sculpture, furthered the 20th-century emancipation of women's dress.

Unmarried, she bore two children, who were accidentally drowned in 1913. Her later marriage (1922) to the Russian poet Sergei Esenin (*q.v.*) ended in separation. She died in Nice, Sept. 14, 1927, accidentally strangled by a long scarf which became caught in a rear wheel of the open automobile in which she was riding.

See her autobiography, *My Life* (1927). (Ln. Me.)

DUNCKER, MAXIMILIAN WOLFGANG (1811–1886), German historian and politician, was one of the scholars diverted to political interests by the movement toward German unity. He was born at Berlin on Oct. 15, 1811, and studied at Bonn and Berlin until 1834, when he was imprisoned for six months for belonging to students' corporations. This imprisonment retarded his advancement, but in 1842 he became professor at Halle.

In 1848 Duncker was a member of the Frankfurt assembly, there becoming the friend of J. G. Droysen (*q.v.*). German unity was Duncker's ruling idea and his deepest ambition was directed toward public, not academic, life. His liberal views prevented his advancement in the Prussia of the time and in 1857 he accepted an invitation to Tübingen. Two years later (under the regency) he was called to a chair at Halle but accepted instead the post of chief press officer in Berlin. In the same year he became assistant in the foreign office and a member of the Prussian lower house. In 1861 he was appointed occasional adviser to the crown prince. In the Bismarck period his position became difficult and he resigned, although he subsequently worked for Bismarck. In June 1867 at his own wish he was appointed director of the Prussian archives, holding the post until 1874. He died at Ansbach, July 21, 1886. In spite of his political career Duncker's reputation rests mainly on his *Geschichte des Altertums*, 9 vol. (1852–86); Eng. trans. by E. Abbott, *History of Antiquity*, 6 vol. (1878–82).

DUNDALK (Dun Dealgan, "Dealga's fort"), a seaport and urban district and the administrative centre of County Louth, Republic of Ireland, lies 22 mi. N. of Drogheda by road, near the mouth of the Castletown river, Dundalk bay. Pop. (1961) 19,706. The town has had a turbulent history, from the legendary exploits of Cú Chulainn and his knights, through the period of Norse attacks in the 10th century, the Anglo-Norman invasion to the invasion of Edward Bruce who was killed (1318) in the neighbourhood. There is a record of sieges after it was walled by Henry IV to the burning during the disorders of 1921–23. Dundalk was a borough by prescription and received charters from King John and other monarchs. It is a junction, with large railway shops, of the Great Northern railway. There are distilleries, breweries, bacon, shoe, clothing, cigarette and tobacco factories, and flour mills. Trade is in livestock and agricultural produce, including barley, and there are sea and salmon fisheries. Coal is imported. Notable buildings include the churches of St. Patrick (Roman Catholic) and St. Nicholas (Church of Ireland).

DUNDEE, JOHN GRAHAM OF CLAVERHOUSE, Viscount (1648–1689), Scottish soldier, known as "Bonnie Dundee," who led the first Jacobite rising in Scotland (1689) but was killed at Killiecrankie in the moment of victory. He was the elder son of William Graham and Lady Magdalene Carnegie and succeeded to his father's estates in 1653. Educated at St. Andrews university, he served as a volunteer in France and the Netherlands from 1672, becoming a captain in 1676. He returned to England in 1677 and had settled in Scotland when, on Sept. 23, 1678, he was appointed captain of one of three troops of horse commissioned in view of the situation caused by the militant conventicles of the southwest. In Feb. 1679 he was named a sheriff-depute for the southwestern shires.

After the murder of Archbishop James Sharp (May 3, 1679), rebels published a manifesto at Rutherglen (May 29). Graham, pursuing the disaffected, came upon a large armed conventicle in a well-protected position upon the marshy ground of Drumclog (June 1). The rebels, galled by fire which they could not effectively return, advanced in an impetuous attack which routed the royal cavalry, Graham himself having a narrow escape. The enthusiasm raised by this action was the beginning of a serious rebellion. On June 22 Graham was present at the head of his troop when the covenanters were defeated at Bothwell bridge. He was then commissioned to search the southwestern shires for rebels, but acted for only a very short period. He was in London in July 1679, establishing himself in the favour of James, duke of York, in whose train he probably returned to Scotland in October. But he was in London again by Feb. 1680 and seems to have remained there until late in 1681, except for a brief visit to Scotland.

It was only in Jan. 1682, when Graham was appointed sheriff of Wigtown, that he resumed operations against the covenanters. He retained his commission in the army and was promoted colonel on Dec. 25, 1682. Both then and later, the wide powers given to him were sparingly used, and his systematic proceedings against ringleaders and men of substance who countenanced the rebels were more effective than the haphazard brutalities of other commanders. On his return from another visit to London, he was sworn a privy councilor (May 1683) and in June he was present at the sittings of a circuit court of justiciary instituted for the imposition of the oath required by the Test act and for the punishment of rebels. He was rewarded for his services when, by charter of April 23, 1684, he obtained the lands and castle of Dudhope, with the office of constable of Dundee. From April to Sept. 1684 Graham was again at his old employment of inspecting the southern and southwestern shires; in May 1685, at the time of the earl of Argyll's rising, he was ordered with his cavalry to guard the borders and to scour the southwest in search of rebels. It is to 1684 and 1685 that his alleged atrocities are mostly assigned; but careful investigation has reduced the number of lives he took to no more than ten. From 1685 he spent three uneventful years, mainly at Dundee, of which he became provost in 1688.

On the invasion of England by William of Orange, Graham, who had been promoted major general in 1686, was second-in-command in the Scottish army ordered to England to aid King James; he was created Viscount Dundee on Nov. 12, 1688. After James's flight, Dundee returned to Scotland, where he attended the meeting of the convention. The convention proving hostile to James, Dundee left it, and as he retired from Edinburgh (March 18, 1689) at the head of about 50 dragoons he conferred with the duke of Gordon and encouraged him to hold the castle for James. On March 30 he was publicly denounced as a rebel. Gen. Hugh Mackay took the field against him, but the secrecy and speed of his movements outwitted his pursuers as he retreated to the north and into the central Highlands. Dundee expected substantial help to arrive from the exiled king, but little came. By June 11 a kind of stalemate had been reached, but in July many Highland clans assembled round Dundee and both sides took the field again. On July 18 a high price was set on Dundee's head. Mackay, in his march toward Blair castle, entered the pass of Killiecrankie, the battleground selected by Dundee and his officers. There, on July 27, 1689, was fought the battle of Killiecrankie (*q.v.*). The Highlanders were completely victorious, but their leader was shot and fell dying from his horse.

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DUNDEE, a royal and parliamentary burgh, county of a city and seaport of Angus (Forfarshire), Scot. Pop. (1961) 182,959. It lies on the north shore of the Firth of Tay, 51 mi. N.N.E. of Edinburgh by road and ferry. Railway approach from Edinburgh is either by way of Perth or across the Forth and Tay bridges. The town has a frontage on the water of more than 8 mi. and rises gradually from the river to Dundee Law (571 ft.) and Balgay hill. The estuary to the east of Tay bridge (more than 2 mi. long) is 1½ mi. wide and the docks—accessible from it at all stages of the tide—are within 12 mi. of the sea. At the 1961 census Dundee was the fourth largest city in Scotland, but second in respect of commerce.

The new city chambers, forming two sides of a large open square, were opened in 1933. The Caird hall, with a fine classic portico, which forms the southern end of the square, was erected largely from a bequest of Sir James Caird (d. 1916) and contains a big concert hall and a banquet hall (the Marryat hall). The Mercat cross, a shaft 15 ft. high, bearing a unicorn with the date of 1586, once stood in High street, but was reconstructed in the southwestern corner of the grounds of the City churches. A library and sculpture galleries in Ward road were finished in 1915 and the Albert institute in Meadowside contains the art gallery, museum and central library. In Dock street stands the Royal arch, erected to commemorate the visit of Queen Victoria in 1844. Dudhope castle, once the seat of the Scrymgeours, hereditary constables of the burgh (one of whom, Sir Alexander, was a companion-in-arms of Sir William Wallace) was granted by James VII of Scotland (James II of England) to John Graham of Claverhouse. On his death it reverted to the crown and was later clubrooms for various organizations. Though Dundee was once a walled town, the only relic of its walls is the East port in Cowgate, preserved because it was said that George Wishart, the Scottish reformer who

was burned as a heretic in 1546 at St. Andrews, preached from the parapet during the plague of 1544.

Of the many churches and chapels the most interesting are the City churches—St. Mary's, Old St. Paul's and St. David's, and St. Clement's, the three parish churches being under one roof. At the west end of the building stands the noble square tower (St. Mary's tower) 156 ft. high, commonly called the old steeple, which was once the belfry of the church erected on that spot by David, earl of Huntingdon, as thanksgiving for his escape from shipwreck on the shoals at the mouth of the Tay (1193). The church perished, but the bell tower remained and was restored in 1871–73 by Sir George Gilbert Scott. Bishop Alexander Forbes (1817–75) transferred the Anglican see of Brechin to Dundee.

Hospitals include the Royal infirmary, Maryfield hospital, King's Cross hospital, the Dundee Royal mental hospital and Ashludie sanatorium. The Baldovan institution for the mentally sick was founded in 1884.

The University of St. Andrew's act (1953) dissolved University college, Dundee, which was endowed in 1881 by Miss M. A. Baxter of Balgavies (1801–84) and John Boyd Baxter (1796–1882), and united with the University of St. Andrews in 1897. Following the 1953 act it combined with the University Advanced Medical school (1898) and Dental school (1914) to form Queen's college, a constituent college of the university. There is a fine technical college and school of navigation, while the Duncan of Jordanstone College of Art was opened in 1954. The high school stands on the site of the old public seminaries. Morgan hospital, in Scots Baronial style, immediately to the north of Baxter park was founded for poor boys in 1858 by John Morgan, a native of Dundee, but is now under the jurisdiction of the local education authority as a secondary school. A training school for teachers was opened in Park place in 1920.

Dundee is well endowed with public parks, a total of 1,150 ac. being available. In one of them, Balgay park, is Mills observatory, open to the public. The large Camperdown park (500 ac.) was opened by Queen Elizabeth II when Princess Elizabeth in 1946. It contains the mansion house of the former earls of Camperdown. Along the shore of the estuary is the esplanade running west from Craig pier and linking with the main road to Perth at Ninewells, thus forming a useful bypass.

With modern changes, some picturesque but unsanitary buildings, narrow winding streets and unsavoury courtyards disappeared, along with a few structures of more or less historic interest, like the castle, the mint and numerous convents. But the large factory population, together with the number of high tenement buildings, gave rise to slum conditions, which had been considerably improved by the early 1960s.

Dundee returns two members to parliament. The city council consists of the lord provost, bailies and councillors, there being 36 elected members, plus the dean of guild.

Suburbs.—Broughty Ferry lies on the Firth of Tay, 3½ mi. E. of Dundee. The name is a corruption of Brugh or Burgh Tay, in allusion to the fortress standing on the rock that juts into the firth. It is believed that a stronghold has occupied this site since Pictish times. The later castle, built in 1498, fell into the hands of the English in 1547 and was held by them for three years. Gradually growing more or less ruinous it was acquired by the government in 1855, repaired, strengthened and converted into a Tay defense, mounting several heavy guns. Because of its healthful and convenient situation, Broughty Ferry became a favourite residence of Dundee merchants. To the northwest lies Benvie. Fowlis, 5 mi. N.W., is remarkable for its 15th-century church, with carved ambry and rood screen (curious representation of the Crucifixion), decorated font, crocketed door canopy and several paintings. The ruined castle adjoining the church ultimately became a dwelling for labourers. Lundie, 3 mi. farther out in the same direction, contains several small lochs, and its churchyard is the burial place of the earls of Camperdown. Tealling, 4 mi. N. of Dundee, was the scene of the ministry of John Glas before he was deposed for heresy. Newport and Wormit, on the opposite bank of the Tay, are connected with Dundee by ferry.

Industry and Commerce.—Dundee is noted first for its large-scale jute industries; the raw materials are imported from Pakistan and fabrics in jute range from the roughest sacking to beautiful carpets. Linen is also manufactured in quantity while the chief textile products are canvas (for which the Royal Navy is the largest customer), ropes, sheetings, sackings, carpets, etc. Dundee is also celebrated for its confectionery and preserves, especially marmalade. Other industries are bleaching and dyeing, engineering, shipbuilding, linoleum manufacturing, foundries, breweries, corn and flour mills, electrical transformers, cash registers, watches, refrigerators, counting devices, batteries and expanded rubber.

On the front, wharves and harbour works extend for approximately 2½ mi. The docks cover an area of 35½ ac. including Earl Grey dock, 5 ac.; King William IV dock, 3⅞ ac.; Tidal basin, 4¾ ac.; Victoria dock, 10¾ ac.; Camperdown dock, 8½ ac., and Fish dock, 1⅝ ac. There are also graving docks, the ferry harbour and timber ponds. There is regular communication by steamer with London, Kingston-upon-Hull, Newcastle-upon-Tyne, Liverpool, Southampton, Portsmouth, Manchester, Leith and Aberdeen, also with Rotterdam, Amsterdam, Hamburg and other continental ports. There is a steady trade with Calcutta, Bombay and Karachi.

History.—The name of the city is derived most probably from the Gaelic *Dun Taw*, "the fort of the Tay," of which the Latin *Taodunum* is a transliteration—the derivation pointing to the fact of a Pictish settlement on the site. Its earliest authentic mention is in a deed of gift by David, earl of Huntingdon, younger brother of William the Lion, dated about 1200, in which it is designated as "Dunde." Shortly afterward it was erected into a royal burgh by William the Lion. Edward I is said to have removed its charter but Robert Bruce and successive kings confirmed its privileges and rights, and Charles I finally granted it its great charter in 1641.

In 1291 the town fell into the hands of the English, and while engaged in besieging the castle in 1297 Sir William Wallace withdrew to fight the battle of Stirling bridge. In their incursion into Scotland under John of Gaunt the English captured and partially destroyed the town in 1385, but retreated to meet a counter invasion of their own country. The English seized it again for a brief space during one of the first earl of Hertford's devastating raids in the reign of Edward VI. Dundee bore such a prominent part in propagating the Reformed doctrines that it was styled "the Scottish Geneva." The marquess of Montrose sacked it in 1645 and then burned a considerable portion of it. Charles II spent a few days in the castle after his crowning at Scone, Jan. 1, 1651. In the same year Gen. George Monk captured it after an obstinate resistance and put more than one-sixth of the inhabitants and garrison, including its governor Robert Lumsden, to the sword. Sixty vessels were seized and filled with plunder; but the ships, says Thomas Gumble in his *Life of Monk*, "were cast away within sight of the town and that great wealth perished." In 1684 John Graham of Claverhouse, to the north of the town, became constable and in 1688 provost, in which year James II created him Viscount Dundee (*see* DUNDEE, JOHN GRAHAM OF CLAVERHOUSE, VISCOUNT). Other famous men who were born or lived in Dundee include Hector Boece (*q.v.*), James Halyburton, the reformer, Sir George MacKenzie (*q.v.*), known as "the bloody MacKenzie," Adm. Adam Duncan, the victor of Camperdown, James Bowman Lindsay, a pioneer of wireless telegraphy, George Constable of Wallace Craigie, the prototype of Jonathan Oldbuck in Sir Walter Scott's *Antiquary*, who lived in Seagate, William Thom (1798–1848), the writer of *The Rhymes of a Handloom Weaver*, who was buried in the Western cemetery, and Sir Richard Claverhouse Jebb (*q.v.*), the classical scholar.

Queen Victoria granted a charter to Dundee dated Jan. 25, 1889, raising it to the status of a city, and since 1892 its chief magistrate has been styled lord provost. In 1894 it was created a county of a city. (G. S. WN.)

DUNDERLANDSDAL, a valley of northern Norway, draining southwestward from the neighbouring glaciers to the Ranafiord (latitude 66° 20′ N.). Valuable deposits of iron ore (magnetite and hematite) occur there. They were worked during interrupted periods from 1902 to 1939 by a British company.

After 1947 they were state owned. In the early 1960s the mines were reconstructed and modernized to supply an iron- and steel-works in Mo, a town at the mouth of the river. The valley is remarkable for caverns in the limestone, some of the tributary streams flowing for considerable distances underground. The North Norway railway and the North Norway highroad follow the valley. (L. H. Hg.)

DUNDONALD, THOMAS COCHRANE, 10TH EARL OF (1775–1860), British admiral, who ranks among the greatest of British seamen for his brilliant and unconventional career, was born at Annesfield, Lanarkshire, on Dec. 14, 1775. He was the eldest son of the 9th earl whose scientific experiments on his Scottish estates impoverished his family. In 1793 Thomas joined the ship commanded by his uncle, Alexander Cochrane. In 1800 he was appointed to the command of the brig "Speedy." His brilliant capture of the Spanish frigate "El Gamo" (1801) brought him fame, and his subsequent cruises in command of the frigates "Pallas" and "Impérieuse" won him a fortune in prize money. His fame as a frigate captain is immortalized in the novels of Capt. Frederick Marryat, who served under him.

Cochrane was elected member of parliament for Honiton in the radical interest in 1806, and for Westminster in 1807. He led a hazardous fireship attack on the French fleet in the Aix roads in April 1809, but the fruits of his courage were thrown away by the commander in chief, Lord Gambier. Cochrane's ill-advised criticisms of Gambier resulted in the latter's court-martial, at which he was acquitted. This, together with Cochrane's unpopularity in government circles in consequence of his demands for parliamentary and naval reform, resulted in his not being employed again at sea. In Feb. 1814 Cochrane and others were involved in a plot to make money on the stock exchange by spreading false rumours about the abdication of Napoleon. In the trial which followed Lord Ellenborough sentenced him to a period of imprisonment; he was expelled from parliament and deprived of the order of the Bath, which had rewarded his exploit in 1809.

At this lowest point of his fortunes Cochrane accepted (May 1817) the invitation of Chile to command its fleet in the war of independence against Spain. His capture of the Spanish flagship "Esmeralda" in Callao harbour contributed largely to the independence of Chile and Peru. From 1823 to 1825 he transferred his services to Brazil in its war against Portugal. Soon after his return to Europe he was employed by the Greeks in their war of independence, but resigned in 1828 on account of factional disputes and delays in the delivery of steamships, which he proposed to use in war for the first time. At home he campaigned vigorously for reinstatement in the navy, which he achieved in 1832, the year after he succeeded his father as earl of Dundonald. From 1848 to 1851 he commanded the American and West Indies station, where he drew attention to the importance of Trinidad Pitch lake. Only his advanced age of 79 prevented him from commanding a fleet in the Crimean War. He died in London on Oct. 30, 1860, and was buried in Westminster abbey. Throughout his life he occupied himself with inventions, particularly in connection with gas and tar, tubular boilers and screw propulsion. The plans which he put forward in a letter to the prince regent on March 2, 1812, for the use of sulfur gas and smoke screens in war remained secret for nearly a century. Few men have had such an adventurous, turbulent and versatile career. Cochrane was the author of *Autobiography of a Seaman*, 2 vol. (1860–61) and *Narrative of Services in the Liberation of Chili, Peru and Brazil*, 2 vol. (1959).

See the *Life*, 2 vol. (1869) by his son Thomas and H. Fox Bourne; C. C. Lloyd, *Lord Cochrane* (1947). (C. C. L.)

DUNE, a mound or hill and ridge of sand heaped by wind. Dunes are numerous in (1) deserts, particularly in low-lying areas; (2) on sandy coasts with onshore winds; and (3) near rivers of which the volume varies, leaving sandy beds exposed during the dry season. The *areg* of the Sahara and Arabian desert are characterized by vast expanses of dunes, as are the *koums* of the deserts of Iran and Turkistan and the plateaus of Gobi and other Mongolian deserts. Few such desert dunes are found in America or Australia, but the sand hill region of western Nebraska affords a good illustration. In Europe the coasts of Brittany, Cornwall, the Landes of France and the shores of the Baltic; in North America the whole eastern coast from Cape Cod southward, and at places along the Pacific coast; and in Africa, Australia and Asia numerous leeward coasts—these serve as examples of oceanic coastal dunes. Lacustrine dunes are admirably developed on the east shore of Lake Michigan, the south shores of Lake Superior and Lake Erie, the shores of former Lakes Lahontan and Bonneville in the Great Basin of the United States, and on the east shores of the Caspian and Aral seas in western Asia. Examples of river bank dunes are found in almost every land, as, for instance, along the east banks of the Mississippi, Missouri and Rio Grande rivers in the United States.

Dunes migrate constantly unless the sand of which they are composed is prevented from blowing by grass or other vegetation. The rate at which dunes move varies, depending upon the velocity of the wind and the height of the dunes, small dunes migrating the faster. In Denmark the rate is from 8 to 20 ft. a year; in France, on the Bay of Biscay, the sands have advanced at a rate estimated from 15 to 105 ft. a year, burying in their progress forests, farms, vineyards, churches and whole villages, some of which may in course of time be exhumed as the dunes migrate onward. On the south side of Lake Michigan forests which were buried by sand dunes have been uncovered as the dunes moved on. Hundreds, perhaps thousands of square miles of towns and cities in central Asia are buried under dunes. Moving dunes constantly encroach upon the Suez canal. Nor are dunes merely a contemporary geologic feature. Sand dune deposits are recognizable by the character of their bedding in sandstone rocks of many geologic periods, indicating that aeolian action has been prevalent throughout geologic history. Fossil dunes are widely distributed.

(W. E. E.)

DUNEDIN, the fourth largest city of New Zealand and capital of Otago provincial district, lies on the southeast coast of South Island. Pop. (1961) 73,226 (105,053 with urban area). Area 21.8 sq.mi.

Dunedin is situated at the head of a 14-mile-long harbour. The deep-water Port Chalmers is on the northern shore and wharves at the city end are able to accommodate medium-sized ships. The site of the town is hilly, the higher suburbs commanding views of the ocean and harbour. The city was planned in Edinburgh, Scot., and many of the streets are named from Edinburgh streets. The main thoroughfare, Princes street and George street, runs southwest and northeast from the central Octagon, a park area. Important public buildings include the municipal chambers, the Anglican cathedral and the impressive stone-built University of Otago, which was founded in 1869 and has schools of medicine, dentistry, mines, home science and physiotherapy. The Otago Boys' high school and Otago Girls' high school are both the oldest of their kind in New Zealand.

Dunedin is notable for its "green belt" planned by the original settlers and surrounding the inner area with 500 ac. of native forest. The botanical gardens display a fine collection of New Zealand and exotic plants and their Ellen Terry garden contains all the kinds of plants mentioned in Shakespeare's works. The Otago museum has a fine Polynesian section and the Otago Early Settlers' museum contains many records of the pioneering days.

Passenger transport within the city is provided by diesel buses and electric trolley buses. Dunedin is on the main railway and is linked with other New Zealand cities by road services and by air services from Momona airport, 18 mi. S.W.

Dunedin is an important industrial centre. The leading industries are wool spinning, the manufacture of clothing, woolen goods and footwear, flour milling, brewing, frozen meat, engineering and ship repairing. Other factories produce foodstuffs, chemicals, fertilizers, soap, cement and building materials, paper and furniture. The chief exports are wool, frozen meat and dairy produce and the chief imports petroleum products, iron and steel, sugar, phosphates and sulfur.

Capt. James Cook in 1770 observed that the coastal region appeared uninhabited. An English settlement arose in 1840 from a whaling station at Waikouaiti, 20 mi. N., and Dunedin was founded in 1848 as a Scottish Free Church settlement by Capt. William

Cargill, a Peninsular War veteran, and the Rev. Thomas Burns, nephew of the poet Robert Burns. The original intention was to name the town New Edinburgh, but later the Gaelic name for Edinburgh, Dunedin, was adopted. The city has strong Scottish associations; kilts and pipe bands are in evidence at public functions and the Dunedin Burns club is the largest outside Scotland. The discovery of gold in central Otago in 1861 brought prosperity and increased population to Dunedin and led to the settling of much hitherto unexplored country in the vicinity by farmers and graziers. Dunedin was constituted a city in 1865.

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DUNES, BATTLE OF THE, was fought on June 14 (new style; June 4, old style), 1658, near Dunkerque, then on the Spanish side of the frontier of France and the Netherlands, between the French and English army under the command of the marshal de Turenne and the Spanish army under Don John of Austria and the Great Condé. The severest part of the fighting was borne by the English contingents on either side. Six thousand English infantry under Gen. William Lockhart had been sent by Oliver Cromwell to join Turenne's army, and several English royalist corps under the command of the duke of York (afterward James II) were serving in the Spanish forces. The object of the Spaniards was to relieve Dunkerque, which Turenne was besieging. Don John had a strong superiority in cavalry, but left behind his artillery so not to delay his advance. He took up a position on the dunes with his right on the sea and his left on the Bruges canal, and there Turenne at once attacked him. Condé's cavalry on the left wing charged with great resolution and despite heavy losses gained the upper hand, but their success was nullified by the failure of the Spanish right and centre to resist the pressure of Turenne's infantry and of Cromwell's veterans in particular. When the rest of the Spanish army was in rapid retreat, the one small corps of English royalists, about 300 strong, held out stubbornly and laid down their arms only on terms that they be allowed to rejoin their king, Charles II, at Ypres. From this corps, the royal regiment of guards, are descended the Grenadier guards of the British army. The surrender of Dunkerque by the Spaniards speedily followed (it was left to the English by France), and the peace of the Pyrenees between France and Spain was signed the next year. (D. M. Sc.)

DUNFERMLINE, a royal and parliamentary burgh and city of Fifeshire, Scot., 14 mi. N.W. of Edinburgh by road and ferry. Pop. (1961) 47,159. The burgh includes Rosyth (*q.v.*), which was added to it in 1911. It is situated on high ground 3 mi. from the shore of the Firth of Forth, with two railway stations. The town is intersected from north to south by Pittencrieff glen, a deep, picturesque ravine, from which the town derives its name (Gaelic, "the fort on the crooked linn") and at the bottom of which flows Lyne burn.

The early Celtic monks known as Culdees had an establishment there; but its fame dates from the marriage of Malcolm Canmore and his queen, St. Margaret, solemnized in the town about 1067. The king lived in a tower on a mound surrounded on three sides by the glen. A fragment of this castle exists in Pittencrieff park, a little west of the later palace. Under the influence of Queen Margaret the foundations were laid about 1072 for the Benedictine priory which was raised to an abbey by David I. Robert the Bruce gave the town its charter in 1322.

With the exception of Iona, Dunfermline abbey has received more of Scotland's royal dead than any other place in the kingdom. Within its precincts were buried Queen Margaret and Malcolm Canmore, their sons Edgar and Alexander I, with his queen; David I and his two queens; Malcolm VI; Alexander III, with his first wife and their sons Edgar, David and Alexander; Robert the Bruce, with his queen Elizabeth and their daughter Matilda; and Annabella Drummond, wife of Robert III and mother of James I. Bruce's heart rests in Melrose, but his bones lie in Dunfermline abbey, where (after the discovery of the skeleton in 1818 during excavations for the New church) they were reinterred below the pulpit. In 1891 the pulpit was moved back and a monumental brass inserted in the door to indicate the royal vault. The tomb of St. Margaret and Malcolm, within the ruined walls of the Lady chapel, was restored and enclosed by command of Queen Victoria. When the Reformers attacked the abbey church in March 1560, they spared the nave, which served as the parish church till the 19th century, and later formed the vestibule of the New church (1821). The old building was a fine example of simple and massive Norman work with a beautiful doorway in its west front. Another rich Norman doorway was exposed in the south wall in 1903. On the south side of the churchyard are the early 14th-century ruins of the frater (refectory) and dorter (dormitory), connected by a gatehouse with the remains of the kitchen and guest house, which was later the palace.

The palace was a favourite residence of many of the kings as the famous lines in the ballad "Sir Patrick Spens" recall,

> The king sits in Dunfermline town
> Drinking the blude-red wine.

It occupied a striking position near the ravine and was of considerable size, judging from the southwest wall, which is all that is left of it. James I, king of Scots, and Charles I were born there and the last royal tenant was Charles II, who occupied it just before the battle of Inverkeithing or Pitreavie (July 20, 1651), which took place 3 mi. to the southwest, and there also he had signed the National League and Covenant.

The staple industry is the manufacture of table linen. The weaving of damask was introduced in 1718 by James Blake, who had learned the secret of the process in the workshops at Drumsheugh near Edinburgh. Other industries include dyeing and bleaching, the manufacture of natural and artificial silk, engineering and the making of soap, rope and fireclay; there are numerous collieries, notably Comrie, in the immediate vicinity.

The high school was founded in 1560. Andrew Carnegie (1835–1919) was a well-known benefactor of Dunfermline. He gave to his birthplace the free library and public baths, and, in 1903, the estate of Pittencrieff park and glen, rich in historical associations as well as natural charm, together with bonds worth £500,000 (increased by £250,000 in 1911), in trust for the maintenance of the park, the support of a theatre for the production of plays of the highest merit, the periodical exhibitions of works of art and science, the promotion of horticulture among the working classes and the encouragement of technical education in the district. A statue of Carnegie was placed in the park, where also stands the music pavilion and where, after 1950, a model traffic area was opened for instruction in road safety. Dunfermline became the headquarters of all the Carnegie trusts. (*See* FOUNDATIONS, PHILANTHROPIC.) The Carnegie memorial hall was built in Tudor style near his birthplace. The town is the seat of the sheriff-substitute for western Fife; it is governed by a provost, bailies and council.

DUNGANNON, a market town and urban district of County Tyrone, N. Ire., 8 mi. W. of the southwest shore of Lough Neagh, and 43 mi. W.S.W. of Belfast by road. Pop. of the urban district (1961) 6,494. Its early history is that of the O'Neills, earls of Tyrone, whose chief residence was there, and a large rath or earthwork north of the town was the scene of the inauguration of their chiefs; but of the family castle and abbey there are no remains. In Dungannon the independence of the Irish parliament (to which the town returned two members) was first proclaimed in 1782. The town was formerly corporate and was a parliamentary borough until 1885. The Royal school, founded in 1614, was moved to new buildings at the end of the 18th century. The main industries produce textiles, glass fabrics and bricks.

DUNGARPUR, a town and district of Rajasthan, India. The town, headquarters of the district, is 90 mi. N.E. of Ahmedabad. Pop. (1951) 9,814. It was founded late in the 14th century and named after Dungaria, chief of an independent Bhil tribe. It has road links with Baroda, Ahmedabad and Indore via Godhra.

DUNGARPUR DISTRICT (area 1,460 sq.mi.; pop. [1961] 407,382) includes a large hilly area inhabited by Bhil (*q.v.*) peoples. In the southwest the country falls away to the valley of the Maki river, which forms the district boundary and flows into the Gulf of Cambay. The majority of the population is engaged in agricul-

ture; wheat and millets are the main crops. The district corresponds with the former princely state of the same name which fell to Moguls and Marathas in turn and was taken under British protection in 1818. Under British rule it was controlled through the Rajputana agency. In 1948 it was merged with Rajasthan.

(S. M. T. R.)

DUNGARVAN (Dun Garbhain), a market town, seaport and urban district of County Waterford, Republic of Ireland, lies 29 mi. W.S.W. of Waterford by road. Pop. (1961) 5,188. The administrative centre of the county, it is situated on the Bay of Dungarvan, at the mouth of the Colligan, which divides the town into two parts. Dungarvan derives its name from St. Gorvan, who founded a monastery there in the 7th century. Under King John walls were built, also a castle, now in ruins. The eastern suburb of Dungarvan is called Abbeyside, where remains of an ancient keep, erected by the M'Graths, still exist, together with portions of an Augustinian friary, founded by the same family in the 13th century. The town has a tannery, a glue works, a factory producing various dairy products and a fruit packing station.

DUNGENESS, a promontory and fishing village on the south coast of Kent, Eng., lies within the borough of Lydd, 11 mi. E. of Rye. This expanse of shingle, triangular in shape and covering about 9 sq.mi., forms the seaward apex of the Romney marsh. Shingle erosion on the southern flank averages about six feet a year, with a corresponding build-up on the eastern flank. For centuries there has been a lighthouse on Dungeness point, and a new structure (50° 55′ N., 0° 59′ E.), entirely automatic in operation, was opened in June 1960. On a site west of the lighthouse work on the fifth nuclear power station in England and Wales started in 1960. On the promontory there is also a lifeboat station, a Lloyd's signaling station, a bird sanctuary and the terminus of the Romney, Hythe and Dymchurch light railway. (Cl. L. W.)

DUNHILL, THOMAS FREDERICK (1877–1946), English composer and author, was born Feb. 1, 1877, in London and was educated at the Royal College of Music, where he studied composition with C. V. Stanford. From 1899 to 1908 he was assistant music master at Eton college. He wrote a good deal of educational music, some chamber and some orchestral music, including a symphony, which he conducted in Belgrade in 1922, but his fame is likely to rest on two songs, "The Cloths of Heaven" and "The Fiddler of Dooney," to poems by W. B. Yeats. In his comic opera, *Tantivy Towers* (1931) to a libretto by A. P. Herbert, the fun turns on a meeting of bohemian artists with the sporting fraternity. His vein of melody affiliated him with Sullivan, of whom he wrote the first serious critical study (*Sullivan's Comic Operas,* 1928). He died at Scunthorpe, Lincolnshire, on March 13, 1946.

(F. S. H.)

DUNKARDS: *see* Brethren, Church of the.

DUNKELD, a civil parish of Perthshire, Scot., is on the left bank of the Tay, 15 mi. N.N.W. of Perth by road; the railway station is at Birnam on the right bank. Pop. (1951) 841. The river is crossed by a bridge (1808–09) of seven arches designed by Thomas Telford.

Dunkeld is one of the most historic places in Scotland. At an early date it emerged as an important centre of the Celtic Church, though whether the first religious community was established there by St. Adamnan about the year 700 or by some earlier missionary is still uncertain. After 800 the story becomes more clear. About the year 815, Constantine, king of the Picts, rebuilt the abbey for the Celtic monks from Iona who had been driven out by the Norsemen. About 850 Kenneth MacAlpine brought relics of St. Columba from Iona to Dunkeld, which was made the head church of his kingdom. Although this dignity passed before long to St. Andrews, Dunkeld continued to be a major religious centre. The church was converted into a cathedral by David I in 1127 and in the 14th and 15th centuries grew into a stately building. The most famous of the bishops was Gavin Douglas (*q.v.*), translator of the *Aeneid.* After the Reformation the cathedral and canonry fell into partial decay, but the cathedral was restored after 1815 and in 1908; there are some traces of the 12th-century building though most of the remaining fabric dates from the 14th and 15th centuries. In 1587 a presbytery of the Reformed Church was established with Dunkeld at its centre. The Royal school was founded in 1567.

Shortly after the battle of Killiecrankie (1689) Dunkeld was held by the Cameronian regiment under the poet Col. William Cleland. An attacking force of 5,000 Highlanders was repelled but Cleland was killed.

To promote its growth the town was made a royal burgh in 1704, but with little effect, and it was not until the building of Telford's bridge that it began to prosper. The coming of the railway to Birnam in 1856, however, again lessened the importance of Dunkeld and by the 20th century the old heart of the town had begun to fall into a half-derelict state. The National Trust for Scotland undertook the renovation of the houses around the old market place and cathedral. The oak and sycamore in front of the demolished Birnam house, 1 mi. S., are believed to be a remnant of Birnam wood which Shakespeare immortalized in *Macbeth.*

DUNKERQUE (Dunkirk), a seaport of northern France in the Nord *département*, lies on the Straits of Dover between Calais and the Belgian frontier and is 78 km. (48.5 mi.) N.W. of Lille by road. Dunkerque was almost completely destroyed by bombs in World War II (1940) but was rebuilt on a spacious plan. Pop. (1954) 20,735. The chief thoroughfares converge on the Place Jean Bart, in the centre of which is a statue by David d'Angers of Adm. Jean Bart (*q.v.*), who was born in Dunkerque in 1650. Close by is the 213-ft. belfry built by the Spaniards in the 16th century and once the western tower of the Gothic church of St. Eloi, from which it is now separated by a street. St. Eloi, partly destroyed in World War I and severely damaged by fire in World War II, was largely rebuilt. In 1960 the town hall (built 1897–1901 and burned down in 1940) was being reconstructed for the ninth time since 1233. The museum, although partly destroyed in 1940, preserved most of its collection of paintings and other works of art. There are a school for navigation, a school of fine arts and a stadium. The statue of victory commemorates the raising of the siege in 1793 and there are monuments to those killed in World War I and to the British dead of World War II.

The harbour of Dunkerque is approached by a fine natural roadstead entered on the east and west and protected on the north by sandbanks. The roadstead is indicated by lightships, and the entrance channel to the port by a lighthouse 193 ft. high and visible for 19 mi. There are 7.5 mi. of quays, berths for 50 vessels of all sizes, three locks, three dry docks, one floating dock, a large basin for oil tankers, sheds and warehouses and 120 electric cranes. There are also 155 mi. of railway lines and a silo for storing grain. There is a daily ferry service between Dunkerque and Dover. Canals connect the docks with Belgium, the coal basins and industrial towns of Nord and Pas-de-Calais and the rich agricultural regions of Flanders and Artois. There is an oil refinery to the west of the docks and a vast shipbuilding yard for naval vessels. Dunkerque is the industrial centre of the region, and its chief industries, which are situated in the suburbs, are oil refining and the production of oil, chicory, chocolate, beer, jam, biscuits, flour, rice, soap, fertilizers, cotton, flax, hemp, jute and fishing tackle. The large chamber of commerce was founded in 1700. The main imports are fuel oil, coal, phosphate, minerals, pyrites, textiles, wine and early fruit and vegetables. Exports include metal products, sugar, cement, cereals, flour, chemical products, fruits and vegetables, cloth and thread, glass, earthenware and china.

Dunkerque derives from the Flemish Dunkerk, "the church of the dunes." The first mention of a town situated there in 1067 is found in a gift of the tithe by Baldwin V, count of Flanders, to the abbey of St. Winoc at Bergues. At the end of the 12th century Philip of Alsace armed a fleet at Dunkerque against the Norman pirates. In 1558, after the French had taken Calais, Dunkerque was besieged and burned to the ground. It was seized by the duke of Anjou in 1582 and retaken in 1583 by the duke of Parma in the name of the king of Spain. The Spanish fleet of Dunkerque was beaten in 1639 by the Dutch admiral Martin Tromp and the following year the Spaniards built new ramparts round the town. It fell, however, to the French in 1646 but was retaken by the Spaniards in 1652. After the battle of the Dunes (*q.v.*) in 1658 the town was given to the English, but four years later it was re-

deemed by Louis XIV. The port and the fortifications were rebuilt and the town prospered until 1713 when by the terms of the treaty of Utrecht the port was demolished and an English garrison installed because of the damage done by Jean Bart and other corsairs of the port. The Mardyck canal was built to compensate for the obstruction of the channel. It was not until the treaty of Paris was signed in 1783, after the American Revolution, that the port was allowed to be rebuilt. The whole region was liberated in 1793 during the French Revolutionary Wars (*q.v.*) after the French victory of Hondschoote.

The 19th century saw the building of the railway in 1838 and the enlargement of the port in 1880. In World War I Dunkerque, close to the Flanders front, was very badly damaged. In World War II (*q.v.*) it was the place from which the British expeditionary force and some other Allied troops were evacuated in 1940 (May 26 to June 3) just before it was occupied by the Germans. The town, almost destroyed, was liberated on May 10, 1945, the last French town to be freed.

See also references under "Dunkerque" in the Index volume.
(JA. P.)

DUNKIRK: *see* DUNKERQUE.

DUN LAOGHAIRE (KINGSTOWN), a seaport of County Dublin, Republic of Ireland, lies at the southeastern extremity of Dublin bay, 8 mi. S.E. of Dublin by road. Pop. of coastal borough (1961) 47,803. Originally called Dunleary (Leary's fort), after the fortress built there by Laoghaire, a 5th-century Irish king, its name was changed to Kingstown after the embarkation of George IV at the port in 1821, and again changed in 1921. The town was a fishing village, but after the construction of an extensive harbour, designed by Sir John Rennie and begun in 1817, enclosing about 250 ac. with a varying depth of from 10 to 28 ft., it grew into a large ribbonlike residential town, with some attractive early- to mid-19th century terraces, but generally lacking in character except for the waterfront. In 1852 the present Carlisle pier, a short pier near the east of the harbour, was begun, but controversies delayed its completion until 1859 when it was opened; it has been used ever since both by the boat trains from Dublin and the mail packets from Holyhead, Wales. This service, begun by the London and North-Western railway and the City of Dublin Steam Packet company, is now operated by British railways in conjunction with Córas Iompair Eireann (Irish transport board).

Dun Laoghaire is the headquarters of the Irish Lights service which operates the lighthouses and lightships round the Irish coasts, and the harbour is also much used by yachtsmen. There are three principal yacht clubs and many hotels and boarding houses. (M. J. CG.)

DUNLIN, *Erolia* (*Calidris*) *alpina,* one of the commonest of the sandpipers (*q.v.*), often called oxbird. It breeds on elevated moors in Europe, northern Asia and North America and in winter, haunts the mud flats and sandbanks in large flocks. A smaller race, *E. a. schinzii* occurs in Great Britain and Baltic Europe. In the breeding season, the male utters a peculiar whistle.

A subspecies of the dunlin, the red-backed sandpiper (*E. a. pacifica*) breeds chiefly in the arctic and is migrant throughout the U.S., usually being seen near the Great Lakes and along the coasts.

DUNLOE, GAP OF (DÚN LOIE) in County Kerry, Republic of Ireland, is a deep ravine between Purple mountain (2,739 ft.) on the east and the fine ridge of the Macgillycuddy's Reeks (highest point, Carrauntuohill, 3,414 ft.) on the west. The gap is said to have been cut by a single stroke of Finn MacCoul, an ancient giant, and many other legends are provided for visitors: in fact it was cut by ice which deepened by several hundred feet the gap that existed before the glacial period. The summit point is 795 ft. above sea level and the grandeur of the scene is due to the towering cliffs with large areas of bare rock. The Gap of Dunloe is entered 6 mi. W. of Killarney (*q.v.*) and the journey is made in jaunting cars in which passengers sit facing the roadside, over the wheels. Mr. and Mrs. Samuel Carter Hall, who traveled through Ireland in the 1830s and 1840s, spoke of the gap as "a scene rarely paralleled for wild grandeur and stern magnificence," with "bleak and barren rocks, of forms as varied and fantastic as they are numerous" and a "brawling and angry stream rushing onwards . . . here a creeping rivulet—here a broad lake, and there a fierce cataract." From the summit of the pass, after three slow miles of ascent, the road bends round the hillside into the upper valley of Killarney and the return journey is made by boat through the small Upper lake which merges into a channel several miles long through a steep-sided, wooded valley of great beauty, with famous echoes, and finally through the larger Muckross lake and Lough Leane. For more than 200 years tourists have visited this remarkable area which during the summer can now be covered in a single day from Dublin. (T. W. FR.)

DUNLOP, JOHN BOYD (1840–1921), Scottish inventor who developed the pneumatic rubber tire, was born on Feb. 5, 1840 at Dreghorn, Ayrshire. In 1867 he settled in Belfast as a veterinary surgeon. There in 1887 he constructed a pneumatic tire for his son's tricycle. The invention was patented in 1888 and production on a commercial scale began in 1890 with Dunlop holding 1,500 shares in the Belfast company. It was discovered that the principle of the pneumatic tire had been patented in 1846, but the company held various accessory patents which enabled them to establish their position. Dunlop himself did not make a great fortune by the invention. He died in Dublin, Oct. 23, 1921.

See Jean McClintock (his daughter), *History of the Pneumatic Tyre* (1923). (W. H. D.)

DUNMORE, JOHN MURRAY, 4TH EARL OF (1732–1809), royal governor of Virginia on the eve of the American Revolution, was born in 1732. A Scottish noble descended from the house of Stuart, he sat in the house of lords from 1761 to 1770. He was appointed governor of New York in 1770, then of Virginia in 1771. Personally interested in western lands as well as officially concerned with protection of the Virginia (western) frontier, he raised 3,000 militiamen to subdue the Shawnee Indians in the upper Ohio valley in 1774, an action known as Lord Dunmore's War.

As the revolution approached, Dunmore's power declined rapidly, especially through his own rashness. He dissolved the Virginia assembly for revolutionary sentiments in 1772, 1773 and 1774. In April 1775 he seized the colony's store of powder, thereby bringing about an armed uprising. Taking refuge aboard an English warship, he shortly declared martial law, proclaimed freedom to slaves who would join the British and proposed to Lord Dartmouth use of Indians against the rebels. Defeated at Great Bridge near Norfolk on Jan. 1, 1776, he ordered his ships to bombard Norfolk, thereby setting it afire. Effective royal government in Virginia having ended, he returned to England in July 1776. After serving again in the house of lords, he was royal governor of the Bahamas from 1787 to 1796. He died at Ramsgate, Eng., early in 1809.

See T. J. Wertenbaker, *Give Me Liberty; the Struggle for Self-Government in Virginia* (1958). (W. R. SL.)

DUNMORE, a borough of Lackawanna county, in northeastern Pennsylvania, U.S., adjoining Scranton on the northeast and a part of the Scranton standard metropolitan statistical area. Anthracite mining and railroading were once the principal occupations. Industries include the manufacture of silk, shoes and fabric gloves. The Pennsylvania State Oral School for the Deaf is located between Dunmore and Scranton. The city was settled in 1787 as Buckstown and renamed (1840) for a son of the earl of Dunmore in a fruitless effort to interest him in a railroad project. It was incorporated as a borough in 1862. The population reached 23,086 in 1940, after which it declined. For comparative population figures *see* table in PENNSYLVANIA: *Population.*
(R. D. WI.)

DUNMOW (GREAT DUNMOW), a market town in Essex, Eng., lies on the river Chelmer, 38 mi. N.E. of London and 24 mi. W. of Colchester by road. Pop. (1961) 3,904. The town was incorporated in the 16th century but the charter, confirmed by Queen Elizabeth I, was withdrawn in 1886. Both charters are preserved in the church of St. Mary the Virgin (14th century) where the register of baptisms dates from 1538 and of marriages and burials from 1558. The town hall, in the centre of the town, was built in 1578. In 1570 Flemish refugees introduced the manufacture of "bays" and "says," the former being

a coarse woolen cloth and the latter a fine thin cloth. The industry became extinct about 1800. Lionel Lukin (1742–1834), inventor of the lifeboat, born in the adjoining parish of Little Dunmow, carried out his experiments on Doctor's pond, Dunmow.

At LITTLE DUNMOW, 2 mi. E. (pop. [1961] 376), an Augustinian priory was established in 1104. The existing remains form part of the parish church of St. Mary's Priory founded by Robert Fitzwalter, leader of the barons who negotiated Magna Carta at Runnimede on June 15, 1215, who lies there in an unknown grave.

The ceremony of the "Dunmow flitch" originated there when Robert Fitzwalter, lord of the manor, offered a flitch of bacon to the man who had not repented of his marriage for a year and a day, the man having to take an oath to that effect before the prior, the monks and the townsmen. The custom survived the dissolution of the monastery and records of the court awarding the flitch in the 18th century hang on the walls of the church, which also contains the original 13th-century oak chair used in the ceremony. A document in the British museum, London, has the names of three men to whom the flitch was awarded in 1445, 1467 and 1510. The first date is the earliest known award, although there are earlier references in *Piers Plowman* and Chaucer. The original manorial court records are in the Essex record office. The ceremony of the Dunmow flitch is now carried out in Great Dunmow.

DUNNE, FINLEY PETER (1867–1936), U.S. humorist and creator of Martin Dooley, homely philosopher, was born in Chicago, Ill., July 10, 1867, of Irish immigrant parents. He was educated in the public schools and in 1884 began working for various Chicago newspapers, specializing eventually in political reporting and editorial writing.

In 1892 he began contributing Irish dialect sketches to the *Chicago Evening Post* and five years later moved them to the *Chicago Journal*. In these Dunne introduced Martin Dooley, an engaging character in the tradition of Benjamin Franklin's "Poor Richard" and James Russell Lowell's "Hosea Biglow." They did not attract a national following until Mr. Dooley's observations on Dewey's victory at Manila in 1898 became a sensation. National syndication followed and soon Dunne's witty penetration of shams and hypocrisies made Mr. Dooley a force for clear thinking and tolerance in public affairs.

No other American humorist, perhaps, exercised as great an influence upon public life as did Dunne between 1898 and 1910. Many remarks such as "the supreme court follows the election returns" became part of American lore. While the dialect in which they are written became dated, a substantial influence continued. Dunne continued to write irregularly until his death in 1936. He republished about a third of the essays in eight volumes, beginning with *Mr. Dooley in Peace and War* (1898) and ending with *Mr. Dooley on Making a Will and Other Necessary Evils* (1919).

See Elmer Ellis, *Mr. Dooley's America* (1941). (E. Es.)

DUNNET HEAD, a round, cliffed headland of Old Red Sandstone, some 3 mi. across, is in northeastern Caithness, Scot. It is 12 mi. E.N.E. from Thurso to the northern tip, as the crow flies. Dunnet Head forms a plateau at about 100 ft., with hills rising to 422 ft. and 10 small lochs, and is the northernmost part of the mainland of Britain. A road from Brough (6 mi. S.E.) reaches the lighthouse (built 1831) on the northern tip. Dunnet village is 2 mi. S. of Brough by road. *See* also JOHN O'GROATS.

(A. T. A. L.)

DUNNOCK, a name for the European hedge sparrow (*Prunella modularis*). *See* HEDGE SPARROW.

DUNOIS, JEAN, COMTE DE (*c.* 1403–1468), French military commander and diplomat, the famous BASTARD OF ORLÉANS, who played so great a part in his country's final victory over the English in the Hundred Years' War, was born in Paris, the natural son of Louis, duc d'Orléans, and Mariette d'Enghien. Brought up by his father's widow Valentina Visconti, he entered the service of his cousin the dauphin, the future Charles VII, in 1420, became his trusted adviser and was appointed grand chamberlain of France. His first notable success was the defeat of the English at Montargis (1427). During 1428–29 he defended Orléans until Joan of Arc arrived to raise the siege. He then took part in the battle of Patay (*q.v.*) and accompanied Charles VII to Reims for his coronation. He captured Chartres and Lagny in 1432 and engaged in a series of campaigns culminating in a triumphal entry into Paris in 1436. He shared in the negotiations with the English at Gravelines (1439) and helped to obtain the release of his half brother, Charles, duc d'Orléans, who gave him the countship of Dunois. Momentarily involved in the Praguerie (*q.v.*) in 1440, he soon returned to the king's service and was given the countship of Longueville (1443). He negotiated the truce of 1444 with the English and was a member of the embassy (1447–49) sent to persuade the antipope Felix V to abdicate. At the end of the truce, he served in the reconquest of Normandy (1449–50) and of Guienne (1451). Charles VII later entrusted him with the arrest of the duc d'Alençon (Jean II) in 1456 and with measures against intrigues of the dauphin. After the dauphin had become king as Louis XI, Dunois joined the rebellious League of the Public Weal, but made his peace, negotiated the treaty of St. Maur (1465) and recovered his confiscated titles and possessions. He died on Nov. 24, 1468, and was buried in Notre-Dame de Cléry, near Orléans. He had been married twice: in 1422 to Marie Louvet; in 1439 to Marie d'Harcourt, from whom the future ducs de Longueville descended. (Y. M. L.)

DUNOON, a small burgh of Argyll, Scot., lies on the west shore of the Firth of Clyde, on the Cowal peninsula, opposite Gourock, with which there is frequent steamer communication. Pop. (1961) 9,211. Including Kirn and Hunter's quay, at the entrance to Holy Loch to the north, Dunoon presents a continuous front of seaside villas with a two-mile esplanade. Picturesquely situated between the Cowal hills and the firth, it is one of the chief holiday resorts on the Scottish west coast and a centre for excursions into the west Highlands. On a bluff above the pier stand the remains of Dunoon castle, of which Sir Colin Campbell of Lochow, an ancestor of the duke of Argyll, was made hereditary keeper by Robert I the Bruce. At Kilmun, on the northern shore of Holy Loch, are the ruins of a collegiate chapel founded in 1442 by Sir Duncan Campbell and used as the burial ground of the Argyll family. The Lamont memorial near Dunoon pier marks the site of a massacre of the local clan by the Campbells in 1646. Hunter's quay is the headquarters of the Royal Clyde Yacht club. The Cowal Highland Gathering takes place at Dunoon at the end of August. In Nov. 1960 a United Kingdom-United States agreement permitted U.S. Polaris (missile) submarines to be based in Holy Loch, an event of considerable economic importance to Dunoon.

DUNS, a small burgh and the county town of Berwickshire, Scot., lies 15 mi. W. of Berwick-upon-Tweed by road. Pop. (1961) 1,838. Trade is agricultural and there is excellent fishing. On Duns Law (713 ft.) the Covenanters, under Alexander Leslie (afterward earl of Leven), were encamped in 1639, an event commemorated there by the Covenanters' stone. Duns castle, adjoining the town on the northwest, includes the tower said to have been erected by Thomas Randolph, earl of Moray, in 1314. The town, originally on Duns Law, was destroyed by the English in 1545 and 1558; the present town dates from 1588. Each July the town's history is re-enacted during festival week. It was the birthplace of John Duns Scotus (*q.v.*), the medieval philosopher.

DUNSANY, EDWARD JOHN MORETON DRAX PLUNKETT, 18TH BARON (1878–1957), Irish dramatist and storyteller, who combined imaginative power with intellectual ingenuity to create a convincing world of fantasy, was born in London, July 24, 1878. Educated at Eton and Sandhurst, he succeeded his father in 1899. He served in the Coldstream guards in the South African War and in the Royal Inniskilling Fusiliers in World War I, and spent most of his life in soldiering and sport. His first book of short stories, *The Gods of Pegana*, appeared in 1905; his first play, *The Glittering Gate*, was produced by the Abbey theatre, Dublin, in 1909; and his first London production, *The Gods of the Mountain*, at the Haymarket theatre in 1911. Like his many later stories and plays they explored in a richly coloured poetic prose what he himself called "the mysterious kingdoms where geography ends and fairyland begins," introducing also a characteristic element of the macabre. Among his most im-

portant works were the plays *The Tents of the Arabs, The Laughter of the Gods* (1910) and *A Night at an Inn* (1911); *A Dreamer's Tales* (1910); *Travel Tales of Mr. Joseph Jorkens* (1931); a novel, *The Curse of the Wise Woman* (1933); collections of verse (1929 and 1938); and three autobiographical volumes, *Patches of Sunlight* (1938), *While Sirens Slept* (1944) and *The Sirens Wake* (1945), the last of which gave some account of his early wartime experiences, when he was Byron professor of English literature at Athens. He died in Dublin, Oct. 25, 1957.

DUNSINANE, a peak of the Sidlaw hills, in the parish of Collace, Perthshire, Scot., 8 mi. N.E. of Perth. It is 1,012 ft. high and commands a fine view of the Carse (alluvial land) of Gowrie and the Tay valley. Its chief claim to interest, however, lies in its association with Birnam wood, about 12 mi. northwest, near Dunkeld (*q.v.*), mentioned in two well-known passages in Shakespeare's *Macbeth*. An old fort on the summit, of which faint traces are still discernible, is traditionally called Macbeth's castle.

DUNS SCOTUS, JOHN (*c.* 1265–1308), called *Doctor Subtilis,* was the greatest medieval British philosopher and theologian.

Born in the village of Duns, Berwickshire, Scotus entered the Franciscan Order about 1280; he studied for the priesthood in Scotland (Haddington, Dumfries), Oxford and Paris and was ordained on April 17, 1291, in the church of St. Andrew, Northampton, by Oliver Sutton, bishop of Lincoln. Scotus studied at Paris probably between 1291 and 1296 under the master Gonsalvus of Spain, and subsequently lived at Cambridge, Oxford and Paris, teaching several times in the latter two cities. On June 25, 1303, because he refused to sign the petition of Philip IV of France against Pope Boniface VIII, he had to interrupt his teaching at Paris, apparently continuing it at Oxford. In 1305 he obtained the doctorate at Paris and became *magister regens* there (1305–07), holding a solemn disputation called "de Quodlibet." Toward the end of 1307 he became professor at Cologne, where he died prematurely on Nov. 8, 1308. He lies buried in the church of the Franciscans at Cologne. His name is included in the Franciscan martyrology and he is venerated in many places.

Works.—The Vatican's complete critical edition, *Ioannis Duns Scoti Opera Omnia,* began to appear in 1950. The only authentic works of Scotus are: (1) commentaries on Peter Lombard's four books of *Sentences,* namely the *Ordinatio* (commonly called *Opus Oxoniense*), the *Lectura Oxoniensis* and several "Reportationes" preserved in various versions (book i has six, book ii three, book iii five, book iv two), of which the chief are *Rep. Parisiensis* (*i.e., Examinata*) and *Rep. Cantabrigensis;* (2) *Quodlibet* and *Collationes* (*Oxonienses* and *Parisienses*); (3) the *Tractatus de Primo Principio* and *Theoremata;* (4) commentaries on Aristotle's *Metaphysica, De Anima, De Praedicamentis, I–II Perihermeneias* and *Liber Elenchorum;* and (5) a commentary *Super Porphyrium.*

The principal work, the *Ordinatio,* preserved in hundreds of codices and published in more than 30 different editions from 1472 onward, is a summary by Scotus from different expositions of his on the *Sentences* of Peter Lombard. As the work was still incomplete when he died, the edition completed by his pupils immediately set off the discussion as to what was the original text. A version close to the original edition, however, was checked with the autograph or "Liber Duns," and this medieval critical edition survives in the codex 136 of the Communal library at Assisi. The *Ordinatio,* dictated or written and carefully revised by Scotus, enjoys the highest authority, while certain of the "Reportationes" and, above all, the *Theoremata* and *De Anima,* are very unreliable.

Character.—Duns was sharp and subtle of intellect, sharing the Oxford school's taste for mathematical argumentation and the study of the positive sciences; deeply religious, he followed the Franciscan school which gave the primacy to love and to Christ as "centrum omnium scientiarum." Faced with the ecclesiastical condemnations of Averroistic and Thomistic theses at Paris (1277) and at Canterbury and struck by the energies consumed in the dual task of assimilating Aristotle while preserving traditional doctrine, he felt the need for an impartial weighing-up of results to date. He did not initiate opposition to St. Thomas Aquinas, who was neither his contemporary nor his rival and whom he rarely cites. Scotus rather aims at Godfrey of Fontaines, Giles of Rome and, especially, St. Thomas' great adversary Henry of Ghent, whose Platonic-Augustinian theories he combats strenuously, while attempting a synthesis with Aristotle. Scotus therefore criticizes constructively, holding that his researches should agree, not with the doctrine of St. Thomas or any other doctor, but with right reason and the *magisterium* of the Church.

Critical study beginning in the late 19th century has dissolved earlier attributions to Scotus of all sorts of theological and philosophical leanings. Eminent medievalists now hail him as the last great scholastic in the orthodox tradition. He did not use dogma for his philosophy, but in his efforts to penetrate the mysteries of faith he sought, like all the scholastics, to form for himself an *intellectus fidei.* Since Scotus states many of the fundamental tenets found throughout scholasticism (*q.v.*), it will suffice to note some of the more characteristic theses in the *Ordinatio.*

Philosophy.—Univocity of being, formalism, hylomorphism, the principle of individuation, the form of corporeity, the primacy of the will—these are the themes of Scotist philosophy. The primary object of the intellect is neither the divine essence (as the Augustinians taught) nor the essence of material things (as the Aristotelian-Thomist current affirmed), but *esse,* being as such, coming before any determination implicit in every reality. This being can be predicated univocally of all things, and without it nothing is comprehensible. Pantheism is thus avoided because being does not mean to have being, as it does for St. Thomas. Being is posited as such in reality always and everywhere. Infinite being and finite being are not specific determinations but intrinsic modes of being.

Yet this unity of being does not imply absolute simplicity. In every concrete, individual being there exist metaphysical elements which, while in reality identical, remain "formally distinct." This formal distinction, which pervades the whole of Scotism, is intermediate between a real distinction, (*i.e.,* between things) and a purely logical distinction (*i.e.,* one made by the intellect alone between aspects of the same thing).

Though Scotus rejects universal hylomorphism, for him too material things arise from the union of matter and form, two really distinct principles. Matter, however, though undetermined, is a positive existing unity, distinct from nothing: it is not pure potency, but has its own act. The unity of the compound is saved because matter and form are ordained to one another not accidentally but essentially.

Furthermore, in every concrete being we must distinguish a common nature, indifferent as to being universal or singular and therefore demanding a principle which determines it to become this or that reality. This is the principle of individuation, a particular positive reality making inherently undetermined natural compounds into this or that individual, this or that essence.

The form of corporeity is the disposition that enables matter to receive the soul; it constitutes the individual in his corporal being as the soul constitutes him in his living being. After death it stays in the corpse a while, causing the body to remain substantially identical with what it was in the living being.

The metaphysical character of transcendent being is the key to Scotus' philosophy, and especially to his proofs for the existence of God, who is known not in himself, but only through the metaphysical properties revealed in creatures—through efficient, final and exemplary causes.

Finally, as the primacy of being characterizes his metaphysics, so the primacy of the will characterizes Scotus' ethics. The will is essentially free and represents the summit of man's perfection and essence. Between intellect and will there is a formal distinction: intellect and will are the sole causes of their respective operations, but this does not exclude their necessary, real and continuous interdependence. While God has absolute liberty as the fundamental attribute of his nature, the divine will, in its essentially rational and infinite nature, finds love as its essential norm of action. While it is the source and origin of created things, including moral values, it is this in sign of the divine wisdom and of the essential order of things established by absolute goodness.

Theology.—The primary object of theology is God or the

divine essence as such. Our theology, as distinct from God's, which embraces all things knowable, treats only of those things "which are contained in Scripture or of what can be derived from these." It is the highest science, but not in the Aristotelian sense "through discourse from the cause to the known"; and since it tends to a right loving of God and the reaching of our ultimate end, it is practical rather than speculative, and more rightly called "wisdom."

That God is one in essence and three in persons can neither be demonstrated by natural reason nor clearly known once revealed, although this mystery is not contrary to natural reason or even altogether impenetrable to it. Between the essence, the personal properties and the attributes of God, there is a formal distinction *a parte rei* quite compatible with divine simplicity.

Because God is formally love he liberally communicates his goodness and love. Because God's will operates in an infinitely rational and ordered way, he wills first the end and then those things immediately ordered to it; thus he first predestines the elect, then wills whatever they need to reach their end, namely the goods of grace, and finally whatever serves them toward it, namely the sensible world. In this plan, in which Scotus differs from St. Thomas and many other doctors, Christ and his mother Mary, love on earth and beatific vision in heaven, are prominent.

Scotus praises the Incarnate Word as the first and absolute term *ad extra* of the infinite love which is God himself. Since therefore Christ is predestined as the exemplary and final cause of all creation and enjoys primacy over all things, Scotus rejects the teaching that the greatest of all works, namely the Incarnation, should have been occasioned by a good of a lower order, namely the redemption of mankind. Only as a consequence of the Fall is Christ, the glorifier of the blessed Trinity, destined to redeem us by his death, in virtue of which he became our one and only mediator, so that remission of sin, grace and salvation are obtained only in and through him.

The excellence and perfection of Christ's mediation demand that in at least one case redemption should take the form of preserving rather than subsequently freeing from the stain of original sin, and this case could be none other than that of his mother. Following the principle that to Mary must be attributed "whatever is more excellent," thereby giving greater honour to the Son from whom the mother has received everything, Scotus attributed to her among other privileges that of the Immaculate Conception.

Because God, who is formally love and infinite perfect in the love which he is, has made all things for himself, wanting others who can to share in that love, it is necessary for man by love to tend toward God, his happiness. Nor is this difficult, for the roots of this love are profoundly embedded in man's soul, and this natural inclination finds its crowning perfection in charity, which is not really distinct from grace or from "wisdom," the gift of the Holy Ghost, so that contemplation consists before all else in love or charity.

But it is Christ who, having perfected the understanding by faith as he perfected the will by charity, is the way to the finding, knowing and loving of God. Of the sacraments instituted by Christ, the Eucharist is the centre of all spiritual life and worship. In it is manifested in the highest possible degree the love that Christ bears for men, whose eternal happiness will consist in an act of the will, an act of the love of benevolence or friendship, toward the supreme good for himself.

Influence.—Many admirers of Scotus' doctrine began to teach it even during his lifetime and so he became and has remained the leader of the Franciscan school, called after him "Scotist." In the 16th–18th centuries, Scotism rivaled Thomism and was expounded side by side with it in nearly all the universities of Europe. Many Thomist thinkers, at times forgetting their own positions, came to Scotist conclusions. On the problem of the immortality of the soul, the Thomist Cajetan before his death "followed the way of Scotus." The Immaculate Conception once called "a Scotist opinion," today is a dogma of the Roman Catholic Church. Scotus' highly developed critical method and his rigorous rational argumentation have created a doctrinal system that continues to exercise great influence.

See also references under "Duns Scotus, John" in the Index volume.

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DUNSTABLE, JOHN (*c.* 1385–1453), is one of the very few English composers who can fairly be said to have had any influence on the development of European music. This was recognized by his contemporaries, including the French poet Martin le Franc, who wrote in his *Champion des Dames* (*c.* 1440) that the two leading composers of the day, Guillaume Dufay and Gilles Binchois, owed their superiority to what they had learned from Dunstable's "English manner."

Information about Dunstable's life is extremely scanty. In 1419 he was presented to a secular canonry of Hereford cathedral, but this carried no obligation of residence, being in the nature of a financial gift by some royal patron—probably the duke of Bedford, in whose service he was at some time. The Mass sections on the plainsong *Da gaudiorum premia* and the famous motet *Veni sancte Spiritus—Veni creator Spiritus* were almost certainly written in 1431 for Henry VI's French coronation; in fact, Dunstable may well have spent the years 1423–35 in France, where the duke of Bedford held his court as regent, although there is no documentary evidence for this. About his later life nothing is known beyond the fact that he died in London on Christmas eve, 1453, and was buried at St. Stephen's, Walbrook. His epitaph, recorded before its destruction in the Great Fire, referred to him as skilled in mathematics and astronomy as well as in music, and this is confirmed by the existence of manuscript treatises on astronomy which belonged to him and are now preserved at libraries in Oxford and Cambridge.

Although the fact of Dunstable's influence on French music was widely admitted by musical historians, its nature remained obscure and misunderstood until it was elucidated by Manfred Bukofzer, the editor of his complete works (*Musica Britannica*, vol. viii, 1953). It is to be seen above all in the relaxation of harmony (by a new regulation of dissonance) and of rhythm (by the cultivation of a flowing, gently asymmetrical triple metre). These characteristics of the English school Dunstable combined with a thorough understanding of the French structural principles of isorhythm, displayed in many of his larger motets and Mass sections. His surviving compositions are almost entirely ecclesiastical, but both this and the fact that scarcely any of them are preserved in English manuscripts are probably mere accidents. It is unfortunate that his only recorded five-part composition has been torn out of the Eton college choirbook, written in the last decade of the 15th century. Three of his compositions are to be found in elaborated keyboard settings in a 15th-century German manuscript, the Buxheim organ book.

See M. F. Bukofzer, "John Dunstable: a Quincentenary Report," *Musical Quarterly* (Jan. 1954); F. L. Harrison, *Music in Medieval Britain* (1958). (J. J. N.)

DUNSTABLE, a municipal borough (1864) and market town of Bedfordshire, Eng., lies 20 mi. S.S.W. of Bedford by road. Pop. (1961) 25,618. It lies at an elevation of about 500 ft. on the north slope of the Chiltern hills known as the Dunstable downs. The

main part of the town extends for a mile along the wide Roman Watling Street, while the highroad from Luton to Tring, which crosses it in the centre of the town, represents the ancient Icknield Way. Dunstable contains several old coaching inns. Many prehistoric remains are in the area and it seems probable that there was a Romano-British village on the site corresponding to the Forum Dianae of the Romans. About 2 mi. W. is the camp called Maiden Bower, consisting of a circular earthen wall enclosing about ten acres. Dunstable (Dunestaple, Donestaple) appears as a royal borough in the reign of Henry I, who granted a charter to the Augustinian priory he had built. The priory church of St. Peter and St. Paul embodies a fine fragment of the original church. Priory house, once part of the priory, and five acres of land belong to the corporation. Foundations of a palace of Henry I are traceable near the church.

About 1100 a miracle play of the life of St. Catherine was produced at Dunstable. The Dunstable Annals deal exhaustively with the history of the monastery and town in the 13th century. The Eleanor cross that once stood in the market place was probably destroyed in the 17th century. At Dunstable Archbishop Thomas Cranmer in 1533 declared Catherine of Aragon's marriage to Henry VIII invalid.

The former straw-hat industry moved to Luton, which is contiguous, but there are printing works and factories making chains, plastics, motor vehicles and accessories. In Houghton Regis, adjacent to the north, is an extensive cement and lime plant. Dunstable has always been an agricultural town and its annals abound with references to the two staple products, wool and grain. The municipal boundaries were extended in 1933 and 1954.

Whipsnade, the country branch of the London zoological gardens, was opened in 1931, occupying 500 ac. It lies 3½ mi. S.S.W. of Dunstable by road. At the foot of the downs to the west is the headquarters of the London Gliding club.

DUNSTAN, SAINT (*c.* 909–988), archbishop of Canterbury and reformer of monastic life, the son of a West Saxon noble, was born near Glastonbury, where he was educated by the Irish monks of that abbey. He entered the household of King Aethelstan, but his love of books and of song and his mechanical skill soon excited the dislike of his kinsfolk at the court. Accused of practising the black arts, he took refuge with his kinsman Alphege, bishop of Winchester, whose persuasion, seconded by a serious illness, induced him to become a monk. Dunstan then lived as a hermit until Aethelstan's successor, Edmund, recalled him as one of his counselors. His enemies again procured his expulsion, but Edmund soon revoked the sentence and about 943 made Dunstan abbot of Glastonbury. Under him the abbey became a famous school, monastic life was revived and St. Peter's was re-erected. Edred, the successor of Edmund, left the administration of the realm largely in the control of Dunstan, who sought to establish royal authority, to conciliate the Danish section, to uproot heathenism and to reform clergy and laity. On the accession of Edwy, however, in 955, Dunstan's fortunes underwent a temporary eclipse. Having given offense to the influential and unprincipled Aelfgifu, the king's wife, he was outlawed and driven to Flanders. But in 957 the Mercians and Northumbrians revolted and chose as their king Edgar, who at once recalled Dunstan and made him bishop of Worcester and London. In 959 Edwy died and Edgar became sole king. Dunstan was appointed archbishop of Canterbury. On Edgar's death in 975 the archbishop secured the crown for Edgar's elder son, Edward, who was murdered three years later. On the accession of Aethelred Dunstan's public career came to an end; he retired to Canterbury, where he died on May 19, 988. His feast day is May 19.

Dunstan reformed monasticism according to the strict observance of the Benedictine rule, which he had seen at the abbey of Blandinium, near Ghent, during his exile under Edwy. Among his foundations were Peterborough, Ely and Thorney. By the rebuilding of churches and the promotion of education he endeavoured to uplift the people. In political matters his policy was one of unification and of respect for law.

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DUNSTER, HENRY (1609–1659), American clergyman, first president of Harvard college, was born in Bury, Lancashire, Eng., where he was baptized on Nov. 26, 1609. He was educated at Cambridge university (B.A., 1631; M.A., 1634) and then taught school and served as curate of Bury. He had a reputation for learning, and three weeks after his arrival in Massachusetts he was installed as president of Harvard (Aug. 27, 1640). The college was all but extinct, instruction having been given for one disastrous year and then suspended, so Dunster had to make a fresh beginning without students, faculty, buildings, income, curriculum, statutes or charter. He proved to be an able teacher, administrator and money raiser, and gave to the college a form and character which persisted in all essential features until the 19th century. In 1653 he scandalized the colony by adopting Baptist views and refusing to have his child baptized. His resignation was demanded by the general court, but the overseers refused to accept it in the hope that he might be persuaded to change his views or at least to keep silent. This he refused to do, and in 1654 he was ejected from the presidency, brought to trial, sentenced to be publicly admonished and put under bond to keep the peace. Although he had contributed generously out of his own limited means to the support of the college, there was delay in paying his back salary, and in the end he received only partial recompense. Removing to the more liberal atmosphere of Scituate, Mass., he continued to preach until his death on Feb. 27, 1659.

See S. E. Morison, *The Founding of Harvard College* (1935), *Harvard College in the Seventeenth Century* (1936). (W. S. H.)

DUNSTER, an old market town in Somerset, Eng., lies 1.5 mi. from Dunster Beach on the Bristol channel and 22 mi. N.W. of Taunton. Pop. of the civil parish (1951) 931.

Dunster lies in a striking setting on the edge of Exmoor National park. Dominated by its ancient castle, the long street of the town winds around the base of the castle hill. The yarn market, a 16th-century octagonal building with open sides and steeply sloping roof, stands in the middle of the wide main street. The Luttrell Arms hotel retains a late medieval porch and some 17th-century paneling. The castle, open to visitors during the summer, has a fine 18th-century staircase and plaster ceilings. A packhorse bridge spans the river Avill, and an 18th-century folly, Conegar tower, provides a well-known landmark. The church of St. George has some early features, a good Perpendicular tower and a splendid screen, but all that remains of the Benedictine priory are a tithe barn and a circular dovecot.

The tourist trade provides the main occupation for Dunster's inhabitants. Agriculture and forestry and their associated industries, including two sawmills, occupy the remainder.

Remains of prehistoric Iron Age settlements lie in the deer park. The Domesday reference mentions Alvric, the Saxon lord of Dunster, but William de Mohun received the estate from the Conqueror. His castle became the *caput* of an honour including lands in Somerset, Dorset, Devon and Wiltshire that in the 14th century was purchased by the Luttrells. That family continued to live in the castle although the estate was sold in 1949 to the crown commissioners.

The town, created a borough in the 12th century, was represented in parliament in conjunction with Minehead until 1832. It provided a marketing centre for woolen yarn and for a local cloth called Dunsters. (T. J. Ht.)

DUNWICH, a village in the Eye parliamentary division of East Suffolk, Eng., on the coast of the North sea, about 26 mi. N.E. of Ipswich by road. Pop. of civil parish (1951) 140. In Anglo-Saxon days it was the most important commercial centre of East Anglia and was probably a Romano-British site. Early in the 7th century, when Sigebert became king of East Anglia, Dunwich was chosen as his capital and became the nursery of Christianity in eastern Britain. A bishopric was founded (according to Bede in 630; the Anglo-Saxon Chronicle gives 635), the name of the first bishop being Felix. Sigebert's reign was notable for his foundation of a school modeled on those he had seen in

France; it was probably at Dunwich but formed a nucleus of what afterward became Cambridge university. At the Norman conquest the manor was granted to Robert Malet. In 1173 the sight of its strength caused Robert, earl of Leicester, to despair of besieging the place. Dunwich received a charter from King John. In the reign of Edward I it is recorded to have possessed 36 ships and barks trading to the North sea, Iceland and elsewhere, with 24 fishing boats, besides maintaining 11 ships of war. The Benedictines, Franciscans and Dominicans all had establishments there.

By the middle of the 11th century Dunwich had already suffered from an evil that later caused its total ruin—the inroads of the sea upon the coast. In 1347 more than 400 houses were washed away, and in 1570, after a terrible storm, appeal was made to Elizabeth I. However, the old wealthy port was gradually engulfed, and inroads of the sea still continue. Many relics have been discovered by excavation or recovered from the sea.

Until 1832 Dunwich returned two members to parliament. The corporation was abolished in 1886, and part of the civil parish was transferred to Southwold in 1934. In the same year a bishopric suffragan to St. Edmundsbury and Ipswich was constituted, receiving the name Dunwich.

DUPANLOUP, FÉLIX ANTOINE PHILIBERT (1802–1878), French Roman Catholic bishop of Orléans, clerical spokesman for the liberal wing of French Catholicism, was born illegitimately on Jan. 3, 1802, at St. Félix, Haute-Savoie. He was taken to Paris as a boy. Ordained priest in 1825, he inaugurated at the Madeleine his novel catechetical classes at which the duc de Bordeaux and the Orléanist princes received religious education. As director of the Parisian junior seminary of St. Nicolas-du-Chardonnet (1837–45), he attracted by his success many nonclerical students and contributed to a bourgeois return to religion. Prominent in the struggle for educational freedom under the July monarchy, he was an architect of the *loi Falloux* (1850), which gave legal status to independent secondary schools. Bishop of Orléans (1849) and member of the French Academy (1854), he helped reorganize the liberal Catholic journal *Le Correspondant*. He defended papal temporal sovereignty, when it was threatened by Louis Napoleon, in a series of public letters (1860), but supported Thiers' refusal to reopen the issue after 1870. His explanation of Pius IX's *Syllabus of Errors* under the terms "thesis and hypothesis" became famous. At the Vatican council (1869–70) he was one of the party that considered the definition of papal infallibility to be inopportune. Bishop Dupanloup died on Oct. 11, 1878.

Of his numerous writings, only *Christian Marriage* and *The Studious Women* have been translated into English. A good sampling is in *Oeuvres Choisies*, 4 vol. (1861). Three volumes on *Higher Education* have merit.

See the biography by F. Lagrange, Eng. trans., 2 vol. (1885).
(J. N. M.)

DUPARC, (MARIE EUGÈNE) HENRI (1848–1933), originally Fouques-Duparc, French composer known for his songs on poems of Baudelaire, Leconte de Lisle, Théophile Gautier and others. Born in Paris on Jan. 21, 1848, he studied with César Franck at the Jesuit college of Vaugirard. In 1869 he met Liszt and Wagner at Weimar and in 1870 published five songs (*Cinq Mélodies*, Opus 2) including "Soupir" and "Chanson triste," later incorporated in his collection of 15 songs, written between 1869 and 1884. In these, of which eight are with orchestral accompaniment, Duparc enlarged the French song into an operatic *scena* ("Au pays où se fait la guerre"), brought to it a poetic sense of musical prosody ("La Vie antérieure") and, in "Phydilé" and "L'Invitation au voyage," a symphonic conception of form. In his youth Duparc wrote two orchestral works, *Aux Étoiles* and *Lénore*, and a motet. He was also keenly interested in Russian literature, planning an opera, *Roussalka*, based on Pushkin, and in the plays of Ibsen. Later he worked at painting, chiefly in water colours, sepias and pastels. About 1890 his creative faculties began to be undermined by doubts, and he thereafter produced little. In a spirit of severe self-criticism he destroyed nearly all his subsequent works and sketches, together with his earlier unpublished manuscripts and the correspondence addressed to him by Wagner and contemporary poets. During the latter part of his life he was associated with Francis Jammes and Paul Claudel and wrote a long religious prayer in prose (*Testament*, 1906–13). He died at Mont-de-Marsan, Landes, Feb. 13, 1933.

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DUPERRON, JACQUES DAVY (1556–1618), French cardinal, memorable especially for his part in the conversion of Henry IV to Roman Catholicism, was born in the canton of Berne, Switz., on Nov. 25, 1556, the son of a Huguenot refugee from St. Lô in Normandy, who gave him an excellent humanist education. Brought to France, however, he eventually became a Catholic, took holy orders and made a name for himself as a churchman attached to the crown's interests. Appointed reader to Henry III, to whom he was introduced in 1576, he kept this post until the king's death. He then for a time supported the claim of the cardinal de Bourbon ("Charles X") to the French crown, but soon transferred his loyalty to Henry IV. Bishop of Evreux from 1591, he instructed the king in the Catholic religion and in 1594 was sent to Rome to obtain absolution for him from the pope. At the conference at Fontainebleau between Catholics and Huguenots in 1600 he eloquently defended the Catholic position against Philippe du Plessis-Mornay and Agrippa d'Aubigné.

In 1604 Duperron was sent to Rome as *chargé d'affaires* and was created a cardinal. In 1606 he became archbishop of Sens. In the estates-general of 1614–15 he strongly opposed the attempt by the third estate to deny the pope's right to depose kings. Duperron died in Paris on Sept. 5, 1618, leaving a large number of writings dealing not only with religious and diplomatic affairs but also with literary questions.

See P. Féret, *Le Cardinal Duperron* (1877); G. Weill, *Les Théories sur le pouvoir royal en France pendant les guerres de religion* (1891).
(Ro. M.)

DUPIN, LOUIS ELLIES (1657–1719), French ecclesiastical historian, born in Paris, June 17, 1657, was the author of *Nouvelle Bibliothèque des auteurs ecclésiastiques*, 58 vol. (1686–1704), breaking with scholastic tradition by treating biography, literary and doctrinal criticism and bibliography all in one work, and by writing in a modern language. Following violent opposition to its opinions, led by Jacques Bossuet, and on the advice of his friend and distant relative Racine, Dupin retracted; but the book was suppressed (1696) and only completed under a new title. It was placed on the Index in 1757. Although he was a Gallican apologist, in 1713, following his protest against the papal bull *Unigenitus*, Dupin was exiled to Châtellerault on a charge of Jansenism, regaining freedom only by another retraction. His later years were occupied by projects for reunion of the churches: he corresponded (1718) with William Wake, archbishop of Canterbury, with ecclesiastical but not official approval; and in 1719, during his visit to France, Peter the Great commissioned Dupin to draw up a plan for Greek and Roman reunion. He died in Paris, June 6, 1719. His works include a *Bibliothèque universelle des historiens*, 2 vol. (1707), and *L'Histoire de l'église en abrégé*, 4 vol. (1712).

DUPLEIX, JOSEPH FRANÇOIS (1696–1763), French colonial administrator who, as governor general of the French establishment of India, was Robert Clive's great rival, was born at Landrecies, France, in Dec. 1696. His father, François Dupleix, who eventually became a farmer-general of taxes, sent him on a voyage to India and America in 1715 in a St. Malo ship. In 1721 his father's influence secured his appointment as a member of the superior council at Pondicherry. There, besides his official duties, he made large ventures on his own account and acquired a fortune. He was made superintendent in 1731 of the French factory in Chandernagore, which he administered with great success, and was appointed governor general of all French establishments in India in 1742. Within a year the news of the outbreak of the War of the Austrian Succession involved the English and French companies in conflict, but actual hostilities awaited the arrival of state forces on both sides. In 1746, with the help of a

French fleet under the comte Mahé de la Bourdonnais, Dupleix took Madras, but the quarrels between the two prevented further progress. The French failed against Ft. St. David and the British could not take Pondicherry. The peace of Aix-la-Chapelle in 1748 restored the *status quo*.

Dupleix now embarked on a political career. Divining the military weakness of the Indian powers of the day, he entered into local alliances with the aim of ruining the British East India company. He supported Chanda Sahib's claim to the Carnatic nawabship, and when the nizam of Hyderabad intervened, placed his own candidate on the throne there (1751). The British supported a rival candidate in the Carnatic and a private war between the two companies, acting as auxiliaries to Indian princes, developed. Largely as the result of Clive's exploits the French were defeated, although those under the marquis de Bussy-Castelnau retained their hold in the Deccan. The French finances were ruined in the struggle, and Dupleix was replaced in 1754 by C. R. de Godeheu, who had orders to arrest him if necessary. Dupleix embarked for France in Oct. 1754. He displayed great talents as an organizer and diplomatist, but lacked military acumen and the ability to work with others. He was the first European to exploit the weakness of Indian military science in order to gain political and territorial influence in India. Dupleix was discredited in his own country and died in obscurity in Paris on Nov. 10, 1763.

The diary of his Indian secretary, Ananda Ranga Pillai, gives a vivid picture of Dupleix's personality. In 1741 he married Jeanne Albert (d. 1756), widow of one of the councilors of the company, known to the Hindus as Joanna Begum, who proved of great help to her husband in his negotiations with the Indian princes. Dupleix defended his case against the company in his *Mémoire contre la compagnie des Indes avec les pièces justificatives* (1759), to which Godeheu replied in his *Lettre à M. Dupleix* (1760).

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DUPLICATING MACHINES: *see* OFFICE MACHINES AND APPLIANCES.

DUPONT, GABRIEL EDOUARD XAVIER (1878–1914), French composer of operas and light songs and piano pieces. Born March 1, 1878, at Caen, he was a pupil of Massenet at the Paris Conservatoire. In 1904 his opera *La Cabrera* was produced in Milan and in 1910 *La Glu*, based on the novel by Jean Richepin, was given at Nice. He later wrote *La Farce du cuvier* (Brussels, 1912) and *Antar*, posthumously produced in Paris in 1921. He also wrote songs and choral and orchestral works, notably a symphonic poem *Le Chant de la destinée*. His piano works include *Les Heures dolentes* and *La Maison dans les dunes*. A spontaneous lyrical gift accounted for his popular appeal. He died after a long illness at Le Vésinet, near Paris, Aug. 2, 1914.

See M. Dumesnil, "Gabriel Dupont: Musician of Normandy" in *The Musical Quarterly* (Oct. 1944).

DU PONT, SAMUEL FRANCIS (1803–1865), U.S. naval officer, was born in Bergen Point, N.J., Sept. 27, 1803. Educated in Philadelphia, Pa., young Du Pont was attracted to the naval service as a result of the exploits of U.S. sea fighters during the War of 1812. He was appointed a midshipman and his training at sea began in 1817 under Capt. Charles Stewart in the ship of the line "Franklin." He served on various naval vessels in South American and European waters, being promoted a lieutenant in 1826 and a commander in 1842. In command of the sloop of war "Cyane," on the Pacific coast at the outbreak of the Mexican War, Du Pont distinguished himself in a series of daring amphibious operations that cleared the enemy out of the Gulf of California. He participated in the capture of Mazatlán and other cities, which drove the enemy from the Pacific coast of Mexico. For the next ten years Du Pont played an important part in the development of steam in the navy. In 1855 he was appointed a captain and, at the same time, brought congressional wrath upon himself as chairman of the naval efficiency board which found several hundred naval officers incompetent. As senior member of the commission of conference, Du Pont was instrumental in planning the naval strategy of the Civil War, and he carried out the first stages of that strategy when, in the command of the South Atlantic blockading squadron, he stormed and took the Confederate forts at Port Royal, S.C. (Nov. 7, 1861). Congressional thanks and a rear admiralcy followed the exploit, the capture of forts by ships previously having been regarded as impracticable. Eighteen months later, in a similar attempt upon the defenses of Charleston, S.C., and using a battle line of monitors and an ironclad, Du Pont met with a severe reverse. He was relieved in July 1863. A dispute with the secretary of the navy, Gideon Welles, as to the responsibility for this defeat continued until Du Pont's death in Philadelphia on June 23, 1865.

Du Pont circle and fountain in Washington, D.C., were named in his honour.

See H. A. Du Pont, *Rear Admiral Samuel Francis Du Pont* (1926); *Official Records of the Union and Confederate Navies in the War of the Rebellion*, 30 vol. (1894–1922). (W. B. CK.)

DUPONT DE L'EURE, JACQUES CHARLES (1767–1855), French lawyer and republican deputy whose distinctive surname indicates his lifelong connection with the *département* of Eure, was born at Neubourg on Feb. 27, 1767. He was admitted as advocate to the *parlement* of Rouen in 1789. From 1790, when the *département* of Eure was formed, he played an active part in its affairs, becoming mayor of Neubourg in 1792, public prosecutor for Eure in 1798, deputy for Eure in the Council of the Five Hundred from 1798 to 1799 and president in the state court at Rouen in 1812. Having been a member of the Corps Législatif in 1813 and vice-president of the chamber of representatives during the Hundred Days, he resisted the absolutism of the Restoration. Re-elected by Eure in 1817, he was dismissed without pension from his post at Rouen in 1818, but his constituents then bought him a property to qualify him for re-election as deputy.

On the establishment of the July monarchy in 1830, Dupont was made minister of justice and keeper of the seals, but he resigned in October in order to rejoin the republican opposition. He was active in the "banquets campaign" for constitutional reform in 1847 and, at the revolution of Feb. 1848, became president of the council of ministers in the provisional government. After the April elections he sat for Eure in the constituent assembly, but his moderate republicanism was overshadowed by Ledru-Rollin's extremism, and he finally lost his seat in the elections of May 1849. He died at Rouge-Perriers, Eure, on March 2, 1855.

DU PONT DE NEMOURS, PIERRE SAMUEL (1739–1817), French economist whose numerous writings were mainly devoted to spreading the tenets of the Physiocratic school (*q.v.*) and whose unfailing adherence to these doctrines largely explains his conduct during his long political career, was born in Paris on Sept. 14, 1739. An early work on free trade, *De l' Exportation et de l'importation des grains* (1764), brought him the friendship of A. R. J. Turgot (*q.v.*), whose biography he wrote (1782) and whose papers he edited (9 vol. 1809–11). He assisted Turgot and, later, C. A. de Calonne (*q.v.*) at the *contrôle général* in planning reforms. He was largely responsible for the clause in the treaty of Versailles of 1783 which stipulated a trade treaty between France and Great Britain, and he greatly influenced the scope of the free-trade treaty which was signed in 1786. For these services he was ennobled. In 1787 he became secretary to the assembly of notables. After the fall of Calonne he joined the "patriots," who opposed privilege and the political claims of the *parlements;* and later he joined the Société des Trente, which favoured voting by head rather than by orders in the meeting of the estates-general convened for 1789. In the estates-general he represented the third estate of Nemours.

One of the chief promoters of the Tennis Court oath and, like his friend Talleyrand, an architect of the civil constitution of the clergy, he played an important part in the beginnings of the French Revolution. He was opposed to the issue of *assignats*, to war, to violence and to tyranny. He defended Louis XVI in Aug. 1792. Though forced into hiding during the Terror and later imprisoned, he was eventually released through the help of influential friends. A member of the *anciens* at the time of the Directory, he was suspected of activities on behalf of the royalists and was again

arrested, but was quickly released. He now planned to go to the United States, not as an *émigré* but hoping to combine official missions with private speculation and to convert the Americans to physiocratic principles. After much delay, he arrived in the United States with his sons, Eleuthère and Victor, in Jan. 1800. He drew up for Thomas Jefferson a scheme of national education and established companies to promote Franco-U.S. trade. These ventures were not successful, but Eleuthère, a pupil of Antoine Lavoisier, founded a powder manufacture which became world-famous. In 1802 Pierre Samuel returned to France to promote the sale of Louisiana to the United States, hoping thereby to improve Franco-U.S. relations. He became vice-president of the Paris chamber of commerce. His political theory enabled him to accept not only the consulate but also the first empire. Later, however, he became critical of Napoleon's economic and foreign policy. In 1814 he assisted Talleyrand to restore the Bourbons, became secretary general of the provisional government and was made councilor of state by Louis XVIII. During the Hundred Days he returned to the United States. He died at Eleutherian Mills, near Wilmington, Del., on Aug. 7, 1817.

Dupont's chief works were: *Physiocratie, ou Constitution naturelle du gouvernment le plus avantageux au genre humain* (1767); *Du commerce et de la compagnie des Indes* (1769); *Mémoires sur la vie et les ouvrages de M. Turgot*, 2 vol. (1782); *Philo-sophie de l'univers* (1796); an edition of the *Oeuvres de Turgot*, 9 vol. (1809–11); and *Examen du livre de M. Malthus* (1817).

See Pierre Jolly, *Du Pont de Nemours* (1956). (D. Dn.)

DUPPLIN, BATTLE OF. This battle, fought on Aug. 12, 1332, marked the renewal of the Scottish War of Independence, which apparently had been ended by the peace of Northampton (1328). But under Henry de Beaumont (*see* Beaumont), and with the secret connivance of the English king Edward III, those who had been disinherited by Robert I for their adherence to the English planned to recover their Scottish lands by force. Edward Balliol (*see* Balliol) came from France to head their expedition. Embarking at Ravenspur with about 1,500 men, the "disinherited" landed at Kinghorn in Fife and routed the local levies who opposed them. By way of Dunfermline the invaders reached the Earn river, on the opposite bank of which lay a Scottish force under Donald, earl of Mar, regent for the young David II. Fording the river on the night of Aug. 11–12, the "disinherited" overwhelmed a Scottish encampment. Despite this initial success dawn revealed the main Scottish force arrayed in two divisions and ready to attack. Greatly outnumbered, Balliol's men adopted tactics later copied by Edward III at the battles of Halidon Hill and Crécy; save for about 40 German mercenaries kept in reserve, all the men-at-arms dismounted, while archers were posted on either flank. When an impetuous charge by the first Scottish division failed to make headway its flanks were riddled by flights of English arrows and converged in disorder upon the centre. At this point the second division (under Mar), charged, collided with the rear-most ranks of the first division, but failed to communicate momentum to those in front. Losing their footing, the Scottish men-at-arms and spearmen trod one another underfoot; more died by suffocation than by the sword. Pursuing the fugitives, Balliol's men entered Perth and crowned their leader at Scone on Sept. 24, 1332. *See* also Scotland: *History*. (R. G. Ni.)

DUPRAT, ANTOINE (1463–1535), chancellor of France and cardinal, the chief judicial counselor of Francis I, was born at Issoire on Jan. 17, 1463. Duprat owed his success to his cousin Antoine Bohier, archbishop of Bourges, who had him well educated and helped his legal career. Duprat became *lieutenant de bailliage* at Montferrand (1490), attorney for the crown at Toulouse (1495), master of requests to Louis XII's household (1503), president in the Paris *parlement* (1507) and finally, because of the influence of Louise of Savoy, premier president of the Paris *parlement* (1508). Louise, moreover, had entrusted him with the education of her son, the future Francis I. On the latter's accession to the throne (1515), Duprat became chancellor of France. In this capacity he negotiated the concordat of Bologna (1516).

After the concordat was signed, Duprat took holy orders. He was given the bishoprics of Valence and Die (1522), Albi (1528) and Meaux (1534) and the archbishopric of Sens (1525) and was made a cardinal in 1527 and papal legate in France in 1530. He was a determined adversary of the Reformation.

Duprat meanwhile continued in his functions as a lawyer. He collaborated with the king in his centralizing policy and advised him on the prosecution of the constable duc de Bourbon. Having amassed great wealth and even entertained hopes of succeeding Clement VII as pope, he died at Nantouillet on July 9, 1535.

See Antoine, marquis Duprat, *Vie d'Antoine Duprat* (1854); A. Buisson, *Le Chancelier Antoine Duprat* (1935).

DUPRÈ, GIOVANNI (1817–1882), Italian sculptor, whose success was due to his lifelike and original interpretation of form when Italian sculpture was deteriorating into a mannered imitation of Canova, was born in Siena on March 1, 1817, the son of a carver in wood. By drawing and modeling in his spare time he succeeded in winning the prize competition of the academy in Florence in 1840 without having attended the academy schools. His first work of importance was "Abel" (1842, Pitti, Florence). He was befriended by L. Bartolini. The grand duchess Marie of Russia commissioned him to do a statue of "Cain" (1844, Pitti), and the grand duchess of Tuscany to do one of "Giotto" (1845, arcades of the Uffizi, Florence). The mourning "Sappho" (1857) was his most famous work of this period. A visit in 1856 to Naples and Rome, where he admired Canova's monument to Pius VI, influenced him toward neoclassicism. His monuments, *e.g.*, that of Cavour in Turin, suffer from the conflict between his temperamental naturalism and the necessities of allegory and ideal grandeur. Duprè also executed many portrait busts. He died in Florence on Jan. 10, 1882.

His autobiography, *Pensieri sull' arte e Ricordi autobiografici* (1882), was translated into English by Peruzzi. (A. K. McC.)

DUPRÉ, JULES (1811–1889), French painter, one of the chief members of the Barbizon group of romantic landscape painters, was born at Nantes on April 5, 1811. Among the Barbizon painters, Corot tended toward the lyric, T. Rousseau toward the epic and Dupré toward the tragic and dramatic aspects of nature. He was the son of a porcelain manufacturer and started his career in his father's works, from which he went to his uncle's china factory at Sèvres. Dupré exhibited first at the Salon in 1831, and three years later was awarded a second-class medal. In the same year he came to England, where he was deeply impressed by the genius of Constable. From him he learned how to express movement in nature; and the district of Southampton and Plymouth, with its wide, unbroken expanses of water, sky and ground, gave him good opportunities for his special gifts. Late in life he changed his style and gained appreciably in largeness of handling, and he arrived at greater simplicity in his colour harmonies. He died at L'Isle Adam on Oct. 6, 1889. *See* also Barbizon School.

DUPUY, CHARLES ALEXANDRE (1851–1923), French statesman, three times prime minister, remembered chiefly for his role during the Dreyfus affair, was born at Le Puy, Haute-Loire, on Nov. 5, 1851. He was first elected deputy for Haute-Loire as an Opportunist Republican in 1885. He became minister of education under Alexandre Ribot in 1892. Dupuy formed a government in April 1893 but resigned at the end of November and on Dec. 5 was elected president of the chamber. During his first week of office the anarchist Auguste Vaillant threw a bomb at him, and Dupuy's calm words, "The debate continues, gentlemen," won him much credit. He became prime minister and minister of the interior in May 1894 and was by Pres. Sadi Carnot's side when the latter was assassinated at Lyons in June. His cabinet remained in office till Jan. 1895, and it was under it that Capt. Alfred Dreyfus (*q.v.*) was arrested and, two months later, condemned (Dec. 1894). In Nov. 1898, and after Henri Brisson had at last remitted the Dreyfus case to the judgment of the supreme court of appeal, Dupuy formed a government of Republican concentration. A special law was passed that transferred the decision from the criminal section to the court of appeal sitting as a whole (*toutes chambres réunies*). The latter decided that there must be a new court-martial, for the *bordereau*, the document that had led to Dreyfus' court-martial, was the work of Maj.

C. F. (Walsin-)Esterhazy. This infuriated the anti-Dreyfusards, who staged demonstrations and insulted Pres. Émile Loubet at Auteuil. Dupuy resigned on June 12, 1899. In June 1900 he was elected senator for Haute-Loire. Dupuy died at Ille-sur-Têt, Pyrénées-Orientales, on July 23, 1923.

DUPUY, PIERRE (1582–1651), French scholar, born in Agen (Lot-et-Garonne), Nov. 27, 1582, was largely responsible for cataloguing the royal archives (*Trésor des chartes*) and, with his brother Jacques, the king's library. His manuscript inventory of the former is preserved in the Bibliothèque Nationale and transcriptions are in the national archives in Paris, the record office in London and elsewhere. He was also employed on the commission constituted to discover the legal titles of the king of France over the bishoprics of Metz, Toul and Verdun. His books on the conflict between Boniface VIII and Philip the Fair, the Templars and the great schism contain important documents.

Dupuy died in Paris, Dec. 14, 1651.

DUPUY DE LÔME, STANISLAS CHARLES HENRI LAURENT (1816–1885), French naval architect, who influenced the design of steamships and armoured vessels, was born at Ploemeur, near Lorient, on Oct. 15, 1816. He entered the École Polytechnique in 1835, and in 1842 was sent to England to study and report on iron shipbuilding. Acting on his report, published in 1844, the French government built its first iron vessels. He planned and built the steam line-of-battle ship "Napoléon" (1848–52) and devised a method of altering sailing ships of the line into steamers that was afterward practised in both France and England. His demonstration of the practicability of armouring the sides of a ship marked the beginning of a great change in ship construction. In 1877 he was elected a senator for life. He died in Paris on Feb. 1, 1885.

DUPUYTREN, GUILLAUME, Baron (1777–1835), French surgeon famous for his researches in surgical pathology, one of the best-known of which is his description of "Dupuytren's contracture" of the hand, a condition that occurs in persons whose work entails pressure on the palms. He was born at Pierrebuffière, near Limoges, on Oct. 5, 1777. In 1802 he joined the staff of the great Paris hospital, the Hôtel Dieu, of which he became surgeon-in-chief and which he attended for over 30 years. In addition he carried on an immense private practice and was surgeon to Louis XVIII and Charles X. As an operator he was bold, self-controlled and undaunted by any emergency. He was the first to excise the lower jaw and to amputate the neck of the womb for cancer. Among his other great triumphs were the ligation of the subclavian artery, the introduction of a new classification of burns, the introduction of operations for the treatment of wryneck and for the creation of an artificial anus, the treatment of aneurysms by compression and the first clear pathological description of congenital dislocation of the hip. He died in Paris on Feb. 8, 1835.

See H. Mondor, *Dupuytren* (1945). (W. J. Bp.)

DUQUESNE, ABRAHAM, Marquis (1610–1688), French naval officer who served with distinction during two periods of great maritime activity in France, under Richelieu's administration and then under Colbert's, was born in Dieppe of a small Calvinist family who did some trade with Canada. He learned his seamanship on a small armed merchantman, the "Petit Saint André" on which he served as lieutenant to his father (1627). Richelieu, wanting to recruit captains for the royal navy, engaged Duquesne, who then served under two great commanders Henri d'Escoubleau de Sourdis and Armand de Maillé-Brézé. In 1638, in command of the "Saint-Jean," he took part in the destruction of a Spanish fleet in the battle of Guetaria. He fought off the coasts of Spain and was wounded at the Cabo de Gata (1643). After a short stay in Sweden as one of Queen Christina's admirals (1644–47), he returned to France. He served the crown loyally during the Fronde.

When Colbert began his great naval program, Duquesne commanded a squadron at Brest and supervised the development of the port. After war had broken out in 1672 (*see* Dutch Wars), he was at Solebay when the Dutch admiral M. A. de Ruyter surprised the Anglo-French fleet. Accused by his superior, Jean, comte d'Estrées, of reluctance to obey orders, Duquesne was then deprived of his command. No doubt he was, as Colbert said, "of an unaccommodating disposition," surly and always complaining and criticizing; but even so he was a conscientious and worthy officer with a strong sense of duty. Neither prospects of promotion nor Bossuet's eloquent arguments could make him renounce his Protestantism. In the second period of the war, however, when the English had left the French alliance and a skilful, hard and aggressive sailor was required to fight in the Mediterranean, Duquesne was chosen for the task. Sailing at the end of Jan. 1675 to help the Sicilian rebels against the Spaniards, he fought his way into Messina and then took Augusta before returning to France for reinforcements and supplies. The Dutch then sent the formidable De Ruyter to help the Spaniards. Duquesne, however, defeated him first off the Lipari islands (Jan. 1676), then in the great battle off Augusta (April 22), in which De Ruyter was mortally wounded. Colbert then wrote to Duquesne: "You have given such great proof of your valour, of your skill, of your consummate experience in naval matters that nothing could be added to the glory which you have acquired."

After peace had been signed with the Dutch, Duquesne fought against the Barbary pirates. Sailing into the Aegean, he bombarded Chios and threatened the Dardanelles (1681). He attacked Algiers in 1682 and in 1683. His last expedition was against Genoa (1684). The estate of Bouchet had been erected into a marquisate (du Quesne) for him in 1681, but his Protestantism prevented his ever being made admiral. After the revocation of the Edict of Nantes (1685) he was allowed to remain untroubled in retirement. He died in Paris in the night of Feb. 1–2, 1688.

See A. Jal, *Abraham Duquesne et la marine de son temps* (1873). (L. Nl.)

DUQUESNE, a city of Allegheny county, Pa., U.S., on the south bank of the Monongahela river facing McKeesport and 10 mi. from downtown Pittsburgh. Both the advance and retreat routes taken by Gen. Edward Braddock's British army in its ill-fated march toward the forks of the Ohio in 1755 passed there. The city's only industry is steel. In 1885 the Duquesne Steel Co. selected the area as a mill site, and the town quickly attracted other steel companies. Duquesne was incorporated as a borough in 1891 and received its city charter in 1917. Its population reached a peak of 21,396 in 1930, slowly declining thereafter. For comparative population figures *see* table in Pennsylvania: *Population.* (J. A. Ke.)

DUQUESNOY, FRANÇOIS (1592/94–1643), called Il Fiammingo, Italo-Flemish sculptor, usually considered, along with Alessandro Algardi, as representing within the baroque movement a more conservative influence than G. L. Bernini, was born in Brussels but lived in Italy from about 1620. His two most famous monumental statues are those of St. Susanna (at Sta. Maria di Loreto, Rome) and of St. Andrew (in the crossing of St. Peter's), the latter being closer to Bernini than most of Duquesnoy's work. Portraits of Van Dyck (Brussels, Palais des Beaux-Arts) and Poussin (Earl Cowper at Panshanger) from his hand survive. He received much praise for his rendering of *putti* (Cupidlike nude child figures), which were perhaps more truly childlike than any by previous sculptors. Duquesnoy was also very skilled as a carver of small ivory figures. He died at Leghorn on July 12, 1643. (A. K. McC.)

DURALUMIN, an aluminum alloy discovered and patented by Alfred Wilm and originally made at Düren in Germany. It possesses the important property of being strengthened and hardened by heat treatment and aging. In addition to 94% aluminum, 4% copper and 0.5% to 1.0% of manganese, duralumin-type alloys contain from 0.5% to 1.5% magnesium. The latter element is responsible for the natural age hardening of this alloy after heating and quenching. The original composition has been varied over a range with regard to copper, magnesium and manganese contents, and this class of alloys is described as the strong aluminum alloy type.

In the normal state these alloys are relatively soft, ductile and workable and may be rolled, forged, extruded or drawn into a variety of products. Cold working strain hardens duralumin al-

loys as it does all metals. The effects of this work-hardening can be removed by annealing at a temperature of 650° F. This type of alloy is heat-treated by heating to 920°–950° F., depending on the alloy, and quenching rapidly in cold water. The heating dissolves and distributes the hardening components and quenching retains them in a supersaturated solid solution. Immediately after quenching, duralumin is relatively soft and workable. On aging at room temperature for about four days, the alloy becomes harder, stronger and less workable. Age-hardening results from precipitation of submicroscopic particles from the supersaturated solid solution. These particles key the slip planes and thereby harden and strengthen the matrix. The aging process can be accelerated in some of the alloys by reheating at temperatures from 200° to 350° F. (*See* also ALLOYS; ANNEALING.)

Heat-treated duralumin is comparatively resistant to corrosion. It is ductile (typical elongation 22% in 2 in.), will bear a load of about 40,000 p.s.i. without permanent deformation and breaks under a load of about 62,000 p.s.i.

These alloys are light (specific gravity 2.75 to 2.80). Thus, they have a high strength per unit of weight as compared with steel. This property makes them particularly suitable for aircraft construction, for which they have been used to a very great extent, and the development of the rigid airship would have been impossible without light, high-strength alloys of the duralumin type. As sheet for aircraft construction, these alloys are made in alclad form, a composite product which has thin surface layers of pure aluminum or some corrosion-resistant aluminum alloy covering the high-strength duralumin-type alloy core.

The duralumin alloys can be welded but they lose their high strength during welding. Duralumin lends itself to all ordinary fabricating processes such as spinning, pressing, riveting and machining. *See* also ALUMINUM. (F. KR.)

DURAN, a medieval Jewish family of rabbis and scholars.

PROFIAT DURAN, called also Efodi (full name, Isaac ben Moses Halevi) (*c.* 1350–*c.* 1415), was educated in Germany and lived in Catalonia. In 1391 he was compelled to profess Christianity, but remained devoted to Judaism. His chief works were grammatical and philosophical. In the former realm his most important contribution was the *Maaseh Efod* (completed in 1403); in the latter, his commentary to the *Guide of the Perplexed* by Maimonides.

SIMON BEN ZEMAH DURAN (1361–1444), called Rashbaz, rabbi of Algiers, was born at Palma, Majorca, but fled to Algiers during the persecutions of 1391. A doctor of medicine, he was one of the first medieval rabbis to be paid a regular salary by the community. Before the 14th century the rabbinical post had been almost invariably honorary. Duran wrote a systematic work on theology, *Magen Aboth,* but is chiefly famous for his numerous *responsa,* published in 1738–39, which give valuable information as to social and religious conditions of his day. He also wrote a critique of Catholic dogmas, pointing out the contrast between the religion of Jesus and the letters of St. Paul. (I. A.; X.)

SOLOMON BEN SIMON DURAN (*c.* 1400–1467), called Rashbash, son of Simon ben Zemah and his successor as rabbi of Algiers, was the author of a defense of Judaism, *Milhemeth Mizvah* (1437), and of a collection of *responsa.*

SIMON BEN SOLOMON DURAN (1439–after 1510), son of Solomon ben Simon, also was rabbi of Algiers.

DURÁN, AGUSTÍN (1793–1862), Spanish literary critic who emphasized the revival of traditional values which distinguished the Spanish romantic movement. He was born in Madrid, Dec. 1, 1793, and became director of the national library there. He died in Madrid, Oct. 14, 1862. His edition of ballads, *Romancero general* (1828–32), the largest yet collected, and of the plays of Tirso de Molina, *Talia española* (1834; 1839–42), reinforced the claims advanced in his academy speech, *Sobre el influjo que ha tenido la crítica moderna en la decadencia del teatro antiguo español* (1828), that Spanish medieval and classical literature was more poetical and so unlike the classicism of Greece and France as to demand appreciation by different rules. (R. F. B.)

DURAN, CAROLUS (CHARLES AUGUSTE ÉMILE DURAND) (1837–1917), French painter, best known as a portrait painter and head of one of the principal ateliers in Paris, was born at Lille on July 4, 1837. He studied at the Lille academy. In 1859 he went to Paris and in 1862–70 to Italy and Spain, studying in particular Velázquez. "The Assassination" (1866) was one of his first successes. His "Lady With the Glove" (1869), a portrait of his wife, was bought for the Luxembourg museum. In 1905 he was appointed director of the French academy at Rome in succession to Eugène Guillaume. He died in Paris on Feb. 17, 1917.

DURANCE (ancient DRUENTIA), one of the principal rivers draining the French side of the Alps toward the Mediterranean. Its total length from its source in the High Alps of Dauphiné to its junction with the Rhône, a little below Avignon, is 189 mi. It takes its origin in some small lakes a little south of the Montgenèvre pass, but it has two other headstreams of much greater length and volume: the Clairée (flowing in from the north) and the Guisane (flowing in from the northwest and rising near the Col du Lautaret, 6,752 ft.). Between its junction with the Cerveyrette and the Gyronde, the Durance passes through spectacular gorges. It then runs through a stony plain where it frequently overflows and causes great damage, this being indeed the main characteristic of the Durance throughout its course. At the foot of the fortress of Mont-Dauphin and some distance above the town of Embrun, it receives (left) the Guil, which flows through the Queyras valley from near the foot of Monte Viso. It becomes the boundary between the *départements* of Hautes-Alpes and Basses-Alpes and receives (left) the considerable Ubaye river, flowing from near the foot of Monte Viso past Barcelonnette.

Flowing through Basses-Alpes, it is joined (right) above Sisteron by the wild torrent of the Buëch from the desolate region of the Dévoluy and (left) by the Bléone (on which Digne, the capital of the *département,* is situated) and the Asse. The Verdon, flowing past the town of Castellane and famous for its scenic gorge, joins it from the lower summits of the Maritime Alps. After passing through some narrow gorges near Sisteron the bed of the river becomes wide and liable to flood, the frequent overflows being kept within bounds by numerous dikes and embankments. These features are especially marked when the river, after leaving Basses-Alpes, bends northwest and, always serving as the boundary between the *départements* of Vaucluse (north) and Bouches-du-Rhône (south), passes Cavaillon above its junction with the Rhône. The drainage area of the Durance is about 5,811 sq.mi. After World War II large dams were constructed on the Durance and its tributaries as part of hydroelectric-power and irrigation water-supply projects. (AR. E. S.)

DURAND, ASHER BROWN (1796–1886), U.S. painter and engraver, one of the founders of the Hudson river school of landscape painting, was born at South Orange, N.J., on Aug. 21, 1796. He worked with his father, a watchmaker; was apprenticed, in 1812, to an engraver named Peter Maverick; and his first work, the head of an old beggar after Samuel Waldo, attracted the attention of the artist John Trumbull. Duran established his reputation by his engraving of Trumbull's "Declaration of Independence." After 1835, however, he devoted himself chiefly to portrait painting. He painted several of the presidents of the United States and many other men of political and social prominence.

In 1840 he visited Europe to study the work of the old masters; after his return he devoted himself almost entirely to landscape. He was among the earliest Americans to work out-of-doors. His ability to romanticize landscapes can be seen in "Kindred Spirits" (1849), which shows his friends Cole and Bryant in a minutely detailed Catskill forest setting. He died at South Orange on Sept. 17, 1886. He was one of the founders of the National Academy of Design (1826) and was its president. 1845–61. He was a well-trained craftsman and his work is marked by sincerity.

CYRUS DURAND (1787–1868), a brother of Asher, formed a partnership with him for bank-note engraving. He invented machines for the mechanical drawing of lines which revolutionized the art.

See John Durand, *The Life and Times of Asher Brown Durand* (1894).

DURANDI, GULIELMUS (GUILLAUME DURAND, DURANTIS, DURANTI, DURANDUS) (*c.* 1230–1296), renowned canonist and liturgist, a churchman of wide judicial and administrative

experience, was born at Puymisson in Languedoc, and obtained the doctorate in canon law at Bologna. He taught briefly at Bologna and later at Modena. Some time after 1260 he was appointed *auditor causarum sacri palatii,* one of the judges commissioned to hear cases of appeal brought to the Holy See. At the second general council of Lyons (1274) he was one of the draftsmen of the statutes which Pope Gregory X promulgated in council; he later wrote a commentary on these *constitutiones*. In 1278, when the city of Bologna and the territory of the Romagna were incorporated into the Papal States, Durandi was one of the first group of commissioners sent there; subsequently he held various posts in the ecclesiastical and temporal administration of the new province and eventually (1283) became its governor general. In 1286 he was consecrated as bishop of Mende, in Languedoc, but took possession of his see only in 1291. At Mende he published a set of instructions and statutes for the clergy of his diocese and occupied himself with liturgical matters. In 1295 Pope Boniface VIII offered him the archbishopric of Ravenna, which Durandi declined, accepting however a new commission as *rector* in the Papal States. He died at Rome on Nov. 1, 1296.

The fame of Durandi as a writer rests chiefly on his *Speculum iudiciale* (first published between 1271 and 1276, revised and reissued *c.* 1289–91), an encyclopaedic treatise of canon law (and, to some extent, civil law) under the aspect of court procedure. The book remains valuable for the information it provides on the judicial practice of the medieval church courts, especially of the Roman curia. Of all his writings on canon law, this book was so universally known in the later middle ages that Durandi was often referred to simply as "the speculator" rather than by name. Of his liturgical works, the *Rationale divinorum officiorum* (*c.* 1286–91) is a general treatise on the liturgy and its symbolism, considered the most important medieval book on divine worship. The *Speculum* was printed at least 39 times between 1473 and 1678, and the *Rationale* even more often (over 40 editions from 1459 to 1500 alone). As bishop of Mende, Durandi undertook a revision of the *Pontificale Romanum*, the book of ceremonial directives and prayers to be used in the liturgical functions of bishops and prelates; this became the model for the official Roman text of the *Pontificale* published by Pope Innocent VIII in 1485.

See L. Falletti, "Guillaume Durand," in *Dictionnaire de Droit Canonique,* vol. v, cols. 1014–75 (1953), with full bibliography.
(S. G. K.)

DURANDUS OF ST. POURÇAIN (*c.* 1270–1334), French theologian and scholastic philosopher, was born at St. Pourçain, in the Auvergne. He entered the Dominican order and studied at Paris, where he received the doctorate in 1313. Shortly afterward Clement V summoned him to Avignon as "master of the sacred palace," in effect theological lecturer to the papal curia. He became successively bishop of Limoux (1317), of Le Puy (1318) and of Meaux (1326). He was known in the schools as *doctor resolutissimus*, and was especially famous for the hardihood with which he attacked the teachings of Thomas Aquinas at a time when Thomas was already accepted as the official doctor of the Dominican order. Durandus taught that a philosopher should prefer the conclusions of his own reason to any authority, except in articles of faith; the acceptance of truths of faith, on the other hand, did not depend on reason at all. He differed from Thomas on the problem of universals, preferring a solution closer to the nominalism of William Ockham; on the relation of divine causality to human free will; on the nature of the act of perception; and on sacramental theology (Durandus held that, while an infusion of grace accompanied the reception of a sacrament, the sacrament itself was not the direct cause of the grace received). Some of his teachings on the Beatific Vision were condemned by a pontifical commission in 1333. His major works are a commentary on the *Sentences* of Peter Lombard (1508) and the *De origine potestatum et iurisdictionum* (1506). Durandus died in 1334.

See J. Koch, *Durandus de S. Porciano O.P.* (1927); E. Gilson, *History of Christian Philosophy in the Middle Ages* (1955).
(B. TY.)

DURANGO, a state in north central Mexico, bounded north by Chihuahua, east by Coahuila and Zacatecas, south by Jalisco and Nayarit, west by Sinaloa, with an area of 47,691 sq.mi. Pop. (1960) 750,220, including fewer than 600 Indians. Rainfall in the eastern sections is sparse and agriculture depends exclusively on irrigation; stock raising and minor forest industries are carried on in the west. Coursing eastward from the Sierra Madre Occidental, the Nazas river, the largest in the state, flows for approximately 373 mi.; when swollen by spring rains it is the main source of water permitting commercial crops of cotton, wheat, maize, tobacco, sugar cane, vegetables and fruits. Durango shares with Coahuila the famous Laguna cotton district, a large co-operative enterprise.

The state is rich in minerals and mining has traditionally been a principal mainstay. Silver, gold, sulfur, tin, coal, cinnabar, antimony, copper and other valuable deposits exist, only partially exploited. A colossal helmet-shaped hill 700 ft. high of nearly pure iron, known as Cerro del Mercado, rises 2 mi. from the capital, Durango city. The hill is estimated to contain between 300,000 and 600,000 tons of hematite in various stages of oxidization, forced out by ancient volcanic action. It supports the iron and steel works near by. The Candelaria mine (argentite) is famous for its prodigious output and purity of ore. Other mining districts are Mapimí, a great arid depression 130 mi. N.N.E. of Durango city; Cuencamé; Nombre de Dios (first Spanish settlement, *c.* 1555); Papasquiaro; and San Juan del Río. Inadequate transportation has hampered development of mineral resources. National Railways of Mexico lines traverse the state northeast to southwest, and another line crosses its eastern parts. The state is also crossed by two branches of the Pan-American highway and has air routes.

Originally explored by Francisco de Ibarra (1562–63), Durango shared the colonial history of Chihuahua as major parts of the realm of Nueva Vizcaya; the two became sovereign and separate states in 1823. At frontier zones, they were plagued by Indian uprisings until late in the 19th century. (HD. C.; J. A. CW.)

DURANGO (VICTORIA DE DURANGO), capital of the state of Durango, Mexico. Pop. (1960) 94,257. It lies 614 mi. N.W. of the federal capital on the main trunk highway to the U.S. border at Ciudad Juárez-El Paso, Tex., and on the Transoceanic highway from Matamoros to Mazatlán. At an altitude of 6,314 ft. it dominates the picturesque and fertile Guadiana valley formed by the eastern spurs of the Sierra Madre. Its climate is mild and healthful and a famous thermal iron water spring is found nearby. An outstanding feature is the Cerro del Mercado north of the city; it is a solid hill of iron that represents one of the world's largest deposits.

Durango is an important commercial and mining centre with diversified local industries that include reduction works, cotton and woolen mills, glass works, iron foundries, flour mills, sugar refineries and tobacco factories. The first Spanish settlement was established in 1556 by Fray Diego de la Cadena. Durango received its formal founding in 1563 under Captain Alonso Pacheco. It was the political and ecclesiastical capital of Nueva Vizcaya, which included Durango and Chihuahua until 1823. Long an important place in northern Mexico, Durango dwindled during the 19th century but revived thereafter. (HD. C.; R. B. MCCK.)

DURANT, WILL (WILLIAM JAMES DURANT) (1885–), U.S. author and lecturer well known for his popular expositions of history and philosophy, was born on Nov. 5, 1885, in North Adams, Mass. He was educated at St. Peter's college, Jersey City, N.J., and at Columbia university, from which he received a doctorate in philosophy in 1917. Durant's early life was marked by religious conflict and political and social disillusionment; *Transition* (1927), his only novel, is largely an autobiographical account of this part of his life. In addition to writing, Durant gave public lectures and had brief teaching assignments at Seton Hall college in New Jersey, at Columbia university and at the University of California at Los Angeles.

His successful career as a writer of popular books on philosophy, history and sociological problems began with the publication of *Philosophy and the Social Problem* (1917). His second book, *The Story of Philosophy* (1926), established Durant as an outstanding stylist of popularized historical writing; more than 2,000,000 copies were sold in less than three decades, and it was

translated into several languages. The *Réformation* (1957) was the sixth volume of *The Story of Civilization*, begun by Durant in 1932. *The Story of Civilization* and *The Story of Philosophy*, although generally regarded as falling short of the exacting standards of historical scholarship, have depicted a pageant of history, both informative and vivid, to millions of readers who enjoy these "humanized" expositions. (J. M. Bk.)

DURANT, WILLIAM CRAPO (1861–1947), U.S. automobile executive, who founded General Motors corporation, was born in Boston, Mass., Dec. 8, 1861. A carriage company he established in Michigan in 1886 soon became the largest buggy manufacturing firm in the world. In 1903 he took over a small firm and soon began manufacturing Buick motor cars. He brought together a large number of automotive manufacturers in the General Motors Co., which he organized in 1908. Financial difficulties cost him control of the company in 1910, but with Louis Chevrolet (1879–1941) he established the Chevrolet Motor Co. and made a remarkable comeback. In 1916 Chevrolet acquired control of General Motors and Durant became president of General Motors. From the General Motors Co. he created the General Motors Corp. and launched a large and successful expansion program. Difficulties encountered after World War I resulted in his being again forced out of General Motors in 1920. He then formed a new enterprise, Durant Motors, Inc. His later ventures, some of which were very large, were not generally successful. He died in New York city, March 18, 1947. (H. J. Sc.)

DURANTE, FRANCESCO (1684–1755), Italian composer of religious and instrumental music, known chiefly as a teacher, was born at Frattamaggiore, in the kingdom of Naples, on March 31, 1684. The details of his early life and musical education are obscure, but he probably received his training at one of the Naples conservatories, and later may also have studied in Rome. All that is known for certain is that he taught at San Onofrio conservatory for a short time in 1710. From 1728 to 1739 he was *maestro di cappella* at the Conservatorio dei Poveri in Naples, from 1742 he taught at Santa Maria di Loreto conservatory, and in 1745 he succeeded Leonardo Leo as principal teacher at San Onofrio conservatory. There was much rivalry between his pupils and those of Leo, but Durante's pupils became the more renowned. They included Niccolo Jommelli, Giovanni Paisiello, G. B. Pergolesi, Nicola Piccinni and Leonardo Vinci. Durante died on Aug. 13, 1755, at Naples.

Many motets, several masses, at least three oratorios, a Pastoral Mass for four voices and the Lamentations of the prophet Jeremiah are among his more important settings. He also composed some harpsichord pieces and eight concertante quartets for strings. (Cs. Ch.)

DURÃO, JOSÉ DE SANTA RITA (*c.* 1737–1784), Brazilian poet, was born in the parish of Cata Preta, near the boundary of Minas Gerais, Braz., probably in 1737, though some authorities place his birth within the years 1718–22. He received his early education at the Jesuit college in Rio de Janeiro, and in 1756 obtained the degree of doctor of theology from the historic University of Coimbra, Port. Two years later he entered the Gratian convent of the Order of St. Augustine. Famous already as a preacher, he offended his superiors by his liberality of thought, and particularly by his openly expressed regard for the proscribed Jesuits. In consequence he was forced to leave the country. He was detained in Spain as a spy in 1762, but was released in the following year, and then went to Rome, where he became acquainted with Alfieri, Pindemonte, Casti and other literary men of the time. In 1778 he returned to Portugal to accept the chair of theology at the University of Coimbra, and at the opening of the university for the year delivered an address in Latin, *De sapientia*, which marked him as one of the foremost intellectuals of his day. He soon retired, however, to the Gratian convent, and became its prior. In 1781 he published in Lisbon his great epic *Caramúru: poema épico do descubrimento da Bahia*, a poetic treatment in ten cantos of the discovery of Bahia (southern Brazil) by Diego Alvarez. This is one of the masterpieces of Brazilian literature, and is remarkable especially for the beauty of its descriptions of South American scenery and Indian life. Failure of the poem to command instant recognition embittered its author, and he burned most of his other works. A French translation of *Caramúru* appeared in 1829. He died in Lisbon on Jan. 24, 1784. (W. B. P.)

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DURATION AND TIME are abstract terms covering a wide range of facts of experience: the fact, for instance, that one thing, state or event lasts longer or shorter than another; or that it comes so much before or after another; or that it has existed, or will exist, or actually exists. Such facts (and a great many others like them) may be called temporal facts, and the notions and expressions that are used to deal with them may be called temporal notions and expressions. The interest of such notions and expressions is that, while they function quite smoothly in ordinary talk and thought, they readily give rise to profound puzzlements when looked at from the more detached standpoint of philosophy. But while older philosophers thought that such difficulties pointed to some radical inadequacy in our temporal notions (or even to some contradiction in the nature of things), many 20th-century philosophers, in particular those influenced by Ludwig Wittgenstein, tend to hold that most of these difficulties have their origin in a misunderstanding and abuse of the normal working of temporal notions and expressions.

Problems in Regard to the "Absolute" or "Relational" Character of Time.—A large amount of our discourse concerning temporal facts is in terms of "times," which are spoken of as if they were entities independent of the things or events which "occupy" or "are present in" them. Thus one might say that a certain time was filled with stirring events, that it was the time of the young Wordsworth and of André Chénier, etc. It also seems proper to say that a time that we pick out by means of the demonstrative adverbs "now" and "then," might quite well have been filled with other contents than the ones that actually occupied it. Furthermore there are facts of experience that would readily be described in terms of empty or unoccupied time intervals, though we should probably hesitate, on reflection, to allow them to be wholly empty. Such modes of speaking readily develop into a metaphysic of "absolute" or substantival "times," which then become the subjects of our predications of duration, succession, futurity, etc., such predications only being made derivatively of other things, inasmuch as they occupy such absolute "times." Such a metaphysic must, however, lead to unhelpful complications, since whatever can be said in terms of it can be as well said without employing substantival phrases: one might say, for instance, that Wordsworth was alive when André Chénier was alive, or that the two men were contemporaries. It is plain, further, that we can attach no meaning to the passage of wholly empty "times," nor to a difference of "times" which is unrepresented in a difference of events and their relations. Talk in terms of "times" may therefore be regarded as a misleading substitute for talk which employs adjectives, adverbs and prepositions of time: events and things then become our only seriously acknowledged subjects of temporal predications. Historically the absolute view of time is associated with Newton and his disciple Samuel Clarke, whereas its criticism is associated with the name of Leibniz.

Problems in Regard to the Division of Time.—There is hardly any definiteness, in ordinary usage, as to what may be regarded as a single state, happening or time, a length that could be covered by one application of the demonstratives "now" and "then." A word, a sentence, a course of lectures, a century, a geological age can all be said to be running their course now, to be comprehended within a single time. If, however, we consider states, happenings and times of some length, we find that they can always be split up into shorter states, happenings and times; and we find also that, as we proceed to shorter sections, we can specify positions, speeds, qualities, etc., more precisely. The notion therefore readily arises of a strictly momentary state or time, one so short as not to admit of further division and to involve the most perfect specification of position, quality, speed, etc. Such a notion has an approach to exemplification in the temporal minimum discernible, a time which could not further be reduced without sink-

ing below the threshold of discernibility. But there remains always, even in such a minimum, a suspicion of variety or diversity: thus the briefest of glimpses may reveal movement. It is therefore necessary to place what is strictly momentary beyond the limits of possible experience and to say, further, that every happening of some length involves an infinite number of such momentary states, none of which comes next after any other. But if we treat such strictly momentary states as events in the same sense as events which take time, we are at once involved in antinomies. We may wonder, for example, how events and processes which have length can be made up of states which have no length (one of the chief worries of St. Augustine—*see* his *Confessions*, book xi); or how continuous processes can be composed out of elements which are wholly disjoined from one another; or how it is possible to pass from one such momentary state to another, if one has first to pass through an infinity of intermediate states (the basic difficulty involved in the paradoxes of Zeno). Such antinomies can be removed by jettisoning the notion of a strictly momentary state, or by giving it a variable and contextual interpretation, or by replacing it by some physical minimum of duration which is not strictly momentary. One may also remove it by interpreting moments in terms of the "abstractive sets" of A. N. Whitehead; *i.e.*, infinite classes of events fitting into each other in Chinese-box fashion and not converging to any minimal event, although their properties converge to a limiting definiteness. One may also deal with it after the fashion of Henri Bergson (*q.v.*), who distinguishes duration, or time as it is actually "lived through," from time abstractly conceived as a series of discrete instants or moments: with duration, "the past gnaws into the future and swells as it advances" (*Creative Evolution*, Eng. trans., 1912), whereas time abstractly conceived breaks itself up into a series of cinematographic "stills." The former is also the datum of an undistorting "intuition," whereas the latter represents an attempt, on the part of a measuring and merely practical intelligence, to assimilate time to space.

Problems in Regard to the Temporal Modalities.—Very severe difficulties have arisen in regard to the temporal modalities of futurity, presentness and pastness, as well as with the passing of events out of one of these categories into another. We have to use a future tense for speaking of events and times that follow the occasion of speech, a present tense for speaking of events and times that overlap it and a past tense for events and times that precede it. Moreover, our reference of events to these several categories constantly changes and may even change within the limits of a single experience (as when we watch a horse coming up to, passing, and going on beyond the winning post). The fact, however, that what can at one time be spoken of in a present tense must at other times be spoken of in a past or in a future tense readily assumes the appearance of a contradiction, and this appearance has led to many philosophical rejections of change, culminating in the ingenious arguments of J. M. E. McTaggart. These, in attempting to show that there is an irremovable contradiction in attributing futurity, presentness and pastness to the same event (because the times in which it shares in these modalities themselves change in temporal modality), really only bring out the impossibility of fitting changing temporal modalities into a scheme of speech which assumes that what is true at one time must also be true at every time. The many difficulties connected with changing temporal modalities have led to views which regard them as "representing nothing in the facts" and as reflecting only the irrelevant standpoint of the speaker; they have also led to attempts to state the same facts in various unchanging tenseless forms of speech. It may be objected to all such schemes that the distinctions represented by the temporal modalities are so all-important for knowledge and practice—we cannot, for instance, give a satisfactory sense to the notion of controlling the past and perhaps not to that of completely foreseeing the future—that nonsense is likely to result if they are obscured in our language.

For the questions about time raised by modern physical theory, *see* SPACE-TIME.

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DURAZNO, a department bounded by the Negro and Yi rivers in central Uruguay. Pop. (1954 est.) 110,729; area 4,710 sq.mi. Mostly ranching country, in the early 1960s there were more than 500,000 cattle and 2,000,000 sheep in the department. Many of the ranches are huge, critics say excessively large. Agriculture is limited; some cereals and forage crops are grown. The departmental capital, Durazno (San Pedro de Durazno; population [1954 est.] 23,200), is a commercial and livestock-trading centre. (M. I. V.)

DURAZZO, the Italian, and conventional, form of the name of the principal seaport of Albania, DURRËS (*q.v.*). The Albanian name is now internationally recognized. It derives from the name Dyrrachium given by the Romans to the existing port of Epidamnus, founded by Greeks in the 7th century B.C.

D'URBAN, SIR BENJAMIN (1777–1849), British general and colonial administrator, chiefly remembered for his controversial frontier policy in South Africa. He entered the army in 1793 and saw varied service in the Napoleonic Wars. In the Peninsular War he distinguished himself as quartermaster general to Lord Beresford. In 1820, when he had attained the rank of major general, he was appointed governor of Antigua. There, and at Demerara and Berbice, where he was transferred as governor in 1824, Sir Benjamin seems to have assimilated the planters' views in the matter of slave amelioration and emancipation. In 1831 he became the first governor of the newly formed colony of British Guiana.

D'Urban arrived at the Cape of Good Hope (*q.v.*) as governor and commander in chief in Jan. 1834. Instructed by the colonial office, then under the influence of the humanitarians, to devise a new policy for the eastern frontier, the governor found the situation complicated by the beginnings of the Great Trek, the organized exodus of Dutch farmers away from the eastern districts of the colony. He also had to put into operation a new crown colony constitution for the Cape and supervise the local application of the Slave Emancipation act. In Dec. 1834 there began the most serious incursion of the colony by the Xhosa which had yet occurred in the course of the so-called Kaffir Wars. With the assistance of Col. (later Sir) Harry Smith, D'Urban expelled the invaders and in May 1835 annexed to the crown, as the province of Queen Adelaide, the region between the Keiskamma river (which was near the existing colonial boundary) and the Great Kei, threatening to expel the tribes "for ever" beyond the latter river. As this proved impossible of execution, Sir Benjamin produced four months later a revised settlement, allowing the natives, under certain conditions, to remain in the territory. D'Urban postponed communicating this revision to Lord Glenelg, the colonial secretary, who, having had to rely for information mainly on missionary sources, caused the abandonment of D'Urban's annexed province in 1836, to the disgust of white farmers in the vicinity. Recalled in May 1837, the governor finally vacated his office in Jan. 1838. He had been popular with the colonists, but the dilatoriness and lack of clarity of his dispatches to England vitiated his work.

In 1847, as lieutenant general, D'Urban assumed command of the imperial forces in Canada. He died at Montreal on May 25, 1849. Durban, the chief seaport of South Africa, is named after him. (L. M. Y.)

DURBAN, the chief seaport of the Republic of South Africa, is the largest city in the province of Natal and the third largest in southern Africa. It is situated on the southeast coast overlooking the Indian ocean, 1,094 mi. E.N.E. of Cape Town by road and 7,019 nautical miles from London by the west-coast route (7,785 nautical miles via Suez). City pop. (1961) 655,370 (194,276

Europeans). Warmed by the southward Mozambique current and within 30° of the equator, Durban has a subtropical climate. The mean annual temperature is 69° F. with comparatively small daily and annual ranges. The mean temperatures for July and January are 61.9° and 74.7°, with a mean minimum of 43.7° for July and a mean maximum of 87.3° for January. In the winter season (especially May to August) the climate is brisk and sunny; the summer months are hot and humid. Of the average annual rainfall of nearly 40 in. only about 30% falls in the six months from April to September; the annual average of rainy days is 117.

Situated between the Umgeni and Umlaas rivers, the city stands on alluvial ground which rises inland to 400–500 ft. at the Berea ridge. On the south a green-clad sandy ridge called the Bluff separates the sea from the harbour bay, a roughly circular expanse of former lagoon 6 sq.mi. in area. Northward the Bluff is separated by a 600-ft. entrance channel from the Point, a low sandspit which is chiefly a dock area. The main business area is laid out north and northwest of the harbour. Along the ocean frontage behind lawns and ornamental gardens stand modern hotels and blocks of flats, with open sandy bathing beaches stretching northward to the Umgeni. Durban is a favourite holiday resort of South Africans and Rhodesians.

The main thoroughfare is West street, named after the first governor of Natal and running inland from the Marine parade. Parallel to it is Smith street and between the two stands the handsome domed city hall with library, art gallery and museum. Nearby are the new government buildings and the general post office, which was formerly the town hall. There, in 1908–09, was held the national convention which led to the Union of South Africa. To the north of the city hall are the main railway station and the Old Fort (1842) and beyond them the Greyville racecourse on which is held South Africa's premier horse race, the July handicap.

On the Esplanade fronting the north shore of the harbour stand the law courts. In St. Andrew's street the Natal Settlers Old House museum is a replica of an early homestead that stood on the site. A short distance northward is the Gothic-style Roman Catholic cathedral, beyond which lie the colourful Indian and Bantu markets. The belt at the foot of the Berea is occupied largely by Asians and the buildings show oriental influences.

The central residential area for Europeans is the Berea, where pleasant houses with shaded *stoeps* stand along tree-lined roads. In 1961 large housing projects for the nonwhite population, including the 18,000,000-rand Kwa Mashu township for Bantus, were in course of construction. Durban is known to South Africans as "the garden city" and its flowering trees are a striking feature—red flamboyant, blue jacaranda, yellow cassia and rich scarlet Kaffir boom. Parks and open spaces include the Medwood gardens opposite the city hall and Albert park overlooking the harbour. The Snake park near the sea front contains many kinds of snakes in near natural conditions. The Ocean aquarium (1959) contains an outstanding collection of Indo-Pacific fishes and of sharks, rays and skates. On the Berea are Jameson and Mitchell parks, with aviaries and indigenous trees in which monkeys are often seen and the 50-ac. botanical gardens with a herbarium and a fine collection of trees, ferns and palms.

The University of Natal is established in Durban and Pietermaritzburg (56 mi. N.W.). Its faculty of medicine in Durban trains nonwhite students. Attached to the university are various research institutes. There are primary and secondary schools.

Communications, Trade and Industry.—Bus services connect the city with the suburbs and with Pietermaritzburg. Durban is linked with all parts of South Africa by railway and by national highways. The Louis Botha international airport is at Reunion, 8 mi. S.

Durban is the only port on the coast between East London and Lourenço Marques in Mozambique and is the nearest in the republic to the mining and industrial regions of the Rand and northern Orange Free State. The port has more than 30,000 ft. of quays with fueling facilities and modern appliances, especially for bulk cargoes (grain, coal, fertilizers, fuels), and a separate fish wharf. A number of powerful tugs are equipped for salvage. There are ship-repair facilities and a 4,000-ton floating dock as well as a large dry dock. Cargo handled annually amounts to more than 8,000,000 tons. The main exports are ores and minerals, grain, sugar, coal, wattle bark, wool and hides; the main imports, petroleum fuels, general cargo, timber and grain.

Industrial development increased rapidly after World War I and by 1960 the gross manufacturing output exceeded 400,000,000 rands (£200,000,000) annually. Durban is the headquarters of the South African sugar industry and has important manufactures of textiles, soap, rubber, fertilizers, paint and food products. Oil refineries are situated on the Bluff, which also has a whaling station. The railway workshops employ more than 4,000 workers.

History.—What is now Durban bay was named Port Natal by Vasco da Gama because he sighted it on Christmas day, 1497. Following a visit by the brig "Salisbury" seeking shelter from a gale in 1823, a landing was made in 1824 by Francis G. Farewell, John S. King and Harry Francis Fynn, accompanied by a band of pioneers who formed the nucleus of Natal colony. Farewell secured the cession of a strip of coast from the Zulu despot Chaka, who in 1828 made a further cession which included the present site of Durban. There followed a troubled period in which the tiny settlement was gradually consolidated as a British outpost. In 1835 it was visited by the missionary and former naval officer Allen Francis Gardiner, who intended to conduct a mission to the Zulus; its white population was then about 35. On June 23 Gardiner presided over a meeting of 15 settlers which decided to lay out the streets of a town to be named after Sir Benjamin D'Urban, governor of Cape Colony.

Durban grew and prospered despite troubles with the Zulu leader Dingaan and quarrels between the British and the Trek-Boers. The Boers proclaimed the area the "Republic of Natalia" and in 1842 besieged the British garrison of about 300 men under Capt. T. C. Smith in the Old Fort. Dick King, one of the settlers, escaped from the fort and with a Zulu outrider rode 600 mi. in ten days to fetch help from Grahamstown; he is commemorated by an equestrian statue on the Esplanade at the foot of Gardiner street. Natal was proclaimed British territory in 1843 and Durban was granted its seal of incorporation as a borough in 1854; in 1935 it was created a city. *See* also NATAL. (P. R. SU.)

DURBAR (Persian and Urdu, DARBAR), a term used in India for a court or levee. A durbar may be either a council for administering affairs of state or a purely ceremonial gathering. In the former sense the Mogul emperors of India received visitors and conducted business in durbar. In the latter sense the word came to be applied to great ceremonial gatherings like Lord Lytton's durbar for the proclamation of the queen empress in India in 1877 or the Delhi durbar of 1911, held to celebrate the accession of George V.

DÜREN, a town of Germany which after partition of the nation following World War II was included in the *Land* (state) of North Rhine-Westphalia of the Federal Republic of Germany. It lies on the Rur, on the northwestern slopes of the Eifel hills, 37 km. (21 mi.) W.S.W. of Cologne by road. Pop. (1950) 35,234; (1959 est.) 47,094. Destroyed in World War II, the town has been largely rebuilt. It produces paper, metal goods, cloth, carpets, felt, glass, sugar and chemicals, exported throughout the world.

Düren, a Frankish settlement first mentioned in 748, grew from Pepin's Villa Duria. Charlemagne held diets and church assemblies there and it was the base for several of his Saxon campaigns. Fortified about 1200, it became a free city. The emperor Frederick V gave it in pledge (never redeemed) to the dukes of Jülich. In 1543 it was destroyed in a war between Duke William V of Jülich and Emperor Charles V and later rebuilt. (J. E. G.)

DÜRER, ALBRECHT (1471–1528), the greatest German Renaissance painter, engraver, woodcut and decorative designer as well as author of a number of theoretical works, was born in Nürnberg on May 21, 1471. He was the second son of the goldsmith Albrecht Dürer, the elder (1427–1502), who had left Hungary to settle in Nürnberg in 1455.

Dürer began his training in the goldsmith's workshop of his father, who in 1486 sent him for four years to the painter and

woodcut illustrator Michael Wolgemut. His years as a journeyman from 1490 to 1495 probably took the young artist first to the Netherlands and then in 1492 to Colmar in Alsace. There he found that Martin Schongauer, the leading German graphic artist of the time, was no longer alive; however, several of Dürer's drawings from the time immediately preceding his travels bear signs that he had already seriously studied the work of Schongauer. In the same year, 1492, Dürer went to Basel; during 1493 or 1494 he was for a short time in Strasbourg, returning again to Basel. At the end of May 1494 he returned to Nürnberg, where on July 7, 1494, he married Agnes Frey, the daughter of a merchant. There were no children of this marriage, and Agnes died on Dec. 28, 1539. In the autumn of 1494 Dürer seems to have undertaken his first voyage to Italy, where he remained, mostly in Venice, until the spring of 1495.

Between 1494 and 1496 Dürer produced a large number of drawings, mainly based on engravings from northern Italy, with which he may have been acquainted already before this journey to Italy. Some are based on Andrea Mantegna (Winkler 59, 60; 1494, Vienna); 20 follow the so-called Tarocchi di Mantegna (Venetian engravings from about 1460 based on Ferrarese drawings; W 122–141), which had already been used by Dürer's teacher Wolgemut. The "Dying Orpheus" which originated from one of the Tarocchi engravers inspired Dürer to a free re-creation (drawing of 1494 in Hamburg, etching Bartsch 73). Among the masters from central Italy, apart from Lorenzo di Credi (drawing, 1495, in the Louvre, Paris, W 84), it was Antonio Pollaiuolo who interested the young Dürer most. He copied this artist's "Rape of Women" (1495, Bayonne, W 82) and freely adapted his Hercules from the "Rape of Deianira" (New Haven, Conn.) for his painting of "Hercules and the Birds of Stymphalis" of 1500 (Nürnberg). In the Job from the Jabach altarpiece one finds echoes of Giovanni Bellini, while the centre panel from the Dresden altarpiece (1498?) betrays Lombard influences (Bramantino).

Eleven years later, in the autumn of 1505, Dürer again went to Italy, where this time he remained until the spring of 1507. Once again he spent most of his time in Venice. Of all the Venetian artists, he most admired the old Giovanni Bellini (letter to W. Pirkheimer of Nov. 7, 1506), and the pictures of men and women from this Venetian period reflect the portrait types specially favoured by Bellini, while the compressed half-length composition of the "Young Jesus With the Doctors" of 1506 (Rome) harks back to Mantegna's "Presentation in the Temple" (Berlin), which Bellini had freely recreated. Those works of Dürer which clearly grew out of recollections of Italian models that particularly impressed him during this second visit to Italy mainly point in the direction of Mantegna and Bellini.

"The Assumption of the Virgin," the centre panel from the Heller altarpiece of 1509 recalls Mantegna (compare with the "Transfiguration of the Virgin Mary" from S. Agostino degli Eremitani in Padua, which, according to K. Gerstenberg, also inspired Dürer's woodcut B 88 from the "Life of the Virgin," depicting a man clasping a pillar). Echoes of Venetian triptychs (compare in particular the altarpieces by B. Vivarini and Giovanni Bellini of 1487 and 1488 in the church of the Frari at Venice) can be found in the side panels, each depicting two saints, from Dürer's Jabach altarpiece (Munich, executed by H. L. Schäufelein?), in the grisailles from the Heller altarpiece (Frankfurt, executed by Hans Dürer?) and in the so-called "Four Apostles" of 1526 (Munich). Toward the end of his second Italian journey Dürer, according to F. Winkler, spent a further two or three weeks in Ferrara and Bologna, where the works of Cosimo Tura and Marco Zoppo impressed him most strongly.

By Feb. 1507, at the latest, Dürer was back in Nürnberg. Between 1512 and 1519 he worked mainly for the emperor Maximilian I, and from 1515 he received a fixed yearly salary of 100 guilders from the court. In the same year Dürer and Raphael exchanged works.

Between the summer of 1520 and that of 1521 Dürer, with his wife, traveled along the Rhine and through the Netherlands, arriving in Antwerp on Aug. 2, after which he visited Brussels, Mechelen and Aachen, where, at the coronation of Charles V on Oct. 23, Dürer met Matthias Grünewald and presented him with several etchings. Dürer returned to Antwerp via Nijmegen and Cologne, remaining there until the summer of 1521. He maintained close relations with the leaders of the Netherlands school, Lucas van Leyden, Quentin Massys, Jan Provost and Bernaert van Orley, all of whom received him magnificently. In Dec. 1520 Dürer visited Zeeland, and in April 1521 he traveled to Bruges and Ghent, where he saw the works of the brothers van Eyck, of Rogier van der Weyden and Hugo van der Goes, as well as the Michelangelo Madonna.

On July 12 the travelers were back in Nürnberg and, from this time onward, Dürer's health began to decline. He devoted his remaining years to theoretical writings and on April 6, 1528, he died and was buried in the churchyard of St. John in Nürnberg.

Dürer's earliest known work is his self-portrait at the age of 13, now in Vienna (silverpoint drawing, 1484). After this talented youthful drawing comes the composition of a "Madonna With Angels" of 1485 (pen drawing, Berlin) which is already a finished work of art in the late Gothic style. The drawing of Dürer's father, in Vienna, can be dated 1486, and in 1490 comes as his earliest painting the portrait of his father, now in Florence, which heralds the familiar characteristic style of the mature master. Against this, the first authenticated woodcut of "St. Jerome in the Wilderness," which appeared in Basel in 1492, seems somewhat ungainly and archaic. Among the Basel book illustrations which later research has ascribed to the young Dürer (the "Comedies of Terence"—drawings on wood blocks; "The Knight of Thurn," 1493, and "The Ship of Fools," 1494—woodcuts) there can be found certain stylistic affinities with the authenticated, and in general more mature, drawings from the years 1493–95. An early masterpiece is the self-portrait with thistle painted on parchment in 1493 (Paris). Several small religious paintings (in Dessau and Karlsruhe) also belong to the period of Dürer's travels. A number of bold water colours dealing with subjects from the Alps of the southern Tyrol are generally linked with Dürer's first journey to Italy in 1494–95, though one or two of the aquarelles may well refer to the second Italian journey of 1505–07.

Between 1495 and 1500, certain stylistic vacillations still remained to aggravate the task of assigning dates and authorship to Dürer's works. A number of important paintings are known in copies only, such as the portrait of Dürer's father (copies in Munich, Syon house, near London and Frankfurt); another is a "Girl in Prayer" (Augsburg, Frankfurt; variant in Budapest) and a "Portrait of a Young Girl" (Lüzschena, Paris) which are all supposed to portray a member of the Nürnberg family of Fürleger. On the model of the "Girl in Prayer," there is also an original tempera by Dürer (Bibliothèque Nationale, Paris). Considerably more rigid and archaic than this last is the portrait of Federick the Wise in Berlin, which must have been painted about 1496. A year later, Dürer painted another self-portrait (now in Madrid). The much more expressive Dresden altarpiece is generally also ascribed to about 1498 and it is difficult to reconcile this with the "Lamentation of Christ," painted for the Holzschuher family (Nürnberg), which by some scholars is also ascribed to the year 1498. On the other hand, stylistically equal with the Dresden altarpiece is the "Hercules and the Birds of Stymphalis," as well as a number of mostly early copperplate engravings (among them the "Prodigal Son," B 28; the "Penitence of St. Chrysostom," B 63; the "Eumenides," B 75, dated 1497; the "Dream," B 76; the "Sea Monster," B 71; "Hercules," B 73, and "St. Eustace," B 57). In 1498, beside some individual woodcuts, Dürer completed his first great cycle of woodcuts, the "Apocalypse," to the 15 pages of which he added a title page in 1511. At the same time he began the cycle of the "Great Passion," completing the first five pictures in 1499 and the remainder in 1510.

Not until 1500 did Dürer's restless striving find a definite direction. Firm ground is achieved in the penetrating half-length portraits of Oswolt Krell (Munich), in the three members of the Tucher family (Weimar and Kassel)—all dated 1499—and in the "Portrait of a Young Man" of 1500 (Munich). In the same year Dürer painted a new self-portrait (Munich), which in its austere and completely symmetrical full-face position doubtless recalls

memories of Italy. The two engravings B 96 and B 97 (1505) show Dürer recalling Italian equestrian statues—a horse in exact profile and another seen from the rear—a favourite subject of the early Italian Renaissance. In the engraving "Adam and Eve" (1504) Dürer expresses the essence of his classical experiences. The grisailles of the "Green Passion," notable for their large-scale composition (Vienna and Florence) and the opening pages of the "Life of the Virgin," the most supple of his graphic cycles, also belong to this period.

Among paintings which should be ranked with these classical endeavours are the Paumgärtner altarpiece, the symmetrical, pyramidal construction of the "Glimm Lamentation" (both in Munich) as well as the "Altar of the Three Kings," executed with the help of pupils (Florence, Frankfurt, Cologne, Munich; reproduction in its entirety by H. Musper, 1952, p. 146).

In Italy, Dürer painted among other things the formal and magnificent "Festival of the Rose-garlands" for the church of St. Bartholomew (1506, Prague), the "Virgin With the Siskin" in a similar vein (Berlin) and the more expressive Mantegna-like "Young Jesus With the Doctors," three charming portraits of women (Berlin and Vienna) and two heads of youths (Hampton court, London and Vienna) in the Venetian style.

Among the paintings belonging to the period after the return from Italy, the "Martyrdom of the Ten Thousand," painted for Frederick the Wise in 1508 (Vienna), and the "Adoration of the Trinity," apparently inspired by the peak of Italian Renaissance, 1511, Vienna are both crowd scenes whose failure is in varying ways due to the intractability of the design. The problem of crowd composition is solved more successfully in the "Assumption of the Virgin" (only known through a copy) from the Heller altarpiece in Frankfurt (1508–09), which again bears signs of Mantegna's influence. The drawings for this picture betray Dürer's striving after classical perfection of form through sweeping lines of drapery of graphic simplicity and plastic firmness. Even greater simplicity and grandeur characterize the disputed "Madonna With the Iris" (traditionally dated 1508; examples in London and Prague), the diptych of "Adam and Eve" (1507, Madrid with a variant in Florence) and the "Holy Family," in half-length figures painted in 1509 and reminiscent of Mantegna (Vierhouten).

Between 1507 and 1513 Dürer completed the "Passion" in copperplate engravings, and between 1509 and 1511 the "Little Passion" in woodcuts, both of which are characterized by their tendency toward spaciousness and serenity. During 1513 and 1514, Dürer created the greatest of his copperplate engravings, the "Knight, Death and the Devil," "St. Jerome in his Study" and "Melancolia." To the same period belongs Durer's most expressive portrait drawing—that of his mother (Berlin).

The marginal drawings for the prayer book of the emperor Maximilian (Besançon) and a number of etchings in iron done between 1515 and 1518 proclaim Dürer's complete mastery of the medium as well as his freedom of imagination. These improvisations form a pleasing contrast to the monumental woodcuts, overloaded with panegyrics, made for Maximilian: the "Triumphal March" of 1515 which, according to M. J. Friedländer, was completed by Hans Springinklee to Dürer's specifications, and the "Triumphal Car," which appeared in 1522. Beside a number of formal show pieces ("Lucretia," 1518, in Munich, two portraits of the emperor, 1519, in Nürnberg and Vienna, also as woodcuts B 153, 154), there also belong to the second decade a number of more improvised paintings of considerably greater charm.

The sketchbooks of the Netherlands journey of 1520–21 contain immensely detailed and realistic drawings. Some paintings which were created either during the journey or about the same time seem spiritually akin to the Netherlands school, such as the portrait of Anna Selbdritt (New York), a half-length picture of St. Jerome (1521, Lisbon) and the small portrait of Bernaert van Orley (Dresden). These are followed by a succession of famous character portraits, such as the following paintings: Hans Imhoff (W. Pirkheimer, Madrid), an Unknown Man (1521, Boston) Hieronymus Holzschuher, Jacob Muffel (both dating from 1526, Berlin), and some important portrait engravings and woodcuts.

BY COURTESY OF KUPFERSTICHKABINETT, BERLIN, GER.

"PORTRAIT OF THE ARTIST'S MOTHER." A CHARCOAL DRAWING BY ALBRECHT DÜRER. IN THE MUSEUM DAHLEM, BERLIN

The so-called "Four Apostles" (St. John, St. Peter, St. Paul and St. Mark) of 1526 in Munich must be counted as the last of Dürer's important paintings.

Among Dürer's various scientific drawings and engravings, the woodcuts such as B 151 and 152 are commissioned works. The two woodcuts B 137 I and II belong to the sketches which Dürer made for his own *Treatise on Fortification* (M. Thausing). Among Dürer's theoretical writings, his *Treatise on Mensuration with the Compasses and Ruler in lines, planes and whole bodies* first appeared in Nürnberg in 1525. *The Treatise on Fortification* appeared in Nürnberg in 1527 under the title *Instruction on the Fortification of Cities, Castles and Towns* with a woodcut illustration. The *Treatise on Proportions* ("herein are comprised four books on Human Proportion") with woodcut illustrations B 146 and 147 (1525) appeared in Nürnberg posthumously in 1528.

See also references under "Dürer, Albrecht," in the Index volume.

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D'URFEY, THOMAS (*c.* 1653–1723), English dramatist, satirist and writer of songs, some of which remained popular until the 19th century, was born in Devonshire, possibly at Exeter,

and is believed to have been related to Honoré d'Urfé, author of the famous pastoral romance *L'Astrée*. His first comedy, *Madam Fickle* (produced 1676), won the favour of Charles II, whom he also entertained as jester and singer, and 11 of his comedies were produced in London between 1677 and 1688. In 1689 he wrote an epilogue for Purcell's *Dido and Aeneas* and during 1690–91 edited a satirical weekly, *Momus Ridens*. In 1691 he produced *Love for Money,* a comedy anticipating the style of Colley Cibber. He had a light touch in dealing with topical subjects in satirical verse directed against the Whigs and was patronized by the nobility and, more cautiously, by James II. He changed his allegiance on the accession of William and Mary, by whom he was also favoured, and delighted Princess Anne with a poem maliciously satirizing the aged electress Sophia, her rival as heir to the throne. His last play to be produced was *The Modern Prophets* (1709), for which Pope wrote a prologue. He died in London, where he was buried on Feb. 23, 1723.

Tom D'Urfey was an attractive person despite his grotesquely exaggerated features and the stammer which he overcame only when singing or swearing, and was a friend of Addison, Steele and many other writers and musicians. Of his 32 plays, the best were the comedies, in which crowded, complicated plots are carried forward by lively dialogue, and which sometimes anticipate 18th-century sentimental comedy. He also wrote nearly 500 songs, several of which were incorporated in contemporary ballad operas. John Blow, John Eccles and Jeremiah Clarke were among the many composers who set his words to music. He wrote texts for works by Purcell, notably the ode, "The Yorkshire Feast Song," and Purcell wrote incidental music for eight of his plays.

BIBLIOGRAPHY.—D'Urfey's first collection of songs was *A New Collection of Songs and Poems* (1683); later songs were collected in the first 2 vol. of the 5-vol. *Songs Compleat, Pleasant and Divertive* which he edited in 1719. C. L. Day, *The Songs of Thomas D'Urfey* (1933) includes a biography. *See* also R. S. Forsythe, *A Study of the Plays of Thomas D'Urfey* (1916); C. L. Day, *Dates and Performances of D'Urfey's Plays* (1950).

DURFORT, a French noble family that rose to great distinction in the 17th and 18th centuries. Bearers of the name are recorded from the 11th century, but it is uncertain whether the original seat was Durfort near Narbonne or Durfort in Quercy. Durfort in Quercy, however, was the seat of ARNAUD DE DURFORT (fl. 1305). This Arnaud married a niece of Pope Clement V, from whose brothers his descendants inherited much property, including the fief of Duras. GAILLARD IV DE DURFORT (d. 1487), of the fifth generation after Arnaud, went to England in 1453 and became a knight of the Garter but returned to France in 1476.

GUY ALDONCE I DE DURFORT (1605–65), marquis de Duras, of the fifth generation after Gaillard, married Élisabeth de La Tour d'Auvergne, the marshal de Turenne's sister. Of their eight sons, three became famous: JACQUES HENRI I (*c.* 1625–1704), marshal of France in 1675 and duc de Duras in 1689 (he is known as the marshal de Duras); GUY ALDONCE II (1630–1702), comte de Lorges, marshal of France from 1676 and duc de Quintin from 1691, who commanded the army in Germany from 1690 to 1695 (the marshal de Lorges); and LOUIS (d. 1709), who made his name in the English service, becoming earl of Feversham in 1677.

Jacques Henri's second son, JEAN BAPTISTE (1684–1770), duc de Duras, became marshal of France in 1741, as did his son and successor, EMMANUEL FÉLICITÉ (1715–89), in 1775. The latter's grandson AMÉDÉE BRETAGNE MALO (1771–1838), duc de Duras from 1800, married Claire de Kersaint (d. 1828), who was prominent in the literary world under the Restoration. As they had no sons, the Duras title passed to their son-in-law, Henri Louis de Chastellux.

GUY NICOLAS (1683–1758), son of the marshal de Lorges, changed his title from duc de Quintin to duc de Lorges in 1706. His elder son, GUY MICHEL (1704–73), was made duc de Randan in 1733 and marshal of France in 1768. After his death his niece's husband, JEAN LAURENT DE DURFORT-CIVRAC (1746–1826), a distant cousin descended from a grandson of Gaillard IV, succeeded to the Lorges title, which remained with his descendants in the 20th century.

DURG (DURGA, "Fort"), a town and district in the Chhattisgarh revenue division of Madhya Pradesh, India. The town, headquarters of the district, is on the South-Eastern railway about 150 mi. E. of Nagpur. Pop. (1961) 133,371 (including Bhilai). It is an important rice market. There are a college of arts and a college of science affiliated to Saugar university.

DURG DISTRICT has an area of 7,576 sq.mi. Pop. (1961) 1,885,906. About a quarter of the district is under cultivation, and forests cover the hilly parts mainly in the northwest and southwest. In the middle of the district, 10 mi. E. of the town on the Durg-Raipur road, is Bhilai, a planned industrial township and the biggest urban centre in the district. At Bhilai is the third steel plant to be built in India under the second five-year plan (1957–61). The plant is a 1,000,000-ton project undertaken by the government of India with Soviet capital, equipment and technical assistance. Bhilai has nearly all the raw materials at hand: iron ore of excellent quality is obtained only 60 mi. to the south at Dalli Rajhara, which is approached by a railway line; water (30,000,000 to 60,000,000 gal. per day) is brought by the Tandula canal; fire clay, power and coal are supplied by the Korba coal field of Bilaspur district to the north; manganese is available in Balaghat and Bhandara districts on the west. By 1960 the third blast furnace was completed. (D. G. NA.)

DURGA, in Hindu mythology, one of the many cult titles of the wife of Shiva. Durga first appears in the epics as a name of Uma, and she may have been originally worshiped by the aborigines. Another of her manifestations is Kali (*q.v.*), and the hook-swinging rite of self-devotion is done in her honour. One of her principal festivals, as a war goddess, is the Durga-puja. Durga is pictured, in spite of her fierce nature, with a gentle face. *See* also HINDUISM.

DURHAM, JOHN GEORGE LAMBTON, 1ST EARL OF (1792–1840), English statesman who gave his name to the famous *Report on the Affairs of British North America* (1839), the "Durham report," which laid down the principles which thereafter guided British colonial policy. Born in London on April 12, 1792, he was the eldest son of William Henry Lambton of Lambton castle, Durham; his mother was Anne Barbara Villiers, daughter of the 4th earl of Jersey. Lambton succeeded to large estates when he was five years old. In 1805 he went to Eton, and in 1809 obtained a commission in the 10th dragoons (later hussars). In 1812, while still a minor, he made a runaway match with Henrietta, natural daughter of Lord Cholmondeley, whom he married at Gretna Green; she died in 1815. In 1813 he was elected to the house of commons as member for the county of Durham in the Whig interest.

In 1816 he married Louisa Elizabeth, eldest daughter of Lord Grey, and as early as 1818 he was taken into the political confidence of his father-in-law and other Whig leaders. However, Lambton belonged to the avowedly radical wing of the party with whose aims Grey had little sympathy, and when Lambton gave notice of a resolution in 1819 in favour of shortening the duration of parliaments and widely extending the franchise, he found himself discountenanced. He warmly espoused the cause of Queen Caroline. In April 1821 he made his first great speech in the house of commons on parliamentary reform, when he proposed a scheme for the extension of the suffrage to all holders of property, the division of the country into electoral districts and the disfranchisement of rotten boroughs. He was now one of the recognized leaders of the advanced liberals, forming a connecting link between the aristocratic Whig leaders and the liberals of the great towns. He supported the ministry of George Canning and, after Canning's death, that of Lord Goderich, on whose advice he was raised to the peerage in 1828 with the title of Baron Durham.

In Nov. 1830 Durham entered the Grey cabinet as lord privy seal. To ardent reformers in the country the presence in the cabinet of "Radical Jack" was a pledge that thoroughgoing reform would not be shirked by the Whigs, now in power for the first time in many years. Lord Grey gave him the task of preparing a scheme to serve as the basis of the proposed legislation. He was chairman of the famous committee of four, which met at his house in Cleveland row and drew up the scheme submitted by the government to parliament. It was Durham who selected Lord John

Russell, not then in the cabinet, to introduce the bill in the house of commons. When the deadlock between the two houses occurred over the third Reform bill (1832) he pressed on the prime minister the necessity for a creation of peers to overcome the resistance of the house of lords.

After the passing of the Reform act, Durham was sent on a difficult diplomatic mission to Russia (July–Sept. 1832). He resigned office in March 1833, ostensibly for reasons of health but in reality because of his disagreement with the government's Irish policy as conducted by Stanley (later Lord Derby; *q.v.*). In the same month he was created earl of Durham and Viscount Lambton. His advanced opinions gradually alienated the more moderate of his colleagues, and even Lord Grey often found his son-in-law intractable and self-assertive. The great banquet to Grey at Edinburgh in Sept. 1834, at which Lord Brougham (*q.v.*) made a venomous attack on Durham, touched off a dispute which raged for several weeks thereafter. The strength of Durham's position in the country was shown when a concourse of more than 100,000 persons assembled to hear him speak at Glasgow green in October. But radicalism and a difficult temper were not qualifications for Melbourne's cabinets, in which Durham found no place. He was ambassador at St. Petersburg (Leningrad) from Nov. 1835 to June 1837.

In Jan. 1838 Durham accepted the post of governor general and lord high commissioner in Canada, with the almost dictatorial powers conferred on him by an act passed in the following month by which the constitution of Lower Canada was suspended for more than two years. Having secured the services of Charles Buller as first secretary, and having appointed Thomas Turton and Edward Gibbon Wakefield (*q.v.*) to be his unofficial assistants, Durham landed at Quebec on May 29, 1838. Louis Joseph Papineau's rebellion had been quelled, but the French Canadians were sullen, the attitude of the United States equivocal and the general situation dangerous, especially in the lower province where government was practically in abeyance. Durham at once issued a conciliatory proclamation. He dismissed his predecessor's executive council and created a new and unprejudiced one. On June 28, the day of Queen Victoria's coronation, he issued a proclamation of amnesty, from which eight persons only were excepted; these were to be transferred from Montreal to Bermuda, where they were to be imprisoned without trial. Papineau and 15 other fugitives were forbidden on pain of death to return to Canada.

These proceedings were violently attacked in England by Brougham. With the exception of Lord John Russell, the ministers did not make a particularly effective defense of the public servant to whom they had promised the "most unflinching" support; the prime minister and the colonial secretary, who had signified their "entire approval," now disallowed the ordinance and allowed the passage of the Act of Indemnity, the terms of which were insulting to Durham. The latter immediately resigned, but before returning to England he put himself in the wrong by attempting a public justification of his actions. He laid his memorable *Report on the Affairs of British North America* before parliament at the end of Jan. 1839. This report, one of the greatest state papers in the English language, laid down the principles, then unrecognized, which afterward guided British colonial policy. With regard to the future government of British North America, Durham had at first inclined toward a federation of all the colonies on that continent, but as a more immediately practical policy he advised the legislative union of Upper and Lower Canada. He further urged the creation of an executive council responsible to the colonial legislature. He advised state-aided emigration on the broadest possible scale and the formation of an intercolonial railway for the development of the whole country. Meantime Durham, who almost alone among the statesmen of his time saw the importance of imperial expansion, became governor of Wakefield's New Zealand company and was thus concerned in the enterprise which forestalled France in asserting sovereignty over the islands of New Zealand. He died at Cowes on July 28, 1840.

Lord Durham's accession to supreme political power was for several years considered probable by many. His opinions were, however, too extreme to command the confidence of any considerable party in parliament. In the first Reform act, of which he was one of the chief authors, and in the famous *Report* on the principles of colonial policy he left an indelible mark on English history. His personal defects of character did much to mar the success of his career. He was impatient, hot tempered, hypersensitive to criticism, vain and prone to take offense at fancied slights, but he was also generous and unvindictive and, while he was personally ambitious, his care for the public interest was genuine and untiring.

By his first wife Durham had three daughters; by his second, two sons and three daughters. The eldest son, Charles William, the "Master Lambton" of Sir Thomas Lawrence's celebrated picture, died in 1831; the second, George Frederick d'Arcy (1828–79), succeeded as 2nd earl.

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DURHAM, a county of England bounded north along the Tyne and Derwent by Northumberland, south along the Tees by Yorkshire, west by Westmorland and Cumberland, and east by the North sea. Area of the geographical county 1,015.1 sq.mi.; population (1961) 1,517,039.

Physical Features.—The northern Pennine hills in the west, reaching 2,452 ft. at Burnhope Seat, are carved from rocks of Lower Carboniferous age and Yordale facies (rhythmically alternating limestones, shales and sandstones) which dip eastward off the Teesdale dome. These rest on Lower Paleozoic slates which, however, outcrop only in upper Teesdale. The Carboniferous rocks are intruded into by basaltic sheets and dikes of the Whin Sill suite, well exposed around High Force and Stanhope. There are also numerous mineral veins which formed the basis of an ancient lead-mining industry.

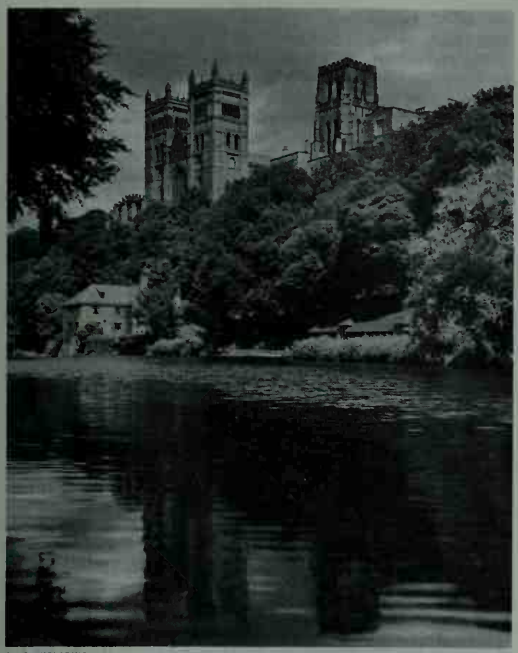
At Middleton and Wolsingham the Lower Carboniferous rocks disappear beneath Millstone Grit, replaced farther east by the overlying sandstones, mudstones and workable coals of the Coal Measures which form the central region of the county. The important east Durham coal field is partly exposed, partly concealed beneath yellow sands and Magnesian Limestone of the Permian, which make an escarpment running from South Shields to Ferryhill. The concealed basin of Coal Measures terminates southward along the Sedgefield-Hartlepool line. The low-lying southeastern part of the county is underlain by Upper Permian and Triassic rocks. A suite of Tertiary basaltic dikes associated with the Mull volcano can be seen near Egglestone and Cockfield.

Glacial deposits include boulder clay and extensive spreads of fluvioglacial sand and gravel. Evidence of Pleistocene and later changes of sea level is provided by concealed river courses like the Team Wash (the ancestral Wear), raised beaches, submerged forests and incised meanders such as the gorge nearly surrounding Durham cathedral.

The rainfall decreases sharply eastward. Temperatures are rather low; winters are cold and summers cool. In some western parts of the county frost may occur at any time of year. Spring is usually late and often extremely short.

In upper Teesdale there occur some rare flowering plants which are either confined to this area (*e.g., Viola rupestris,* the Teesdale violet; *Minuartia stricta,* the bog sandwort) or are to be found in very few other localities in the British Isles (*e.g., Potentilla fruticosa,* the shrubby cinquefoil; *Gentiana verna,* the spring gentian; *Draba incana,* the hoary whitlow grass; *Polygala amara,* the bitter milkwort).

Peat bogs and remains found in caves testify to the former occurrence of wild ox, elk, roe deer, red deer, boar and wolf. Some of these persisted until Tudor times, and the red deer re-



A. F. KERSTING

DURHAM CATHEDRAL, CHURCH OF CHRIST AND BLESSED MARY THE VIRGIN, ON THE WEAR RIVER, DURHAM, ENG.: BEGUN LATE 11TH CENTURY

mained until early in the 19th century. The black rat still maintains itself. In the 20th century the roe deer returned, with an intruder, the American gray squirrel. Similarly, after an absence, butterflies and moths such as the wall brown, the holly blue, the large skipper and the five-spot burnet re-established themselves.

History.—Evidence of early man is scarce. It would seem that the area was but sparsely populated, at least until Saxon times. Copt Hill, Houghton-le-Spring, has a barrow which shows a series of burials, the earliest of which may be Neolithic. Finds of the Bronze Age are more numerous, yet from their characteristic distribution along the river valleys, especially those of the Tyne and Wear, it may be taken that the Bronze Age invaders were more birds of passage than settlers. The Bronze Age hoard at Heathery Burn cave yielded important finds. A fine Late Iron Age sword at Barnston near Sadberge is the only evidence of Iron Age habitation.

In Roman and Romano-British times County Durham was an outpost, and the main concern of the Romans was for the safety of communications to the frontier and Hadrian's wall. Their Great North road entered the county at Piercebridge and passed through Binchester (Vinovia), Lanchester (Longovicium) and Ebchester (Vindomora) to Corbridge (Corstopitum), with a branch to Chester-le-Street (Concangium) and Gateshead (Pons Aelii) and a subsidiary branch to South Shields. There were Roman forts at Piercebridge and South Shields. The post-Roman centuries saw the county overrun by northern raiders until the Saxon settlement and the establishment of the kingdom of Northumbria. The church sites at Monkwearmouth (Sunderland), Jarrow and Escomb, near Bishop Auckland, and numerous sculptured crosses (as those at Aycliffe) are of the Anglo-Saxon period. In the 6th century Northumbria was divided into Bernicia and Deira, separated by the Tees, the latter including the district afterward known as Durham.

In the middle ages the great power exercised by the bishops of Durham as prince-bishops of a county palatine was a factor of cardinal importance in the history of the district. The origin of the palatinate goes back to an early date, certainly well before the Conquest. As early as King Alfred's time substantial grants of land had been made to the bishops, who inherited something of the prestige of St. Cuthbert (d. 687). The bishops of Durham became great feudal lords as well as ecclesiastical leaders and this, coupled with the remoteness of London and the nearness of the Scottish border, brought them political and military importance. They enjoyed great privileges—among other things the rights of holding courts of chancery, exchequer and admiralty, of appointing judges, justices of the peace, coroners and other legal officers within their diocese, of coining money in their own mint at Durham, of pardoning treasons and felonies, of holding councils similar to parliament, of granting charters to towns and of licensing fairs and markets. (All these powers would normally have been exercised by the king.) The bishops also had a great responsibility, the defense of England against invasion from Scotland. Some of them led their own armies into battle and many wielded great influence in national affairs. Between the time of the Conquest and the reign of Henry VIII about three-quarters of the bishops of Durham, including the greatest, were in fact appointed by the king, though in theory elected by the monks of Durham abbey. The palatine powers of the bishops were curtailed by the Tudors and abolished during the Commonwealth, but the palatinate was recreated at the Restoration. Many of the prerogatives were gradually lost, and the remaining powers were vested in the crown in 1836. Certain reflections of former glory still fall upon the bishop of Durham. He stands at the right hand of the sovereign at coronations (a privilege claimed and allowed on the grounds of "immemorial precedent") and takes precedence over all other bishops except those of London and Winchester.

Much of the history of Durham during, and even after, the middle ages is concerned with war. In the 13th century in particular there are repeated references to large-scale invasions of the county by the Scots, culminating in the battle of Neville's Cross, at which they were heavily defeated and their king, David Bruce, was captured. Two armed risings occurred in the 16th century. The Pilgrimage of Grace (1536) was inspired by opposition to changes being made by Henry VIII. The rising of 1569 was a struggle by adherents of the "Old Religion," always strong in the county, against the principles of the Reformation. In 1640, a breach having occurred between Charles I and the Scots, the latter, after the battle of Newburn (on the Tyne), took over the administration of the county and seized the revenues of the bishopric and the cathedral. In 1644 they were again in the county as part of the parliamentary forces.

During the 19th and 20th centuries the great change in the county was the increase in industrialization, based largely on the expansion of coal mining. Roads for the transport of coal had been introduced late in the 17th century and steam engines for draining mines early in the 18th. The first public steam passenger train in the world ran on the Stockton and Darlington railway, opened in 1825. Two well-known inventors of this period worked in the county: Sir Charles Parsons, an early inventor in the steam turbine field, and Sir Joseph Swan, who produced an electric light bulb.

Administration and Population.—The population of Durham (1951) was 1,463,868, including the county boroughs. The area of the administrative county (*i.e.*, excluding the county boroughs) is 969.5 sq.mi.; the population (1961) 953,410. The county boroughs are Darlington (pop., 1961, 84,162), Gateshead (103,232), South Shields (109,533), Sunderland (189,629) and West Hartlepool (77,073). Municipal boroughs are the city of Durham, the county town (20,484), Hartlepool (17,674), Jarrow (28,752) and Stockton-on-Tees (81,198). There are 21 urban districts and 10 rural districts. Durham is in the northeastern circuit, and assizes are held at Durham thrice yearly. There are 2 courts of quarter sessions, at Durham and Sunderland, and 18 petty sessional divisions. The county, which is in the diocese of Durham, has 274 ecclesiastical parishes and 190 civil parishes. Until 1654 the opposition of the prince-bishops prevented the return of members to parliament. The county returns one mem-

ber for each of 17 divisions. The five county boroughs and Stockton-on-Tees also return one member each, except Sunderland, which returns two.

Industries and Communications.—The agriculture of the county falls into three divisions: the western uplands, with thin soil and ill-drained peat supporting the hill sheep, the Swaledale breed predominating; the middle and lower reaches of the dales, where the traditional stock-rearing farms are found; and the lowlands in the east, lying below 500 ft., supporting intensive milk production and cash-crop farming well suited to this urbanized area. More than half the county is under either grass (including rough grazing) or crops (oats, wheat, potatoes). The Shorthorn breed of cattle originated in Durham.

The economy of County Durham is based largely on heavy industry. Of the county's working population, about one-fifth are engaged in mining and quarrying and one-eighth in engineering and shipbuilding. Other important heavy industry groups include chemicals and allied trades and metal manufacture. These industries employ mostly men, but much new employment, for both men and women, was created after 1945, through the establishment of newer and lighter industries. Of these, the manufacture of electrical goods, clothing and textiles were numerically the most important.

The main concentrations of industry are on the south bank of the Tyne (South Shields, Jarrow, Hebburn and Gateshead), the north bank of the Tees (Stockton and Billingham), Sunderland on the Wear, the Hartlepools and Darlington. The coal-mining areas are scattered, and there are important industrial centres at Consett, Bishop Auckland, Chester-le-Street and Birtley. In northwest Durham the coal, mostly coking coal, is the best of its kind in the world, but most of the important seams have been extensively worked. Reserves are limited, and exist mainly in the upper seams, where the coal is gas and steam coal. In southwest Durham the position is more favourable. Measures to deal with flooding gave a new lease of life to a number of pits. In the east of the county deeper and thicker seams are found where considerable reserves still exist, particularly in undersea extensions. Other minerals which are extracted include fluorspar, barite and witherite. Frosterley marble has been quarried for many centuries, and excellent slate is found at several places.

Shipbuilding and ship repairing are the great industries of the Tyne, Wear and Tees rivers. It is claimed that Sunderland, with eight shipyards, builds more ships than any other town in the world. The yards on the "three rivers" (including the north bank of the Tyne and the south bank of the Tees) construct about two-fifths of the annual output of new tonnage in the United Kingdom and are responsible for an even greater proportion of the total repair work. Marine engineering is an important ancillary on the south bank of the Tyne, on Wearside and in the Hartlepools.

In the iron and steel industry enormous developments took place after World War II, particularly north of the Tees and at Consett. Mechanical engineering works exist at all the main centres of industry, notably the production of railway locomotives at Darlington and mining machinery at Gateshead. The expanding electrical engineering industry is centred on Tyneside.

The chemical industry, which has its main concentrations at Billingham, also greatly expanded. In south Durham there is an extensive salt field, the brine being refined to ordinary table salt at Greatham. At Billingham are the largest chemical works in the commonwealth. Petrol (gasoline) is produced in considerable quantities, by a catalytic process. Underlying the salt field is a bed of anhydrite which is used on a very considerable scale in the manufacture of ammonium sulfate and nitrochalk for agricultural fertilizers. It is also an essential raw material in the greatly increasing production of sulfuric acid.

Extensive port facilities exist on the Tyne. On the south bank the Tyne dock has been developed to handle iron ore for Consett, and deals with the export of coal. At Sunderland a wide variety of goods is handled, including an increasing tonnage of oil and petroleum products. At Hartlepool there is an extensive timber import. Seaham Harbour is essentially a coal port. Tees-side is a rapidly expanding area, but most of the port installations are on the Yorkshire bank. The sea fisheries of Sunderland and Hartlepool are valuable.

The years of economic depression between World Wars I and II hit the county of Durham (then very heavily dependent on declining export and capital goods industries) extremely hard, and there was widespread unemployment and poverty. Misery reached a peak in 1933 when about one-third of the insured population was unemployed. The whole of County Durham was designated as a "special" area. Later, in 1945, it was scheduled as part of the North East Development area. Trading estates were established at Gateshead (Team Valley), Sunderland (Pallion) and St. Helen's Auckland to attract newer and lighter industries to the area, and some success had already been achieved when World War II broke out.

After 1945 there was a rapid increase in the number of estates and factories built. Simultaneously, there was a rapid expansion of newer industries on private sites, and many of the older industries turned to new types of production. Lighter industry includes clothing; hosiery and knitwear; light engineering; furniture and bedding; electrical equipment and radios; paint, chemicals and plastics; glass and china; cardboard and printing.

The main railway line to Edinburgh runs through Darlington, Durham and Gateshead and there are branches through the mining and industrial districts. Three main roads pass through the county from south to north. Some airfields exist and civil flying is carried out from Greatham airport near West Hartlepool.

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DURHAM, a city, parliamentary borough and the county town of Durham, Eng., 258 mi. N.N.W. of London and 16 mi. S. of Newcastle upon Tyne by road. Pop. (1961) 20,484. The nucleus of the medieval city is formed by a sharp bend of the river Wear round a rocky peninsula on which stand the castle and cathedral. Indications of an earlier settlement are to be found a short distance to the east on Maiden Castle, a plateau with steep sides bearing traces of pre-Roman fortifications, and at St. Oswald's church in the same direction, where Saxon work has been found. The only evidence of Roman occupation near the city came from the discovery of the remains of a Roman villa (later destroyed) at Old Durham. In 995 the body of St. Cuthbert, first buried at Lindisfarne in 687, was brought to Durham after two centuries of being taken from place to place in the northeast of England. The community of St. Cuthbert settled on the peninsula, a naturally strong position to which artificial fortifications were soon added. The layout of the old city has changed very little, later building being of necessity outside the fortified area.

The cathedral church of Christ and Blessed Mary the Virgin was begun in 1093 by Bishop William of St. Calais when he replaced the monks of the Saxon foundation by Benedictines. The nave, transepts and choir show typical Norman work, though the pillars bear decorations which are almost unique and the ribbed vaulting of the choir aisles is the earliest in England. The Galilee chapel, at the western end of the church, was begun by Bishop Hugh de Puiset in 1176, attempts to build a Lady chapel at the east end having failed; it is a fine example of the late Norman style and contains the tomb of the Venerable Bede. Early English work is to be seen in the eastern end of the choir which is there bounded by the Neville screen (1372–80), once bearing 107 statues. Bishop Thomas Hatfield (1345–81) built the bishop's throne, reputed to be the highest in Christendom. Farther east still is the Chapel of the Nine Altars, begun in 1242 in the style typical of that period. It contains the tomb of St. Cuthbert, long shorn of its magnificent medieval shrine which was despoiled in 1538, two years before the dissolution of the monastery. The greater part of the woodwork in the cathedral was introduced by Bishop John Cosin (1660–72) to replace that destroyed during the Civil War. Beside the adjacent cloisters is the chapter house, once a fine Norman building,

largely destroyed in 1796 and rebuilt in the original style in 1895. The former monastic dormitory (1400), with a fine timber roof, houses the chapter library, as does also the partly rebuilt refectory. It contains a collection of Saxon carved stones and grave covers, many illuminated manuscripts and relics of St. Cuthbert, including a stole (the only piece of Anglo-Saxon needlework extant) and his pectoral cross, which is believed to date from the 5th century. Substantial remains of other conventual buildings exist.

In the middle ages Durham was a fortified city and, with the exception of a section of about 50 yd., the walls (sometimes modified) can still be seen, with their projecting turrets. The castle protects the northern side of the site, where there is no river to provide natural defense. The earliest part of the extant buildings is the Norman chapel (late 11th century). It is in the basement of Bishop Puiset's hall (12th century), the massive walls of which face Scotland, whence attack was most likely to come. The castle was until 1837 one of the palaces of the bishops of Durham, many of whom left their mark on the building—the great hall (Bishop Antony Bek, *c.* 1300), the Tunstall gallery and chapel (Bishop Cuthbert Tunstall, 1530–59), the black staircase (Bishop Cosin, 1660–72). In 1928 the foundations of the building were found to be insecure, and collapse was averted only by prolonged repairs.

Three of Durham's parish churches, St. Giles's, St. Margaret's and St. Oswald's, show considerable 12th-century work. St. Mary-le-Bow is a 17th-century building on the site of a vanished 12th-century church; it has interesting contemporary woodwork. Of the three stone bridges, Elvet bridge is in large part 12th century and Framwellgate bridge was originally built in the same era. Each leads to one of the ancient suburbs of the city. Prebends' bridge, standing in the beautifully wooded ravine through which the river passes, was opened in 1778. Cosin's hall and almshouses and Cosin's library are all late 17th-century buildings. The Baileys, north and south, contain many 18th-century frontages. Durham school, an ancient foundation connected with the cathedral, has modern buildings.

The University of Durham was founded by act of parliament in 1832, after two abortive attempts, one immediately after the suppression of the monasteries in the 16th century and the other during the Commonwealth. A royal charter was granted in 1837, at the instance of the then bishop, William van Mildert, and the dean and chapter of Durham, who were responsible for financing it.

It originally consisted of two divisions, in Durham and Newcastle upon Tyne (*q.v.*), but in August 1963 King's college at Newcastle became the University of Newcastle upon Tyne. The two universities continue to organize jointly certain boards and committees, including the university appointments board. Durham university comprises University college (1833), housed in the castle, Hatfield college (1846), St. Mary's college (1920) for women and St. Aidan's college (1961), previously a noncollegiate society for women. Women were first admitted to the university in 1896. These four colleges are maintained by the council of the Durham colleges. St. Chad's college (1904) and St. John's college (1909) are constituent colleges of the university, but are independently governed. The College of the Venerable Bede was founded in 1841 as a Church of England training college for men teachers and became a constituent college in 1947. St. Hild's college (1858), a Church of England training college for women teachers, and Neville's Cross college (1921), for training women teachers, maintained by the Durham County council, are also licensed halls of residence and many of their students read for degrees of the university. These colleges are essentially residential; in addition there is a noncollegiate society, St. Cuthbert's, for men. The statutes of the university have undergone several revisions, latterly in 1937 (when the College of Medicine and Armstrong college were combined to form King's college, Newcastle upon Tyne) and 1963. The University of Durham confers degrees in the faculties of divinity, arts, science, music and education.

Codrington college, Barbados, became affiliated to the University of Durham in 1875, and Fourah Bay college, Freetown, Sierra Leone (the University college of Sierra Leone), in 1876. Students can read for Durham degrees at both.

Durham city owes its origin partly to the fame of the 7th-century saint Cuthbert, which brought religious importance and pilgrim traffic, and partly to its strategic position on the invasion route between England and Scotland. These two factors combined to elevate the bishops of Durham and their office to a position of great ecclesiastical and political importance—a palatinate. (*See* also DURHAM [county].) In the middle ages the city was governed by the bishop through his bailiff. Charters granted by successive bishops gave to the city a limited amount of self-government which continued until the Municipal Corporations act of 1836. Before that year self-government rested in the hands of the freemen of the city, the members of the trade guilds, who controlled admission to their own ranks through charters granted to them by bishops of Durham.

Durham is not, and has never been, an industrial city, though it contains a number of small factories of which the best-known are those making organs (1873) and carpets (1814). In the 18th and 19th centuries it was noted for the manufacture of Durham mustard. The largest individual contributions to employment are made by the university, local government administration (the offices of the county council are in the city) and the distributive trades. A weekly market is held, and the city is a shopping centre for the inhabitants of the surrounding districts. (C. W. GY.)

DURHAM, a city of north-central North Carolina, U.S., seat of Durham county, is an industrial, educational and medical centre, located in the tobacco-growing eastern Piedmont area about 20 mi. N.W. of Raleigh, the state capital. Pop. (1960) 78,302; standard metropolitan statistical area (Durham county) 111,995. For comparative population figures *see* table in NORTH CAROLINA: *Population.*

Though the surrounding region was first settled about 1750 (largely by people of English and Scotch-Irish extraction), Durham is one of North Carolina's youngest cities, dating from 1853 when a village called Prattsburg, after William Pratt, a large landowner, served the farmers of the vicinity with its wheat and corn mills. Construction of the North Carolina railroad (1852–56) encouraged growth. After Pratt had refused to give a right of way or land for a station, Bartlett Durham donated four acres about 2 mi. W. of Prattsburg. The town which grew up there was known as Durhamville and Durham Station; the name was later abbreviated to Durham. The town was incorporated in 1866 and again in 1869, the first charter having been invalidated by action of the U.S. congress, since North Carolina was still out of the union. Durham became the county seat with the creation of Durham county in 1881. It adopted the city-manager form of local government in 1921.

The tobacco industry transformed Durham from a small town of 256 people in 1870 into a flourishing manufacturing centre by 1900. The Duke family played the leading role in this development, though Washington Duke and his three sons Brodie, James Buchanan and Benjamin N. did not establish a factory in Durham until 1874. Robert F. Morris pioneered the tobacco industry in Durham in 1858, and John R. Green was manufacturing the famous Bull Durham smoking blend shortly after the close of the Civil War. To avoid competition with the blended tobacco, James Buchanan ("Buck") Duke decided to start making cigarettes. Within a quarter of a century Duke's tobacco business had 150 factories and controlled most of the tobacco trade of the United States.

Ranking high as a modern industrial city, Durham produces about one-fifth of the nation's cigarettes. It is also an important cotton textile and hosiery manufacturing centre. Other manufactures include lumber and wood products, machinery, electrical equipment, precision instruments, chemicals, flour and other food products, proprietary medicines, boxes, fertilizer and building materials. The status of the Negro is significant in Durham. Negroes, mainly in the Hayti section, control extensive business and industrial enterprises, including large insurance and bank interests, newspapers and real estate.

Durham became an important educational and medical centre largely through the philanthropy of the Duke family. Duke university, established there by "Buck" in 1924 as the principal beneficiary of the Duke endowment (*see* FOUNDATIONS, PHILANTHROPIC), was built around Trinity college, which was originally

known as Union institute, founded in 1839 and reorganized as Trinity in 1851. Undergraduate training is provided in Trinity college, the college of engineering and the woman's college and graduate work in the graduate school of arts and sciences, and in the schools of law, divinity, medicine, nursing and forestry. The university hospital serves the people of North Carolina and many other states and is a teaching institution for medical, nursing and auxiliary training. Other hospitals there include Lincoln hospital (for Negroes) and a Veterans administration hospital. The city also is the site of North Carolina College at Durham (formerly North Carolina College for Negroes), founded 1910.

Six miles west of Durham is the Bennett memorial, site of the signing on April 26, 1865, of the papers of surrender between Gen. William T. Sherman of the Union army and Gen. Joseph E. Johnston of the Confederate army. The spot is marked by a monument upon which is inscribed the word "Unity." (H. T. L.)

DURHAM'S REPORT (1839). Following the rebellions in Upper and Lower Canada (the present provinces of Ontario and Quebec) at the end of 1837, the British government appointed Lord Durham governor general of all the North American colonies and also high commissioner to make recommendations "respecting the form and future Government" of the colonies lately in rebellion. On Jan. 31, 1839, he submitted his *Report on the Affairs of British North America* (1839; *Lord Durham's Report*, 3 vol., ed. by Sir C. P. Lucas, 1912), generally regarded as the greatest state paper in British imperial history. Its breadth of view and plainness of speaking are probably unique in official reports of its kind.

Durham's two basic recommendations were that Upper and Lower Canada should be united and that these and other British colonies should be accorded the right of managing their local affairs through the device of responsible government.

Originally, Durham favoured a federation of the British North American provinces, thus anticipating the form of the later Canadian nation. Direct experience on the scene convinced him, however, that a legislative union of Upper and Lower Canada, and possibly including the maritime provinces of Nova Scotia, New Brunswick and Prince Edward Island, was preferable as the only means of anglicizing the French Canadians. He considered the latter to be a backward people whose feudal and unprogressive attitudes were delaying not only their own advance but that of the other colonies as well. He recommended that the French Canadians be submerged by a British majority until they gave up their language, laws and customs.

This proposal was the great blind spot in the report. He underestimated the tenacity of a people who had already been established in North America for two centuries, and he failed to see that French Canadians could be loyal subjects of the Queen without ceasing to be French.

It was in his recommendation for responsible government that Durham reached heights of greatness. By responsible government Durham meant simply that the executive council in each colony should be composed of men who had the support of a majority of the legislature, and who would resign when they lost that support. He was, in short, recommending that the British system of cabinet responsibility should be extended to the colonies, with the governor following the advice of the executive council in all matters of local concern. The result would be to "place the internal government of the colony in the hands of the colonists themselves," reserving only a few subjects for imperial authority.

In answer to those who argued that legislative union and local self-government would lead to independence and separation from the mother country, Durham asserted that they were the surest guarantees against absorption by the United States and the surest means of retaining the loyalty of the North American colonies. Thus he looked to the evolution of the empire into the modern Commonwealth of Nations.

The report and its appendixes also contained much informative material on land policy, emigration, education and other subjects. *See* also CANADA: *History;* DURHAM, JOHN GEORGE LAMBTON. (G. M. C.)

DURIAN, the fruit of *Durio zibethinus,* a tree of the family Bombacaceae, which attains a height of 70 or 80 ft., has oblong, tapering leaves, rounded at the base, and yellowish-green flowers, and bears a general resemblance to the elm. The durian is cultivated in Sumatra, Java, Celebes and the Moluccas and northward as far as Mindanao in the Philippines; it is also grown in the Malay peninsula and in southern Thailand. The fruit is spherical and 6 to 8 in. in diameter, approaching the size of a large coconut; it has a hard external husk or shell, and is completely armed with strong pyramidal tubercles, meeting one another at the base and terminating in sharp, thorny points. If the fruit is divided at the joints of the carpels, where the spines arch a little, it is found to contain five oval compartments, each filled with a cream-coloured, glutinous pulp, in which are embedded from one to five seeds about the size of chestnuts.

The pulp and the seeds, which latter are eaten roasted, are the edible parts of the fruit. Although the fruit has a sweet, somewhat balsamic flavour, it also has a rather offensive odour, which has been compared to that of rotten onions or of putrid animal matter. Because of its odour, the durian has had little popularity with people outside its natural range.

DURKHEIM, ÉMILE (1858–1917), pioneer French sociologist, achieved international recognition as a social scientist by successfully combining empirical research with sociological theory. He was born of a rabbinical family on April 15, 1858, in Alsace. A student of law, philosophy and social science, he was educated in France and Germany, where he also studied folk psychology and anthropology. A chair of sociology was established for him in 1887 at the University of Bordeaux where he taught for five years before joining the faculty of the University of Paris and becoming a lecturer at the Sorbonne. He early became an exponent of the positive social philosophy of Auguste Comte (*q.v.*). Generally regarded as the founder of the French school of sociology, his work and that of his disciples and their followers had broad influence on the methodology of all branches of social science. Such 20th-century anthropologists and ethnologists as A. R. Radcliffe-Brown and Robert Lowie, as well as Talcott Parsons, W. Lloyd Warner and other sociologists, acknowledged the value of the interest he aroused. (For a review of his influence in the field of sociology *see* SOCIOLOGY: *History of Sociology: Pioneer Sociologists.*)

Durkheim applied methods of objective science in the study of human relationships, but insisted that pure statistical correlations are not adequate unless logical connections are also established. He emphasized the importance of studying "social facts," such as social rules and customary beliefs, which are objective to the empirical observer and yet possess moral aspects, for they affect the welfare of individuals.

His best-known contribution to social theory is the concept of collective representations, which refers to group ideas or symbols that are widely accepted and socially forceful because they are collectively created and developed through the interaction of many minds. These symbols are the products of the *conscience collective,* usually translated "collective consciousness" (social psychology), although "collective conscience" (ethical) may be closer to the meaning intended by Durkheim. The *conscience collective* is viewed as the ethical authority of juridical decisions.

Division of labour is another important concept developed by Durkheim. In preliterate societies he found little division of labour but a great deal of "mechanical solidarity" (mutual dependence) or like-minded solidarity in which the individual is subordinated to the group. As a society develops, a division of functions and corresponding activities takes place, mechanical solidarity gives way to a considerable degree to an "organic solidarity" and individuals become aware of social values. Under organic solidarity, conflicts of interests occur and constraint, represented, for example, by juridical decisions, becomes necessary.

Durkheim is noted for his study of personality problems as found in his work entitled *Le Suicide* (1897), in which three types of suicide are described: (1) egoistic suicide, which may result when an individual shuts himself off from other human beings; (2) *anomique* suicide, which comes from the belief that one's social world has fallen apart around him; and (3) altruistic suicide, which springs from great loyalty to a cause.

Durkheim also attempted to demonstrate the social and ceremonial origins and basis of religion, especially totemism (*q.v.*). He held there are no religions "which are false." All are "essentially social" and a religion is "a universal system of beliefs and practices relative to sacred things" that are set apart and forbidden, that unite all those who adhere to them into "one single moral community called a church." (Émile Durkheim, *The Elementary Forms of Religious Life*, trans. by J. W. Swain, Free Press, Glencoe, Ill., 1947.)

He founded and served as editor of *L'Année sociologique* from 1897 to 1912. He died in Paris on Nov. 15, 1917.

His chief works are *De la division du travail social* (1893); *Les règles de la méthode sociologique* (1894); *Le suicide* (1897); and *Les formes élémentaires de la vie religieuse* (1912). The chief translations of his works are *The Division of Labor in Society*, trans. by George Simpson (1947); *The Elementary Forms of the Religious Life*, trans. by J. W. Swain (1947); *The Rules of Sociological Method*, trans. by G. E. G. Catlin (1950); *Suicide*, trans. by J. A. Spaulding and George Simpson (1951); *Sociology and Philosophy*, trans. by D. F. Pocock (1953); *Education and Sociology*, trans. by S. D. Fox (1956); and *Socialism and Saint-Simon*, ed. by A. W. Gouldner and trans. by Charlotte Sattler (1958).

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DUROC, GÉRAUD CHRISTOPHE DE MICHEL, DUC DE FRIOUL (1772–1813), French general and diplomat, one of Napoleon's closest advisers, was born at Pont-à-Mousson, Oct. 25, 1772. The son of Claude de Michel, chevalier du Roc, who was a cavalry officer, he went to the Châlons artillery school, emigrated in 1792, but changed his mind, returned to France, entered the Metz school (1793) and was drafted to the artillery of the army of Italy. In 1796 Gen. A. de Lespinasse, the artillery commander, took him as aide-de-camp. Both were mentioned in dispatches after the battle of Roveredo (September) and a few weeks later Napoleon took Duroc as his aide. He was major in Egypt, colonel in Syria and, after the *coup d'état* of Brumaire (Nov. 1799), senior aide-de-camp of the first consul and his intimate friend. All contemporaries praised this reserved, unambitious man who so often checked Napoleon's angry impulses.

From 1804 he was grand marshal (lord high steward of the empire) and kept good order in the palaces. Furthermore he was often on diplomatic missions, and it was he who signed the treaties of Fontainebleau and Bayonne (1807–08) determining the intervention in Spain. He was also general of division (1803), led a division at Austerlitz and was in all the campaigns. He was usually consulted by Napoleon on questions of promotion and became the best channel by which Napoleon's lieutenants could approach him.

On his journey back from Russia in 1812 the emperor chose Armand de Caulaincourt as his immediate companion; Duroc and G. Mouton followed in another sledge. In 1813 Duroc, like Caulaincourt, was made a senator. He had heavy work in the organization of the new army and was with it at the battles of Lützen and Bautzen (1813). In the outposts in Silesia he came, by chance, under artillery fire and was mortally wounded. He died near Görlitz on May 22, 1813. Napoleon deeply regretted his death. (I. D. E.)

DURRA, a variety of sorghum, a grain-yielding grass. *See* KAFIR; SORGHUM.

DURRES (Ital. DURAZZO; Serb. DRAC), the first seaport of Albania and headquarters of the *rreth* (district) of the same name, is located on the Adriatic sea, 19 mi. (31 km.) W. of Tirane. Pop. (1960) 39,937. Until a few years before World War II the harbour was unprotected, subject to silting and suitable only for vessels of shallow draft. Sea walls and modern quays were then built. The quays and installations were destroyed by the retreating German forces in 1944 but they were later restored and improved and the harbour deepened. The railway runs to the dockside, and there are modern cranes and warehouses and an oil-discharging point on the east wall with oil storage tanks nearby. Wide streets, begun before 1939, were driven through the straggling town, and motor roads lead from the central square to the interior of the country. There are a railway station and repair yard, and two lines, built after World War II, link the port with the capital, Tirane, and with Elbasan. There are modern commercial buildings, flour mills, a rubber factory and a building yard for small vessels. The ruins of the Byzantine citadel overlook the town from a hill to the north, and the old towered walls, restored by the Venetians in the 14th century, run down to the harbour.

Epidamnus, the ancient name of Durres, was founded in the 7th century B.C. by Corcyraeans and Corinthians on the shore of Illyria. Disputes between these colonists led to its decline and in 312 B.C. it was seized by the Illyrian king Glaucias. It later passed to the Romans who renamed it Dyrrachium, and from it the military highway, the Via Egnatia, led past Elbasan and Lake Ohrid to Salonika and the east. The old harbour, known as Porto Romano, lay north of the hill at the entrance (later silted up) to a lagoon or marsh. Pompey made his last successful stand against Caesar just south of Durres in May 48 B.C., before his defeat at Pharsalus. Augustus made the place a free city, and it was most prosperous in the 4th century A.D. when it became the capital of Epirus Nova. A bishopric was created there about 58 and an archbishopric in 449. The town was besieged by the Ostrogoth Theodoric in 481 and attacked by the Bulgarian invaders in the 10th and 11th centuries. It was captured by the Norman Robert Guiscard in 1081, later passing to the Byzantines. It fell to King William of Sicily in 1185, passed to the Venetians early in the 13th century and to King Manfred of Sicily in 1258. In 1272 Charles of Anjou captured it with a Neapolitan army, but in 1273 it was devastated by an earthquake. Next it became an independent duchy under John of Anjou and later under Philip of Otranto. It was annexed by Achaea in 1333 but was conquered by the Serbs of Stephen Dushan in 1336. After Dushan's death in 1358 it passed into the control of the Albanian family of the Topias. It was ceded about 1394 to Venice, under whom it prospered. The Turks captured it in 1501 and held it until their defeat in the Balkan War of 1912. The Serbs then occupied it but were obliged by the great powers to withdraw. The Albanian Esad Pasha Toptani formed a government of his own there, but after the landing at Durres in 1914 of Prince William of Wied as king of Albania, Esad Pasha was arrested and deported. A revolt, however, led to the departure of Prince William. Austrian forces occupied the town during World War I and on their defeat Italian forces held it but withdrew from the country in 1920. On April 7, 1939, Durres was the main port of disembarkation for Fascist Italy's invasion of Albania, and during World War II it was bombed and shelled by British forces. Under the Communist regime Durres became the main lifeline of an Albania politically isolated from its landward neighbours.

(D. R. O.-H.)

DURUKULI, the native name of a small South American monkey, the owl monkey or night monkey, *Aotes* (or *Aotus*) *trivirgatus*. Durukilis range from Colombia and the Guianas southward to Paraguay and northern Argentina. They are nocturnal in habit and are distinguished by their large eyes and by the pattern of the surrounding area, which includes three dark bands on the crown separated by lighter markings. The tail is bushy and not prehensile. The modified larynx ensures a powerful voice. *See* also PRIMATES: *New World Monkeys (Platyrrhines)*: *Durukulis and Sakis*. (W. C. O. H.)

DURUY, VICTOR (1811–1894), French historian, author of a valuable *Histoire des Romains*, 7 vol. (1879–85) and, as minister of education, initiator of controversial reforms, was born in Paris, Sept. 11, 1811. From 1833 to 1861 he taught at the Collège Henri IV. His early publications were textbooks and works on historical geography and ancient history; his *Histoire des Romains et des peuples soumis à leur domination*, 2 vol. (1843–44), was later greatly enlarged. He assisted Napoleon III with his life of Caesar and was appointed minister of education by him in 1863. His policies enlisted liberal and anticlerical support and met with con-

siderable opposition. He organized higher education (*enseignement spécial*) and the training of teachers, initiated provincial extramural lectures (*conférences publiques*), began a course of secondary education for girls with lay teachers, and introduced the study of contemporary history and modern languages in *lycées* and colleges. His greatest interest was primary education, but his particularly controversial proposal to make it both free and compulsory failed to gain the emperor's support. In 1869 the government was reconstructed and Duruy made a senator; later he returned to academic work, becoming a member of the Académie Française in 1884. *Histoire des Grecs*, 3 vol. (1886–89), and an enlarged edition in 1891 of *Histoire de France de 1453 à 1815* (1856) renewed his reputation as a scholar, and many other works confirmed it as a writer of popular history. Duruy died in Paris, Nov. 25, 1894.

See V. Duruy, *Notes et Souvenirs*, 2 vol. (1901); E. Lavisse, *Un ministre, Victor Duruy* (1895); G. Monod, *Portraits et Souvenirs* (1897).

DUSE, ELEONORA (1859–1924), Italian actress, whose great powers were shown most fully in the plays of D'Annunzio and Ibsen, was born on Oct. 3, 1859, near Vigevano, in a railway coach. She came from a family of actors. Her grandfather, Luigi Duse (1792–1854), had specialized in Goldonian parts; her father, Alessandro Duse, was the leading man in a company of strolling players, and her uncles were members of the same troupe. Eleonora Duse acted for the first time at the age of four at Chioggia, when she played Cosette in a dramatization of Victor Hugo's *Les Misérables*. At the age of 14 she acted Juliet in Verona, where her talents were recognized by the critics. After she lost her family and was thrown on her own resources, she passed from one company to another, experiencing the hardships of a nomadic life and often enduring hunger, until she appeared in Naples in 1878. This marked the turning point in her career. Her Electra in Alfieri's *Oreste* received good notices, for her Ophelia she was acclaimed, and when she undertook the title role of Emile Zola's *Thérèse Raquin* (1879) audiences and critics had to admit that a woman's anguish had never before been portrayed with such truth. The actor Cesare Rossi hired her as the leading lady of his company, and with him she toured most of Italy, struggling to rouse lethargic audiences, bored by the stale pieces of the repertory.

In 1882 the Duse had the opportunity to watch Sarah Bernhardt perform. Bernhardt's success gave the Duse new courage and the idea of turning to the modern French dramatists for new plays. She studied the part of Lionette in the younger Dumas's *La Princesse de Bagdad*, a play from which Parisians had recoiled when Sophie Croizette played the lead. The new role was a triumph, however, for the Duse, who then selected another Dumas character for her next vehicle, Cesarine in *La Femme de Claude*. In 1884 she created the title role of Dumas's latest play, *Denise*, and in the same year Santuzza in Giovanni Verga's *Cavalleria Rusticana*. She toured in South America in 1885 as a member of the Cesare-Rossi company. After her return to Italy Rossi's star began to sink, and his company disbanded. The Duse then formed her own troupe, the Drammatica Compagnia della Città di Roma, and with it undertook tours to Austria, Germany, England, France, Russia, Egypt, Belgium and Portugal, making visits also to the United States in 1893, 1896 and 1902. She was idolized wherever she went, but she always regarded Vienna as the city where she was most appreciated as an artist.

In 1897 she met the rising young poet Gabriele d'Annunzio (*q.v.*) and fell in love with the man and the artist. The actress began to crusade for the playwright, who gave her three successful vehicles, *La città morta* (1898), *La Gioconda* (1898) and *Francesca da Rimini* (1902), and two failures, *Sogno d'un mattino di primavera* (1897) and *Gloria* (1899). Her faith in D'Annunzio was boundless, and his cult of beauty added another dimension to her acting; a radiant glow is said to have emanated from her when she played his characters. D'Annunzio wrote the story of their love in the novel *Il fuoco* (*The Fire;* 1900).

Aside from D'Annunzio's dramas, the Duse found those of Ibsen an inexhaustible source of self-expression. She never grew tired of Nora in *A Doll's House*, Rebecca West in *Rosmersholm*, Ella Rentheim in *John Gabriel Borkman* or, above all, of Ellida in *The Lady From the Sea*. To Hedda Gabler she brought something the author was troubled by when he saw her perform the part: a demonic quality, a touch of the fantastic; she went beyond the narrow frontiers of realism. One of her Viennese critics wrote at the time of her first appearance in Vienna (1892) that the Duse played what was between the lines, she played the transitions. Hugo von Hofmannsthal, one of her Austrian admirers, stated that the actress supplied psychological motivation wherever it was lacking in a play. To watch her was to read a psychological novel. She even was able to introduce Ibsen psychology into the marionettes that were pulled by the strings of Sardou and Dumas, lending her soul to these stiff figures and completing what the dramatists had left uncompleted. In every role she was different, in contrast to the great technician Sarah Bernhardt, who never pretended to hide her personality. The Duse had a thousand faces. Bernard Shaw was one of the critics who studied her metamorphoses with fascination. He was struck by her ability to produce the illusion "of being infinite in variety of beautiful pose and motion." A tremor of her lips revealed what went on in her mind; her hands spoke a distinct language; she had a different way of walking for each part; she even mastered the colour of her face (unspoiled by make-up); and Shaw's professional curiosity was aroused when he pondered the question whether the Duse's blush always came spontaneously. And yet, this was not naturalistic acting, for the Duse acted not only the reality but also commented on the characters: as Hofmannsthal said, she knew more about Nora than Ibsen's heroine could possibly know about herself. Shaw confessed that "in an apparent million of changes and inflexions" he had never seen her at an "awkward angle" in defiance of the "natural gravitation to the finest grace." (George Bernard Shaw, *Dramatic Opinions and Essays*, Brentano's, New York, 1907. By permission of The Public Trustee and The Society of Authors.)

In 1909 Eleonora Duse decided to quit the stage, primarily for reasons of health. During World War I, however, she incurred financial losses that forced her to emerge from her solitude in 1921. Her acting powers were undiminished, but her health was failing and interfered with her late career. In 1923 she appeared in London in six matinee performances. Three nights in Vienna followed before she embarked upon her last tour of the United States, which began with an appearance on the yawning stage of the Metropolitan Opera house and ended in Pittsburgh, Pa., where the actress died on April 21, 1924. In compliance with her request, she was buried in the small cemetery of Asolo.

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DUSHANBE (STALINABAD from 1929 to 1961), the capital of the Tadzhik Soviet Socialist Republic of the U.S.S.R., is situated on the Dushambinka river, a branch of the Kafirnigan, at the junction of the Karshi-Ordzhonikidzeabad and Dushanbe-Nizhni Pyandzh railway lines and of the Dushanbe-Kurgan-Tyube-Kirovabad-Kulyab and Dushanbe-Khorog metaled roads. Pop. (1959) 224,242. The town, which occupies the site of an old Tadzhik village (formerly spelled Dyushambe or Diushambe), has developed greatly since 1926, when the population was only 6,000. It has been completely rebuilt on modern lines with large public buildings, squares and gardens. There is a thriving light industry including one of the largest cotton textile works in the U.S.S.R. and there are many other factories and spinning works. An Academy of Sciences was founded there in 1951. There are more than 30 schools and a number of technical and educational training establishments including the T. G. Shevchenko Pedagogical institute. Public health has been greatly developed: in addition to a piped water supply there are hospitals, maternity clinics and dispensaries. In 1939 a state medical institute was established and named after Abu-Ali ibn Sina (Avicenna). After the renewed denunciation of Stalin at the 22nd congress of the Communist party of the U.S.S.R. in Nov. 1961 the town reverted to its former name. (G. E. WR.)

DUSSAUD, ÉLIE PIERRE RENÉ (1868–1958), French

orientalist who encouraged the excavations at Ras Shamra, Mari and Byblos, was born at Neuilly-sur-Seine, near Paris, on Dec. 24, 1868. Five journeys in Syria between 1895 and 1901 resulted in his first publications, which included *Notes de mythologie syrienne* (1903) and *Les Arabes en Syrie avant l'Islam* (1907), a subject to which he returned in his last book, *La Pénétration des Arabes en Syrie avant l'Islam* (1955). A visit to Crete led to *Les Civilisations préhelléniques* (1910; 2nd ed. 1914). After a brief university career he joined the staff of the Louvre in 1910, being head of the department of oriental antiquities from 1928 till his retirement in 1935. In 1927 he published his most important work, *Topographie historique de la Syrie antique et médiévale*. From 1929 onward he became passionately interested in the discoveries at Ras Shamra, which were the subject of *L'Art phénicien du IIe millénaire* (1949) and *Les Découvertes de Ras Shamra (Ugarit) et l'Ancien Testament* (2nd. ed. 1941) and necessitated the revision of *Les Origines cananéenes du sacrifice israélite* (1921; 2nd ed. 1941). He touched on the problems of Anatolian history in *La Lydie et ses voisins aux hautes époques* (1930) and *Prélydiens, Hittites et Achéens* (1953). From 1908 he was co-editor of the *Revue de l'histoire des religions* and from 1920 of the periodical *Syria* which he helped to found. He died in Paris on March 17, 1958. By his personal activities even more than by his publications he exercised a profound influence on French oriental studies.

(R. DE V.)

DUSSEK (DUSIK), **JAN LADISLAV** (1760–1812), Bohemian pianist and composer known for his piano music, was born at Caslav, Bohemia, on Feb. 12, 1760, the son of the cathedral organist. He studied with his father, sang in the choir at Iglau and later studied theology at Prague. He found a patron in Count Männer, whom he accompanied to the Netherlands. He attained a great reputation as a pianist and wrote a large number of "accompanied sonatas" for pianoforte and strings before going to Hamburg about 1783 to study under C. P. E. Bach. Later he went to Berlin and St. Petersburg and found another patron in the Polish prince Sapieha, on whose estate he remained for a year. In 1786 he went to Paris, where he was patronized by Queen Marie Antoinette. After a stay in Italy he returned to Paris in 1788, but later left the unsettled French capital for London, where he made a successful debut in 1790. In 1792 he married Sophia, the daughter of the music publisher Domenico Corri, with whom he entered into business partnership. The business failed, and about 1800 Dussek fled from England to escape his creditors; he never saw his wife and daughter again. He went to Hamburg and Berlin, and again was fortunate in securing wealthy patrons, Prince Louis Ferdinand of Prussia and later Talleyrand. He lived in Talleyrand's household from about 1809 until his death at St. Germain-en-Laye, March 20, 1812.

Dussek's works include a large number of pianoforte sonatas and concertos and numerous chamber works for piano and strings. His piano sonatas represent him at his best, and though his works were later forgotten he had a considerable influence on the growth of piano technique, both as pianist and composer.

See L. Schiffer, *J. L. Dussek* (1914); S. V. Klima "Dussek in England," *Music and Letters* (April 1960). (CS. CH.)

DÜSSELDORF, a city of Germany which after partition of the nation following World War II became capital of the *Land* (state) of North Rhine-Westphalia, Federal Republic of Germany. The centre of the industrial Rhine-Ruhr area, it lies mainly on the right bank of the Rhine, 25 mi. N.N.W. of Cologne. Pop. (1950) 500,516; (1959 est.) 691,740.

Although industrial, it is a finely laid-out town which attracts an elegant and often international society, especially at the Carnival season, the shooting festival (July), the traditional St. Martin's procession (Nov. 10) and when exhibitions and congresses are being held. The main street is the Königsallee, with its town moat and beautiful chestnut trees, under which are terrace cafés. Among old buildings is the town hall (1567; later extended), in front of which is the equestrian statue of the elector palatine Johann Wilhelm II (Jan Wellem) by the Flemish sculptor Gabriel Grupello. The crooked tower of the 13th–14th century St. Lambertus-Kirche has become the town's symbol. Only the tower of the electoral prince's castle, otherwise burned down in 1872, remains. Schloss Jägerhof, which houses the town historical collection, was built in 1752–63; Schloss Benrath, with its great park, was built by Nicolas de Pigage in 1755–69. To the north in the district of Kaiserswerth lies the palace of the emperor Frederick I Barbarossa. Notable 20th-century buildings include the Wilhelm-Marx-Haus and the Ehrenhof buildings by W. Kreis (1924–26). Düsseldorf was badly damaged in World War II and consequently contains much modern architecture.

Among Düsseldorf's institutions of learning are a medical academy and an academy of arts (founded 1767). The Hetjensmuseum has a notable collection of ceramics covering 6,000 years. The unusual *Land* museum, "People and Industry," illustrates the society and industry of the world. There is a Goethe museum and the city library contains a unique collection of Heinrich Heine's work and his library.

Düsseldorf lies on the *Autobahn* and is a big railway junction. It has one of the most important German civil airfields, at Lohausen, 4 mi. from the town. Three Rhine harbours connect it with ports in Great Britain, northern Europe and the Mediterranean.

The city is a banking and wholesale centre, the home of many industrial associations and of the international wool secretariat. Its chief industry is iron and steel but its manufactures also include chemicals (washing powders, etc.), cars, concave glass, electrical engineering and precision tools, paper, textiles and clothing (it is the centre of the women's clothing industry in Germany).

Düsseldorf's importance began when it was raised to the rank of city by Count Adolf von Berg in 1288. It suffered considerably in the Thirty Years' War and the War of the Spanish Succession but regained its consequence under Johann Wilhelm II, who was born and died there. In 1795 the town surrendered to the French after a violent bombardment, and after the peace of Lunéville the fortifications were dismantled; in their stead arose the royal garden and the Königsallee. In 1805 the city became the capital of the Napoleonic grand duchy of Berg and in 1815 was transferred with it to Prussia. Its industrial development dates from 1870.

(O. J.-A. H.)

DUST is finely subdivided solid matter that can be carried in suspension by air. It is normally lifted by the wind from its place of origin, is carried along by the turbulent atmospheric currents and finally settles either by gravity under conditions of calm or is brought to the surface by precipitation. Wind can carry tremendous quantities of dust from one region of the earth to another. Geologists have generally accepted the theory of German geologist and geographer Ferdinand von Richthofen (1833–1905) that loess deposits are wind-borne sediments. In China these deposits reach thicknesses of 700 ft.

Dust plays an important part in cloud formation and precipitation processes in the atmosphere. In 1875 M. Coulier first recognized that condensation of water vapour in air occurs only when nuclei are present around which water droplets form. Not all of these atmospheric condensation nuclei are solid particles. Some of them are hygroscopic liquids such as nitric and sulfuric acid, others are ionized gas molecules. Christian Junge showed in 1935 that all particles of sizes between 10^{-7} and 10^{-5} cm., even oils, will act as nuclei for condensation. Hygroscopic nuclei only act sooner than the others. For the formation of clouds, 300 to 500 nuclei per cubic centimetre are needed. In some cases coagulation of cloud droplets to raindrops will take place only if ice crystals form initially. The small water droplets usually subcool below the freezing point and require other particles, so-called freezing nuclei, before ice crystals are formed.

Sources.—The main sources of dust in the free atmosphere are soil blowing, oceanic spray, volcanic activity, forest fires, domestic and industrial combustion processes, vehicle exhaust and meteoric matter penetrating from the universe into the earth's atmosphere. Organic dusts such as parts of plants, pollen and bacteria are minor constituents of atmospheric dust. Air currents and turbulence are responsible for the horizontal and vertical distribution of dust, sometimes to points at considerable distances from its origin.

Oceanic spray has been estimated to bring annually about 2,000,000,000 tons of salt dust into the air. The main chemical constitu-

ents of the salt left in the air after the spray water has evaporated are sodium chloride, calcium chloride, potassium bromide and magnesium chloride. The individual salt nucleus weighs between 10^{-10} and 10^{-18} g. and has radii up to 10^{-4} cm.

In settled areas combustion processes are next in importance as sources of dust. The estimated annual world dust production of all major cities is 0.2 cu.mi. Another man-made dust source is the atomic explosion. Debris from thermonuclear blasts has been carried in the air around the earth. Occasionally, volcanic eruptions bring tremendous amounts of dust into the atmosphere. The spectacular eruption of Krakatau (*q.v.*) in the Sunda strait, between Sumatra and Java, on Aug. 26–27, 1883, threw about 4 cu.mi. of earth into the air, where some of it stayed for three years.

Dust storms originating in deserts and during droughts in areas where natural vegetation has been removed bring thousands of tons of dust into the air and carry vast amounts at times as far as 2,000 mi. from the point of origin. For example, the great dust storm of Nov. 12–13, 1933, starting in the plains states of the U.S., caused discoloration of snow in New England where 25 tons of dust per square mile were deposited. Sahara dust has been noted as far east as Syria. It is rather regularly observed in the Alps, when air masses originating in North Africa are carried by storms into that region, and gives rise to red- and yellowish-coloured snows and rains (blood rains). These also have been occasionally reported from the British Isles and most areas of central Europe.

Some meteoric dust penetrates from space into the atmosphere. Magnetic dust definitely traced to a meteorite was first observed on Jan. 13, 1835, at Löbau, Saxony. In 1883 John Murray and Alphonse F. Renard reported the find of magnetic dust traces in deep-sea sediments dredged by the expedition of H.M.S. "Challenger." Brown or black in colour the dust had diameters of 0.2 to 0.5 mm. From its suspected origin it got the name cosmic spherules. A systematic survey was made in 1910 during the passage of the earth through the tail of Halley's comet. Inadequate methods led to negative results. In 1940 H. H. Nininger reported on nickel-containing dust found in the western United States, allegedly of cosmic origin. Particles had diameters of 90μ (1 micron = 1μ = 10^{-3} mm.). Rather positively identified as micrometeorites were dust particles collected after the Giacobini-Zinner meteorite shower of Oct. 9, 1946. These had sizes from 5 to 30μ. A systematic analysis of dust precipitated with rain by John Davis Buddhue yielded magnetic particles with a most frequent size range of 5 to 25μ. A check on dust layers found on an arctic ice island (T-3) showed magnetic spherules of sizes 0.01 to 0.4 mm. The age of the dust deposits ranged from several hundred to several thousand years. This and the remote locality ruled out the possibility of industrial contamination. The various size ranges were found to agree fairly well with theoretical calculations by Ernest Öpik, placing micrometeorites of the aerolite type in the bracket of 0.03 to 0.23 mm. The amount of meteoric dust accretion by the earth is widely in dispute. While the ice island data yield an accretion of only 125 tons per year for the earth, W. D. Crozier has estimated as much as 200 to 800 tons per day or up to 292,000 tons per year. Buddhue's data point to 35,000 to 70,000 tons per year. Paul W. Hodge in 1956 published data leading to the then highest estimate of 1,000,000 tons accretion per year.

Concentration.—Dust exists in the atmosphere in prodigious quantities. It has been estimated that over the United States about 43,000,000 tons settle per year. Of this, 31,000,000 tons is from natural sources, including 1,000,000 tons of pollen. The remainder of 12,000,000 tons is caused by human activities. Near cities the pollution is a particularly serious problem. Measurements of the dust fall per square mile per month have indicated the following general variations: Detroit, Mich., about 72 tons; New York city, 68 tons; Chicago, Ill., 61 tons; Pittsburgh, Pa., 46 tons; Cincinnati, O., 34 tons; and Los Angeles, Calif., 33 tons. In sections with heaviest industrialization amounts of 200 tons per square mile per month have been observed. Industrial pollution in valleys or troughs combined with suitable weather conditions can lead to a serious health hazard. A combination of low wind speed with stable air stratification, *i.e.*, cold near the ground and warmer aloft, and dry weather for any length of time can lead to dangerous accumulations of contaminants. Catastrophic incidents of this nature occurred in the Meuse valley, Belg. (1930), and in Donora, Pa. (1948), where deaths and many cases of respiratory diseases were attributed to aggravated combinations of these circumstances. At Donora, for example, zinc plants were found to discharge 67,000 lb. of particulate matter per day. One of the worst "smog" disasters on record occurred between Dec. 4–9, 1952, in London, where about 4,000 persons died as a result of exposure to contaminant concentrations of up to 4 mg. per cubic metre. This is about ten times the amount usually found in heavily polluted localities. The concentrations usually decrease by one-half for every three-mile interval from the polluting source. Industrial combustion and smelting operations, mining, construction and road-building activities, traffic and incinerators are the worst sources of dust. Coal, *e.g.*, contains 4% to 11% ash, much of which escapes through chimneys and smokestacks. Of the typical incinerator charge, 1% results in fine dust with particle sizes less than 6μ. Table I shows the usual size ranges of some of the commoner air contaminants.

TABLE I.—*Size Ranges of Contaminants*

Type	Usual radii in μ
Carbon smoke	0.01— 0.2
Metal oxide fumes	0.03— 0.3
Hazardous silica dust	0.5 — 10
Bacteria	1 — 15
Cement	10 — 150
Pollens	20 — 60
Fertilizer	30 — 800
Sand	200 —2,000

Many cities instituted vigorous campaigns to prevent air pollution, and industries installed devices to remove the offending substances from their exhausts. For example, Pittsburgh reduced fly ash and other contaminants by 69% between 1946 and 1953. Weather observations showed that periods of poor visibility caused by pollution were reduced from 1,000 to 300 hr. per year. A major factor was the replacement of steam locomotives by diesel engines on the railroads. (*See* also SMOKE AND ATMOSPHERIC POLLUTION.)

The environmental variations of condensation nuclei are good indicators of relative pollution. *See* below, *Methods for Measuring Dust* for a description of condensation nuclei counting. On the basis of about 20,000 measurements in all parts of the world these variations are summarized in Table II.

TABLE II.—*The Environmental Variation of Condensation Nuclei*

Type of environment	Average number of nuclei per cubic centimetre
Cities	147,000
Towns	34,300
Countryside	9,500
Oceans	910
Mountains, 500–1,000 m. elevation	6,000
Mountains, 1,000–2,000 m. elevation	2,100
Mountains, higher than 2,000 m.	950

Of the values measured over the ocean two-thirds indicated less than 400 nuclei per cubic centimetre. In the free atmosphere A. Wigand found on balloon flights the average concentrations shown in Table III.

TABLE III.—*The Average Concentrations in Free Atmosphere*

Elevation in metres above surface	Average number of nuclei per cubic centimetre
1,000–2,000	2,500
2,000–3,000	780
3,000–4,000	340
4,000–5,000	170
more than 5,000	80

Indoors the concentration of dust is normally higher than in the free atmosphere, although the variations follow the outdoor changes, depending somewhat on ventilation conditions. Ordinarily, room air contains between 50,000 and 100,000 condensation nuclei per cubic centimetre. From a hygienic point of view it is

important to note that the number of bacteria indoors varies in the same sense as the number of dust particles. Similar environmental conditions, such as humidity and ventilation, keep both in suspension.

Plant pollens suspended in the atmosphere are often responsible for attacks of hay fever in allergic persons. During the summer and autumn these are usually counted, in a somewhat unsatisfactory manner, by observing the number of pollens settling on a coated slide of 1.8 $cm.^2$ in 24 hours. In the case of pollen from ragweed, which is the pollen most commonly associated with hay fever, attacks in sensitive persons start with counts of 10 to 25. Maximum counts in midseason may reach up to 1,000 pollens per 24 hours.

Since the mid-1950s the problem of fallout of radioactive dust from nuclear explosions has become a matter of considerable attention. Natural radioactive substances always have been minor constituents in the atmosphere. Minute quantities of radon and its decomposition products, carbon-14 and potassium-40, are usually among the atmospheric admixtures and suspensions. Most of the fission products in nuclear blasts are quite short-lived and are quickly eliminated from the atmosphere by fallout and washout. The principal exception is strontium-90 which has a half-life of about 28 years. The force of the explosions brings nuclear debris into the stratosphere. Air currents at the high levels carry the dust from the point of origin to practically all parts of the earth. Settlement may take from weeks to years. One year after the first hydrogen bomb tests in the Marshall Islands, strontium-90 dust from these explosions caused an average soil contamination in the United States of 2 to 3 millicuries per square mile. This is about $\frac{1}{240}$ of the activity caused by natural radioactive sources. Because of the long half-life each explosion with significant fallout adds to the total amount of radioactive dust in transit or in the upper soil layers.

The Dust Problem in Industry.—In many industrial establishments dust is of paramount concern to management and labour. Abrasive dusts cause considerable wear on machinery, but even more important is the menace dust constitutes in many cases to the safety and health of employees. One of the most dangerous hazards is created by explosive suspensions of dust in mills and mines. The explosibility of dust is governed by its fineness and its contents of volatile combustible matter. The danger of dust explosions is reduced by higher moisture and ash contents of industrial dust. By admixing either inert, noncombustible dusts or water to combustible dusts the hazards are kept under control, especially in coal mines. The concentration of various types of dust which causes maximum explosibility is given in Table IV. The size of these dusts is such that all will pass through a 200-mesh sieve (200 holes per lineal inch).

TABLE IV.—*Dust Concentrations of Maximum Explosibility*

Type of dust	Ounces per 1,000 cu.ft.
Coal	200– 600
Sugar	200–1,000
Corn, wheat, starch	200– 600
Aluminum	500
Sulfur	1,000

The most disastrous dust explosions have occurred in coal mines, often as a sequel to methane explosions. The ignition of air-dust mixtures is often due to sparks of accumulated static electricity, which, if created by moving parts such as transmission belts, may convey uniform charges to the particles. This will cause them to remain dispersed and suspended for a longer period of time and counteract coagulation and settling.

The health of workers in dusty trades is continuously menaced by large concentrations of particles. These may be (1) toxic dusts which cause direct poisoning; (2) nuisance dusts which generally increase the incidence of diseases of the upper respiratory tract; and (3) fibrosis-producing dusts which lead to chronic lung ailments. Among the toxic dusts are those of lead, arsenic and manganese and their compounds. The fibrosis-producing dusts lead to the so-called pneumonoconioses or pneumoconioses (dust-lung diseases). The most prevalent among these are known by names incorporating the causative agent (*e.g.*, silicosis, anthracosis and asbestosis). The best-explored hazard is that caused by the breathing of free silica, SiO_2, in the mining, quarrying, ceramic and abrasive industries. However, pneumoconiosis is also caused by other silicates such as pyrophyllite (a hydrous aluminum silicate) and talc (a magnesium silicate).

Most dangerous from a health point of view are particles below 5μ in diameter. The hazard to the individual is predicated not only on the amounts present in the air breathed by the worker but on the period of time for which he is exposed to the polluted air. The acute danger limit is reached if 5,000,000 free silica particles per cubic foot of air with sizes below 5μ are present. Of these as much as 25% is retained in the respiratory tract. In typical industrial dusts 70% of the particles are between 1 and 3μ and 20% below 1μ in diameter. The median was found around 1.3μ. In outdoor dusts the median of gross particles is around 0.5μ, in sandblasting and granite cutting 1.4μ, in aluminum plant dusts 2.2μ, in anthracite coal mining 0.8 to 1.0μ.

Table V shows some typical dust exposures according to surveys of the U.S. public health service and the U.S. bureau of mines.

For industrial dust control, the use of hoods over dust-producing machinery is recommended. Ventilation systems of the exhaust type, vacuum cleaners or blower fans in mines help dilute the dust concentrations. Some high-voltage electrical precipitators have been installed, especially where valuable materials can be recovered from the dusts. Wet drilling and water sprays through the air also materially reduce the suspensions. Individual protection of workers exposed to dust hazards is afforded by wearing of pressure masks or respirators. Industrially, maximum allowable concentrations of contaminants, in milligrams per liter, are: iron or zinc oxide 0.015, arsenic, 0.0005, lead 0.00015, uranium 0.00005. (*See* also COAL AND COAL MINING; PNEUMOCONIOSIS.)

TABLE V.—*The Concentration of Typical Dust Exposures*

Type of work or location	Concentration in millions of particles per cubic foot
Talc mining; jack hammer drillers	2,160
Granite quarrying, jack hammer drillers	112
Anthracite coal mining; miners and helpers	231
Bituminous coal mining; coal cutters and loaders	112
Bituminous coal mining; 3 to 5 min. after blasting	3,300
Bituminous coal mining; before work	0.5
Municipal dust; street cleaners, congested district	4.1
Municipal dust; street cleaners, residential district	1.8

Relation to Atmospheric Phenomena.—Dust that is able to remain suspended in the atmosphere for any length of time cannot be discerned by the human eye. Most individual particles remain below 0.5μ diameter. In accumulation they can be noted as haze or by the Tyndall phenomenon (*see* below) in bright light. The rate of fall of particles in calm air under the influence of gravity is given by Stokes's formula:

$$v = \frac{2}{9} g \frac{(D_p - D_a) r^2}{\eta}$$

where v is the velocity of fall in centimetres per second, g the acceleration of gravity, η the viscosity of air, r the radius of the particles, D_p the density of the particles and D_a the density of the surrounding air.

For particles with diameters less than 10^{-4} cm., Stokes's formula is inadequate. At sea level pressure particles of 10^{-5} cm. diameter will fall about twice as fast, particles of 10^{-6} cm. diameter about 12 times as fast as indicated by Stokes's formula. A few velocities of fall for rock particles of density 2.3 at sea level pressure are as follows:

Size of particle in microns:	0.25	0.5	1	2	5
Time needed to fall 1 ft.:	10 hr.	3 hr.	1 hr.	15 min.	3 min.

In the free atmosphere only the largest dust particles will settle by gravity. Thermal and dynamic turbulence keeps most of the smaller ones in suspension long beyond the period indicated by Stokes's formula. The particles hurled by the Krakatau eruption to heights of 20 mi. needed about one year to fall to 10 mi. In

lower layers condensation in the form of cloud droplets and precipitation are by far the most effective eliminators of dust from the atmosphere.

Although supersaturations of atmospheric water vapour of 400% to 800% would be necessary for spontaneous condensation, there are nearly always enough condensation nuclei present to cause condensation at 100% relative humidity. Spontaneous freezing of water droplets will take place only at about −40° C. Since ice crystals initiate many precipitation processes, nuclei inducing freezing at higher temperatures have to be present. Vincent J. Schaefer found that loam and loess particles begin to act as freezing nuclei at −12° C. and are fully active at −25° C. Usually there are sufficient particles of this type in the atmosphere. At Mount Washington, N.H., the following frequency distribution of ice crystal nuclei was found:

Number per cubic metre	Per cent of cases
$1 \times 10^0 - 1 \times 10^2$	23.5
$1 \times 10^2 - 1 \times 10^4$	31.3
$1 \times 10^4 - 1 \times 10^6$	38.7
$1 \times 10^6 - 1 \times 10^7$	6.5

Bernard Vonnegut reported in 1947 that silver iodide particles are highly effective as freezing nuclei, acting at temperatures between −4° and −8° C. This material has been widely used for modification of clouds. Lead iodide and cupric sulfide are also effective freezing nuclei. Temperature inversions in the free atmosphere form sharp boundaries with the air below the inversion having normally about 20 times as many nuclei as the air just above the inversion.

W. D. Crozier and Ben K. Seely collected air-borne particles in the 0.5 to 30μ size class on a transcontinental flight from California to the Appalachians at 3,000-m. height. They found a minimum of 15,000 per cubic metre over Santa Catalina Island, Calif., and a maximum of 207,000 per cubic metre near Dunning, Neb. The high inland values presumably resulted from blowing soil in the Great Plains. Chlorides, presumably NaCl, dropped from a high value of 4,800 per cubic metre in eastern California to 0 in Nebraska.

The diurnal variation of nuclei in areas undisturbed by local pollution sources shows a maximum in daytime, a minimum at night. The same variation is noted for mountains where upward directed convection carries nuclei aloft during the day and where at night subsidence brings cleaner air to lower levels. The annual variation always shows more nuclei in winter than in summer. This is caused partly by greater pollution through domestic heat sources in winter and partly by the greater stability of the air which tends to keep the nuclei during that season close to the surface.

The variation of nuclei and gross particles in relation to the meteorological elements is not uniform. Both types tend to decrease in number with increasing wind speeds. However, in case of the relative humidity the gross particles tend to decrease with lower humidity values, while the nuclei, especially in areas far from pollution, increase in number. It is probable that with high humidities many of the hygroscopic nuclei grow into relatively big droplets and either escape counting in the conventional Aitken counter or settle because of their size. For the gross particles it was found that their number also shows a maximum directly under clouds and decreases rapidly inside a cloud.

Similarly, the relation of the number of nuclei to visibility is very complicated, although in first approximation the visibility increases with a decrease in nuclei. In air with a uniform type of nuclei, such as salt particles, at visibilities below 1 mi., only about one-half to one-fourth the number of nuclei is found than with visibilities above 20 mi. For the gross dust the inverse proportionality of numbers to visibility is much closer.

Industrial areas receive more rainfall because of the increased pollution with hygroscopic nuclei. In the Ruhr region of Germany the difference is about 1.2 in. to 1.6 in. per year compared with undisturbed surrounding areas. The increase is mostly noted in the number of rainfalls with less than 0.04 in. in 24 hours. It results in an average increase of 20 rainy days per year for the polluted region. For Tulsa, Okla., a 7% increase in rainfall compared to the environment has been calculated. Similar differences were found in Moscow, Munich and the English midlands. In addition to the pollution factor, it is likely that the increased turbulence over the cities and the water vapour added to the atmosphere by industrial processes are also responsible for the increase.

The reduction of visibility and absorption of solar radiation is another important influence of atmospheric dust. It depletes particularly the short wave lengths of the solar radiation.

Harry Wexler found in central North America that the turbidity of clean continental polar air originating in Canada is only one-half of that observed in continental tropical air from the southwestern interior of the continent, carrying considerable quantities of dust.

Other measurements of turbidity showed that in the Alps radiation at the surface was only 69% of the normal at times when Sahara dust storms were observed there. After the Katmai eruption in Alaska in 1912 only 80% of the normal radiation was observed in the subsequent summer and autumn. Following the Krakatau eruption, measurements at Montpellier, Fr., indicated that radiation had decreased by 25%; it remained below normal for three years. A smoke pall from forest fires in Alberta, drifting across eastern North America and the Atlantic ocean into Europe and the near east in Sept. 1950 cut the radiation at Washington, D.C., to 52% of normal and lowered maximum daily temperatures by an estimated 6° F., according to Wexler.

These effects are cited because pollution of the atmosphere by volcanic dust has been adduced as a cause of major climatic changes on the earth. William J. Humphreys advocated the hypothesis that more frequent volcanic eruptions in earlier geological periods led to climatic changes causing ice ages. It has been claimed that both the Krakatau and Katmai eruptions were followed by abnormally low temperatures throughout the world.

The everyday influences of dust on the optical properties of the atmosphere find, for the casual observer, expression as haze of varying intensity. Yet sometimes more striking phenomena are noticeable. One is the familiar Tyndall phenomenon of a bright streak of glittering minute particles scattering light from an intense source. In the open atmosphere this can be noted as sunbeams on cloudy days when a few rays penetrate through small holes in the clouds and cause the dust to scintillate in the illuminated column. During twilight hours similar beams originating from broken clouds below the horizon cause the so-called crepuscular rays, which give evidence of the presence of dust particles in high layers of the atmosphere as light from the setting sun strikes them.

During the periods of highest concentration of volcanic dust in the upper atmosphere after the Krakatau and Katmai eruptions, a corona of brownish colour known as Bishop's ring, caused by diffraction, was seen around the sun. In the case of the Krakatau dust the width of this ring was about 10 angular degrees, and the distance from the sun to its outer edge was 22 angular degrees. Joseph M. Pernter found from diffraction equations that the size of the particles causing the ring was about 1.85μ. Optical phenomena referred to as blue sun or blue moon are not infrequently noted as a result of high smoke or dust layers.

In the free atmosphere sharp horizontal boundaries separating a dusty layer from the clean upper layer can frequently be noted. These dust horizons are invariably associated with inversions of temperature which prevent convection and keep the polluted air confined to the lower layer. Over industrial regions, especially in winter and during the night and early morning hours, dust horizons are observed almost daily. Increasing daytime convection raises the ceiling of the dust horizon and the boundary becomes diffuse.

Methods for Measuring Dust.—In order to determine the concentration and properties of atmospheric dust, the amount of dust in the air, the size of the particles and the chemical and mineralogical composition are measured. For the first two objectives, methods developed by mid-20th century were adequate; for the last only qualitative tests existed. The determination of amounts of dust in the air is based on six fundamental principles: (1) deposition; (2) absorption; (3) impingement; (4) condensation;

(5) electrical precipitation; and (6) thermal precipitation.

The deposition methods are all simple but give only crude results. Paper strips, glass or metal plates, bowls coated with adhesive material or grids of very fine wires are exposed for specified intervals, and the dust particles spontaneously deposited on them are counted through a microscope, or, in case of heavy deposits, the weight increase of the sampler is determined. An instrument employing the deposition principle is called a konimeter. The British advisory committee on atmospheric pollution made use of the Cohen gauge as a standard. It is a funnel collector similar to the familiar rain gauge. Filtration of dust precipitated with rain has been resorted to, and similarly the dust deposited on a snow cover has been recovered by melting and filtration. This leaves, of course, only the water insoluble constituents.

Some of the absorption methods aspirate air through a filter, which in some designs is in the form of a porous paper thimble. The weight increase of the filter is measured after a specified amount of air has passed through it. In some recorders air is passed through a slowly moving band of filter paper. It leaves gray to black spots which are evaluated colorimetrically. For insoluble dusts a layer of moist, clean sugar has been successfully used as a filter. The air is passed through this filter and after sampling, the sugar is dissolved in water and the dust in a drop is counted microscopically. In another procedure the dust is centrifuged from the sugar solution and later weighed. Still another process is to bubble dusty air through clean liquids and count the number of particles in a sample of the liquid. This method is often combined with an impingement method in which the dusty air is expelled at high speed through an orifice against a surface and the deposited dust washed away by a liquid, such as grain alcohol. A sample of liquid is drawn into a pipette and a specified amount transferred to a counting cell similar to those used in bacteriological work. The counting is done microscopically, or, more conveniently, by microprojection of the cell onto a ruled screen. This general principle is used in the Greenburg-Smith impinger apparatus which became the widely used standard in the U.S. for investigation of dust in industrial establishments.

The impinger principle is also used in the various konimeters. The first construction of that type was developed by R. N. Kotze in 1916. A sample of dusty air is drawn by a pump through a nozzle 0.0225 in. in diameter and impinged on a glass plate, covered with a sticky substance, 0.0197 in. away from the nozzle. The dust particles are deposited on this plate by the high impact velocity. Modifications of the original construction have a round disk as impinger surface. This disk can be rotated so that a number of samples can be taken in rapid succession, each forming a dust spot on a numbered sector of the disk.

For recording purposes W. G. Hazard and Philip Drinker had the dust impinge on a slowly moving gelatinized film and recorded the density of the deposit photoelectrically.

A further modification combining the impinger feature with the condensation principle is used in J. S. Owens' jet dust counter. A measured amount of air is passed by a pump through a small chamber with wet blotting paper on its walls. The air is moistened to saturation and expelled through a narrow jet against a microscope slide, 1 mm. away. The sudden expansion of the air after exit from the jet causes condensation by adiabatic cooling, and droplets surrounding the dust particles are deposited on the slide. The water evaporates and the dust is left on the slide where it can be counted microscopically. Owens' counter is one of the most widely used pieces of equipment for the determination of dust in the open air.

The very small, submicroscopical condensation nuclei require a different technique to make them accessible to counting, as in the ingenious nuclei counter invented by John Aitken. An air sample is drawn by a graduated pump into a receiver which is kept near saturation by wetted filter paper. Afterward the air in the closed receiver is rapidly expanded by pumping with adiabatic cooling taking place. Water droplets form around the condensation nuclei and a shower of these droplets falls on a graduated disk where they can be counted through a lens system in dark-field illumination. It is assumed that each droplet represents one nucleus.

For continuous records a compressor-activated adiabatic expansion chamber with a photoelectric cell measuring the density of the cloud formed was described by Vonnegut in 1950.

The electrical precipitation method for dust sampling, using an alternating current of 15,000 v. on a wire and thus attracting and collecting dust, had not found widespread application by mid-20th century. The same could be said of the thermal dust precipitator. In that apparatus a heated wire is exposed between microscope slides. Around the wire a dust-free space develops while the dust in the aspirated air is deposited on the slides by convection currents.

To determine composition, microanalytical spot tests have been used. Counts of salt particles have been attempted by counting the number of yellow flashes (sodium D-line) in a flame. Radioactive particles have been counted by Geiger or scintillation counters.

Size Determinations.—For obtaining the size distribution of large samples as they settle on the floors of factories and mines the sedimentation balance has been used. A balance pan is suspended in a cylinder filled with liquid into which the dust sample is introduced at the top. The particles are weighed at fixed time intervals as they settle on the pan. The size distribution can be calculated from Stokes's formula from the observed settling rates.

The turbidity of the liquid in a sedimentation cell in which a sample of dust is settling can be measured photoelectrically at specified intervals. The absorption of light at a fixed level in the cell is a function of the size of the particles.

Air separation methods are also used for size determinations of large samples. A slow air current of known speed is passed through the sample. The smallest particles are raised, carried along and deposited in a filter thimble. The filter is removed and weighed. Then the air speed is increased and the procedure repeated. In this fashion the whole sample can be fractioned into size groups, the diameters being determined by Stokes's formula.

In the case of industrial dusts the X-ray diffraction method (*see* X-RAYS: *Modern Industrial Applications: Powder Diffraction Analysis*) and petrographic immersion methods, have been used, the last ones particularly for the determination of free silica in the suspensions. (H. E. Lg.)

DUST STORMS

The term dust storms covers a class of phenomena resulting from palpable amounts of dust or sand being raised from the ground into the air. Included are sandstorms, rising sand, blowing sand, sand drift, blowing dust, duster, dust haze and harmattan haze. They are common to most semiarid and desert regions of the continents. Excluded from this article are dust devils (*q.v.*).

Although dust connotes finer particles than sand, it is not customary to make a distinction between a dust storm and a sandstorm. Dust storm is the more popular term in the U.S., and sandstorm in north Africa and Asia Minor.

Meteorologists have long studied the occurrence of dust storms with respect to appearance, severity, distribution by region, season and hour, and to associated meteorological conditions. Maj. R. A. Bagnold has made the best field observations (Sahara) on the physics of blowing sand and checked them with aerodynamic theory and laboratory experiments. He found that when the wind at the ground exceeds a certain critical speed, its stress on the exposed sand grains moves the lighter grains to bump into other larger ones, rolling and jumping them along the ground in a general sand drift. This drifting reaches greater heights as the wind speed increases, but under thermally stable air conditions (temperature lapse rate less than the dry adiabatic equilibrium of 1° C. per 100 metres) it is unable to exceed several hundred feet. However, with unstable air, finer sand (*i.e.*, dust) is rapidly carried farther upward, as high as the rising currents go, an altitude which may sometimes surpass 15,000 ft. If referred to some standard height close to the ground, the critical wind speed for starting a sand drift depends on the size distribution of the exposed grains and their stability as an aggregate. Long exposure to a

given regime of winds may sort the grains into an arrangement which tends to resist erosion. Livestock and vehicular traffic can disturb this balance, and initiate wind erosion. M. G. El-Fandy computed that the rising dust particles heated by the sun's rays may warm the air as much as 3° C. per day (summer), increasing the thermal instability and thus accentuating the lifting of the dust.

It is now generally agreed that there are two essential requirements for the initiation of the dust storm: (1) Wind speed at the ground must exceed a certain critical speed. This generally ranges between 15 and 30 m.p.h., depending on the shape, size, specific gravity, dampness and temperature of the ground particles. In addition, the turbulence and instability of the lower atmosphere tend to enhance the raising of the dust (*i.e.*, lower the critical speed). (2) The ground must provide loose particles of the size that can be lifted by the air, and this loose material must not be so damp from dew or rain as to prevent the wind from raising it.

Most dust storms fall into one or the other of two broad types, though cases of an intermediate or mixed character do occur. The khamsin of Egypt (or gibleh of Libya) is the classical example of the first type. In this the blowing dust occurs over a rather extensive area associated with one or more sectors of air masses of a traveling barometric depression. The other type is local, associated with a thunderstorm or cumulo-nimbus cloud. The haboob of the Sudan is the classical example of the latter.

Haboob Type.—M. H. Freeman, writing of the Khartoum region, describes the well-developed haboob as

> . . . an impressive sight. It begins to form on the edge of a cumulonimbus cloud from which rain has begun to fall. The rain evaporates before reaching the ground and is visible as virga (precipitation trails). At first dust is blown upwards from the ground and resembles smoke from a line of fires on a windy day, with dense columns swirling upwards. As the haboob develops the columns merge to form a billowing wall of dust. The leading edge bulges forward to form a nose and the upper surface slopes back as in well-developed cold fronts. The dust soon rises to the level of the cloud base, about 5000–6000 feet and later extends still higher. Haboobs near Khartoum are usually reddish in colour, but they may be yellow or black according to the type of sand in the locality. When viewed from a distance a haboob appears as a whitish haze below the cloud. This is due to dust reflecting the sunlight, the wind is light and variable ahead of the haboob. Its arrival coincides with a sudden increase of wind and the initial squall is often severe. Almost instantaneously the visibility falls from good to some hundred of yards. Thereafter the gusty wind gradually decreases and the visibility improves. Most storms are over in less than an hour and a half, but occasionally one may last several hours. Many of the shorter ones are terminated by the onset of rain which soon washes the dust out of the air and damps the ground, thereby preventing further dust rising. Once formed haboobs sometimes move away from their parent cumulonimbus, and the deterioration is then likely to last longer. Three quarters of the haboobs started between noon and an hour after dusk. Many of those which began during the night were formed elsewhere earlier and arrived at Khartoum after dark. (M. H. Freeman, "Duststorms of the Anglo-Egyptian Sudan," *Meteorological Reports No. 11*, pp. 6–7, Meteorological Office, H.M.S.O. 1952.)

The haboob type belongs to the warmer season, especially the late spring and early summer. It occurs in dusty regions other than Khartoum, particularly those of India, Asia Minor, Australia and west Africa.

Khamsin Type.—The khamsin type is primarily a phenomenon of the colder season, in many regions tending to occur in the late winter and spring. It is the characteristic weather situation causing dust over coastal north Africa. From time to time, between October and June, a low-pressure area, passing eastward along the Mediterranean coast, causes, on its forward side, a strong flow of warm, desert air from the south (the khamsin proper); it is followed by a burst of cold air from the north on the rear side. The southerly current, as a result of its desert origin and its force, is always more or less dusty or hazy, and in spring and fall is likely to bring severe sandstorms as well. After the cold front leading the northerly current has passed a station, the sand may rise there again in the cold air rendered unstable by its transit over the warm Mediterranean and desert, especially in winter; it soon subsides, except well inland. There is likely to be a greater frequency, thickness and extent of the dusty air during the daytime, as a result of convection. The sandstorm, on the other hand, may begin and end at any hour, and it often continues severely all night, indeed for several days consecutively. Extensive dust storms analogous to the khamsin occur in Asia Minor, Iran, the U.S.S.R., India, China, Australia and the United States. The many severe dust storms over the Great Plains of the United States are mostly formed in the sectors of cyclonic storms occupied by dried-out polar maritime air of Pacific origin, as this is usually the most unstable air. The khamsin dust which follows a cold front may approach as a wall like the haboob, but the dust in the warm-air current generally sets in gradually as the wind slowly increases. The extent of the dust is variable, from scattered areas of a few hundred yards each to solid belts of over 100 mi.

Special Considerations.—Outside of khamsin and haboob situations of the classical type, sandstorms or shallow blowing sand and dust may occur locally over loose sand areas whenever in unstable air (afternoon hours) the wind speed rises to more than 15 or 20 m.p.h., whether summer or winter.

Dust once raised into the atmosphere takes on a variety of appearances as it is carried upward and away with the winds aloft. The typical dust wall, as with the haboob, forms when a sudden and marked increase of wind speed raises the dust along a broad and more or less continuous advancing front (squall line or cold front). Another aspect of some khamsin-type dust storms is the dust ceiling or dust overcast. This results when a warm dust-laden air mass overruns a shallow cooler air mass, and a heavy dustfall follows. Dustfalls around the Canary and Cape Verde islands are sometimes so thick that navigation is dangerous and birds roost it out on ships' riggings. Dusty air drawn into a distant cyclonic wind system and forced to rise over a colder air mass may precipitate muddy rain or snow down through the clean underlying air—the mud rains (*q.v.*) or red rains well known in Europe, and recorded occasionally in the U.S., Australia and China.

As the wind and instability associated with a dust storm subside, the larger (sand) particles soon fall out. However, the fine particles, of the order of .01 mm. diameter, have a terminal falling speed of about 1 cm. per second. Thus the upper air currents, usually moving more rapidly than the surface air layers, can carry dust composed of finer particles for several thousand miles before a sufficient amount has settled out or the dust has become so diffused by vertical and lateral mixing that the visibility and colour of the sky are no longer noticeably affected. This explains the widespread dust haze observed in regions far removed from the area of dust storms. Dust from the frequent haboob-type squalls (simooms, tornadoes) in the Sudan is spread by the prevailing easterly winds so that for much of the year the whole of west and central Africa from lat. 5° to 30° N. experiences a persistent dust haze (harmattan haze, dry haze, French: *brûme sèche*) which changes in density from day to day and season to season, becoming at times troublesome to aviation. This type of haze in more transitory form is also a feature of the Saudi Arabia-Iraq-Iran-Pakistan region.

The dust storm has serious practical consequences in obstructing vision, damaging machines and matériel, causing electrostatic discharges and radio static, soil erosion and dust deposition, impairing human health, etc.

For predicting dust storms the weather forecaster requires experience with the local vulnerability to blowing dust, a knowledge of the usual behaviour of the storms and an ability to forecast the winds, the thunderstorms or low-pressure systems with which the dust is associated.

See also references under "Dust" in the Index volume.

(R. G. Se.)

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DUST DEVIL. Also called sand devil, *diablo*, is a dusty whirlwind normally a few feet in diameter and about 100 ft. tall. At times it may be several hundred feet wide and several thousand feet high. Low pressure at the centre and strong vortex winds cause dust and small debris to be carried upward making the whirl appear as a vertical tube or funnel. Duration of the whirls range from a few minutes to more than an hour; wind speeds range from less than 10 to over 50 m.p.h. Strong ones may cause property damage. In appearance, a dust devil resembles a small tornado (*see* TORNADO); however, it usually forms over dusty, sandy, barren soil strongly heated by the sun on days of fair weather, such as are common in desert regions in the summer. Rotation of the whirls may be either clockwise or counterclockwise. They generally move with the wind but follow a curved path which depends on the direction of rotation and topography.

(L. J. Bn.)

DUST STORM: *see* DUST.

DUTCH EAST INDIA COMPANY, a body founded by a charter from the Netherlands states-general on March 20, 1602. It had a double purpose: to regulate and protect the already considerable trade carried on by the Dutch in the Indian ocean; and to help in prosecuting the long war of independence against Spain. Before the union between Portugal and Spain in 1580–81, the Dutch had been the chief carriers of eastern produce from Lisbon to northern Europe. When they were shut out from the Portuguese trade by the Spanish king they were driven to sail themselves to the east in order to make good their loss. Unsuccessful attempts were made to find a route to the east by the north of Europe and Asia, which would have been free from interference from the Spaniards and Portuguese. It was only when these failed that the Dutch decided to intrude on the already well-known route by the Cape of Good Hope and to fight their way to the Spice Islands of the Malay archipelago. A first expedition, commanded by Cornelius Houtman, a merchant long resident at Lisbon, sailed on April 2, 1595. It was provided with an itinerary or book of sailing instructions drawn up by Jan Huyghen van Linschoten (*c.* 1563–1611), a Dutchman who had visited Goa with the Portuguese before taking part in the Dutch arctic voyages of 1594–95 (his *Navigatio ac itinerarium* was published in 1595–96; Eng. trans., 1598). The voyage was marked by many disasters and losses, but the survivors, who reached the Texel on their return in Aug. 1597, brought back some valuable cargo and a treaty made with the sultan of Bantam in Java.

These results prompted a great outburst of commercial adventure. Companies described as "Van Ferne"—that is, of the distant seas—were formed, and by 1602 from 60 to 70 Dutch vessels had sailed to Hindustan and the Indian archipelago. On the distant seas the traders could neither be controlled nor protected by their home government. They fought among themselves as well as with the local peoples and the Portuguese, and their competition sent up prices in the eastern markets and brought them down at home. Largely at the suggestion of Johan van Oldenbarneveldt, and in full accordance with the economic principles of the time, the states-general decided to combine the existing separate companies into one united Dutch East India company, which could discharge the functions of a government in those remote seas, prosecute the war with the Spaniards and Portuguese and regulate the trade. A capital, estimated variously at a little above and a little under 6,500,000 florins, was raised by national subscription in shares of about 3,000 florins. The independence of the states which constituted the United Netherlands was recognized by the creation of local boards at Amsterdam, in Zeeland, at Delft and Rotterdam, Hoorn and Enkhuizen. The boards directed the trade of their own districts and were responsible to one another, but not for one another as toward the public. A general directorate of 60 members was chosen by the local boards. Amsterdam was represented by 20 directors, Zeeland by 12, Delft and Rotterdam by 14, and Hoorn and Enkhuizen also by 14. The real governing authority was the "Collegium," or board of control of 17 members, of whom 16 were chosen from the general directorate in proportion to the share which each local branch had contributed to the capital or joint stock. Amsterdam, which subscribed a half, had eight representatives; Zeeland, which found a quarter, had four; Delft and Rotterdam, Hoorn and Enkhuizen had two respectively, since each of the pairs had subscribed an eighth. The 17th member was nominated in succession by the other members of the United Netherlands.

A committee of ten was established at The Hague to transact the company's business with the states-general. The "collegium" of 17 nominated the governors-general who were appointed from 1609. The charter, which was granted for 21 years, conferred great powers on the company. It was endowed with a monopoly of the trade with the East Indies, was allowed to import free from all custom dues, though required to pay 3% on exports and charged with a rent to the states. It was authorized to maintain armed forces by sea and land, to erect forts and plant colonies, to make war or peace, to arrange treaties in the name of the stadtholder and to coin money. It had full administrative, judicial and legislative authority over the whole of the sphere of operations, which extended from the west of the Strait of Magellan westward to the Cape of Good Hope. Its headquarters were early fixed at Batavia in Java. Only the main dates of its progress can be mentioned here. By 1619 it had founded its capital in Batavia on the ruins of the native town of Jakarta. It expelled the Portuguese from Ceylon between 1638 and 1658, and from Malacca in 1641. Its establishment at the Cape of Good Hope, its only colony in the strict sense, began in 1652. A treaty with the local princes established its power in Sumatra in 1667.

The flourishing age of the company dates from 1605 and lasted till the closing years of the century. When at the summit of its prosperity in 1669 it possessed 150 trading ships, 40 ships of war and 10,000 soldiers and paid a dividend of 40%. In the last years of the 17th century its fortunes began to decline, for a variety of causes. The rigid monopoly that it enforced wherever it had the power provoked the anger of rivals. When Pieter Both, the first governor general, was sent out in 1609, his instructions from the board of control were to see that the Dutch had the entire monopoly of the trade with the East Indies, and that no other nation had any share whatever. The pursuit of this policy led the company into violent hostility with the English, who were also opening a trade with the east. Between 1613 and 1632 the Dutch drove the English from the Spice islands and the Malay archipelago almost entirely. The English were reduced to a precarious footing at Bantam in Java. One incident of this conflict, the torture and judicial murder of the English factors at Amboina in 1623, caused bitter hostility in England. The success of the company in the Malay archipelago was counterbalanced by losses elsewhere. It had in all eight governments: Amboina, Banda, Ternate, Macassar, Malacca, Ceylon, Cape of Good Hope and Java. Commissioners were placed in charge of its factories or trading posts in Bengal, on the Coromandel coast, at Surat and at Gambroon (or Bandar Abbas) in the Persian gulf, and in Thailand. Its trade was divided into the "grand trade" between Europe and the east, which was conducted in convoys sailing from and returning to Amsterdam; and the "Indies to Indies" or coasting trade between its possessions and native ports.

The company always placed its trading interests first, often preferring in the East Indies to rule indirectly through local princes who could relieve them of the work of government and supply contributions in kind. Nevertheless its political and military burdens slowly destroyed its profits, and, like the British East India company, it suffered from servants who put their own private trading interests before those of the company in an attempt to "get rich quick." In addition, the company's dividend policy

proved to be disastrous. The level of dividends was allowed to remain unduly high when the financial position would no longer justify it, money being borrowed for the purpose at the cost of creating a heavy burden of debt for the future. The final blow to its credit came when in 1780 the Dutch were involved in war with the British during the American Revolution. Thereafter it remained in existence only with help from the state, until the United Provinces were overrun by the French revolutionary armies in 1795. With the connection between the Dutch and their overseas empire broken, the company was administered by a government committee from 1796 and the government officially took over its possessions in 1798. *See* also references under "Dutch East India Company" in the Index.

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DUTCH EAST INDIES (NETHERLANDS EAST INDIES), located between 6° N. and 11° S. and between 95° and 141° E., was until Dec. 1949 one of the overseas territories of the Kingdom of the Netherlands. It comprised Sumatra and adjacent islands, Java with Madura, Borneo except for the British-controlled north and northwest parts, Celebes with Sangihe and Talaud Islands, the Moluccas and the so-called Lesser Sunda Islands east of Java with the exception of the Portuguese (eastern) part of Timor. These former Dutch territories form the Republic of Indonesia. New Guinea west of the meridian of 141° E., with its offshore islands of Waigeo, Salawati and Misoöl, was retained by the Netherlands until, on Aug. 15, 1962, it was ceded to Indonesia and renamed Irian Barat (West Irian). Before 1922 the Netherlands Indies were among the "colonies and oversea possessions" of the Kingdom of the Netherlands, but in that year an amended constitution recognized in principle the equality of the parts of the kingdom by using the term "territories" for describing the Netherlands as well as the overseas units. In World War II the entire area was occupied by Japan. The years 1945 to 1949 formed a transition period in which the Netherlands tried to regain control of the islands, but failed because of stubborn nationalist resistance and pressure from the United Nations. For geography *see* MALAY ARCHIPELAGO and articles on the separate islands, and for history, MALAY ARCHIPELAGO and INDONESIA, REPUBLIC OF. (J. O. M. B.)

DUTCH ELM DISEASE: *see* ELM.

DUTCH GUIANA: *see* GUIANA: *Surinam*.

DUTCH LANGUAGE is the name popularly applied to the Netherlandic (Netherlandish) language as spoken in Holland (kingdom of the Netherlands), whereas the same language in northern Belgium is popularly called Flemish. During the middle ages the name of the language was *Dietsc* or *Duutsc*, historically equivalent to German *Deutsch* and meaning simply "language of the people," as opposed to Latin, the language of religion and learning. The form *Duutsc* was borrowed into English and gives modern "Dutch." The present official name of the language is *Nederlands*, "Netherlandic." In Holland it is also popularly called *Hollands*, "Hollandish," reflecting the fact that the standard language is based largely on the dialect of the old province of Holland (now North and South Holland). *See* NETHERLANDIC LANGUAGE. (W. G. MN.)

DUTCH LITERATURE. Of the earliest inhabitants of the Netherlands only the Frisians have survived and although the modern province of Friesland is but a small part of the territory once held by them, they have maintained their own separate language and literature from the time of Bernlêf, who lived in the 8th century, to the 20th century. The remainder of the Netherlands was overrun and colonized by the Saxons and Franks between the 3rd and 9th centuries, resulting in a predominantly Frankish culture in the south and Saxon or an amalgam of Saxon and Frankish language and culture elsewhere.

Under the less nomadic Franks the south prospered more than the north and it was there that a literary language first developed, but only very gradually because of the marked differences between the dialects of the east (Limburg, with Middle German traits), the centre (Brabant) and the west (Flanders, with many Inguaeonic features which link the coastal dialects with Old English; *see* BELGIAN LITERATURE: *Flemish*).

In the early middle ages when Latin and, later, French were the languages of the educated, the vernacular was largely confined to unrecorded oral legend and folk songs. The earliest text which can claim to contain Old Dutch is the "Wachtendonk Psalm Fragments" (early 10th-century), though since the preponderant dialect is Middle Franconian, it probably originated on the German side of the border; and of course even the specifically Low Franconian parts are representative only of the eastern form of Old Dutch.

Medieval Poetry.—The writings of the earliest known Dutch poet, Henric van Veldeke (*see* HEINRICH VON VELDEKE and BELGIAN LITERATURE: *Flemish*), are typical of an age of religious zeal emanating from the centres of learning in France. His life of Servatius (*c.* 1170), patron saint of Maastricht, is a rendering of a Latin original into the Limburg dialect and his *Eneide* (*c.* 1185) is a diffuse Limburg version of the 12th-century French transposition of Virgil's epic into a Christian and feudal setting. The *Eneide* and his love songs (*see* MINNESINGER) had a significant influence on poetry in Germany, where Rudolf von Ems (1200–54?) referred to him as the originator of rhymed verse. That neither Henric himself nor any of his countrymen made this claim suggests that there were earlier Dutch poets in rhyme who were unknown in Germany.

Apart from one other early Limburg text, a fragment of the Carolingian epic *Aiol* (*c.* 1200), 13th- and 14th-century texts were generally written in Flanders and Brabant, provinces where expanding trade produced centres of culture in which the prevailing influence was French. Fragments of indifferent Dutch versions of Frankish precourtly epics (*Renout van Montalbaen, Het Roelantslied, De Lorreinen*, etc.) are redeemed by a complete and probably entirely original romance, the 12th- or 13th-century *Karel ende Elegast*, a Flemish masterpiece of feudal reverence quickened by dry humour (*see* CHARLEMAGNE LEGENDS).

The crusades brought the courtly romances into vogue: some were derived from classical history, such as Segher Dengotgaf's delightful *Het Prieel van Troyen* and *Parlement van Troyen* (both from the French of Benoît de Sainte Maure (*q.v.*), also the source for van Maerlant's history of Troy); others, like the sentimental idyl *Floris ende Blancefloer* by Diederic van Assenede (d. *c.* 1292), were oriental tales; and most popular of all were the Celtic sagas, including the Arthurian cycle which came to the Netherlands through France, and *De reis van Sinte Brandaen* (12th-century), a lively tale based on an Irish odyssey in Latin. But by the 1260s, when Jacob van Maerlant (*q.v.*) wrote his *Alexander, Die Historie van den Grale, Merlijns Boeck* and *Historie van Troyen*, chivalry was on the decline and the titles of van Maerlant's later works reveal something of the utilitarian reaction to romanticism and mysticism at the end of the 13th century: *Der Naturen Bloeme, Rijmbijbel* and *Spieghel historiael* (1290). The compendia of knowledge which van Maerlant had popularized were multiplied in worthless imitations in the 14th century, though two *clercken* ("scholars") are worthy of note, Jan van Boendale (1280–1365) for his *Der Leken spieghel* (written 1325–30) and Melis Stoke for his *Rÿmkronek van Holland* (1305). Indeed popular didactics have remained, as will be seen, a favoured genre throughout Dutch literature.

Equally typical of the change in fashion and of far greater literary importance is *Van den vos Reinaerde* (*c.* 1250), one of the most important versions of the cycle of stories associated with Reynard the Fox (*q.v.*). A parody of the Germanic epic and manners at court, it is a composite work by two Flemish poets (Aernout and Willem). The best part is also the earliest, a late 12th-century rendering of the French poem *Le Plaid*. This ageless classic of subtle caricature and sly good humour is an outstanding contribution to the whole world of literature.

Far removed from the clamour of the rising third estate for factual knowledge, the nun Hadewych (*q.v.*) was writing mystical songs that winged their way over the level of popular taste. Her poetry is a radiant example of the love lyric, which must have been passed on from van Veldeke in works now lost. The burning

sincerity of the ecstatic *minnesangen* and *Visioenen* and her hortatory letters inspired later mystics, the greatest of whom was Jan van Ruysbroeck (*q.v.*). This disciple of the great 14th-century German mystic Meister Eckhart (*q.v.*) was undoubtedly the Netherlands' greatest medieval prose writer. He was also typical of Dutch didacticism at its best, for (like the 19th-century Flemish poet Guido Gezelle, *q.v.*) he had the true artist's gift of expressing great truths in simple terms. His most famous work, a guide to the soul in search of God, is *De Chierheit der gheestliker Brulocht* (1350, "The Glory of the Spiritual Marriage"). The rapid spread of Ruysbroeck's prose writings in Latin translations and the powerful influence of German mysticism in the 14th century were due to a reawakening in the religious foundations which called for and produced a quantity of instructional literature for the laity. Ruysbroeck's influence is appreciable well into the 15th century, when Thomas à Kempis' *Imitatio Christi* sets the tone of the *devotio moderna*. Other popular means of instructing the laity in the middle ages were the *exempelen*, short stories illustrating tracts, sermons, Bible stories and so on, and of course the legends. *Beatrijs*, the best of the European Mary legends, was written in a dialect similar to Hadewych's East Flemish and the courtly reverence in it suggests that it is a 13th-century work. Legends about the miraculous powers of the Virgin were widely current at this time. One other, *Theophilus*, has been preserved and many others were later collected in abridged prose versions, but there is a rare beauty in the simplicity of *Beatrijs*.

Medieval Drama and the Rederijkers.—It is unfortunate that no early religious drama has been preserved, particularly since there must have been a dramatic tradition up to the *abele spelen*. These were entirely secular plays, possibly the first in Europe, exotic romances of chivalry and love, such as might well have been the natural development of simple mime added to the minstrel's popular ballads and lays. It is impossible to discover the date of the songs since they had been in circulation for centuries before scribes and printers started recording and collecting them in the 15th and 16th centuries. But many of them have Germanic line structures and sing of ancient legends and sagas. The earliest *abele spelen* and farces (*sotternieën* or *kluchten*) that often followed them as a light (and frequently bawdy) diversion date from the 14th century. Further romantic plays were certainly written in the 15th and 16th centuries, but only one of these has survived, Colijn van Rijssele's *Spiegel der Minnen*. Van Rijssele was a "Rederijker," and it was in the "Rederijkers Kamers," or chambers of rhetoric, that the farce thrived in the 15th century.

These chambers, which spread rapidly from the French border in the 15th century, were organized like guilds with functions similar to those of the medieval French dramatic societies (*puys*); French influence is evident both in their organization and in their name (from *rhétoriquer*). Towns which protected them commissioned them to provide the ceremonial at local religious and secular festivals and they were of great influence in popularizing art and morals.

Drama by this time had largely passed from the hands of the clergy to the hands of the laity (*see* DRAMA: *Medieval Drama*); and the introduction of secular themes had necessitated the use of stages or carts outside religious buildings. The *Rederijkers Kamers* depended on literary performance for their very existence and lacked neither the enterprise nor the wealth to display their prowess on a grand scale. To this end national festivals (*Landjuwelen*) were lavishly organized and competitions held at which prizes were offered for poetry and drama. One of the finest plays of this period, *Elckerlyc*, a morality of *c.* 1470 (by Pieter Doorlant?) won a prize at a *Landjuweel* and became famous in England (as *Everyman*). *Mariken van Nieumeghen*, a miracle play (*c.* 1500), is remarkably modern both in its psychological insight and its technique. The "miracle" of the renegade's conversion is achieved by the simple and realistic device of confronting her with a topical "pageant" street play, a theme within a theme.

The Rederijkers also developed a new poetic form, the *referein*, seen at its best in the militant anti-Lutheran poetry of Anna Bijns (1494–1575). But as the number of Kamers multiplied they degenerated into mutual admiration societies for poetasters and only the Egelantier ("Wild Briar") and the Wit Lavendel ("White Lavender") remained famous into the 17th century because of the leading Renaissance poets associated with them in Amsterdam.

Renaissance and Reformation.—The 16th century is characterized by the diversity of its literary forms which reflect an age in decline confronted by the first articulation of the new art coming to the Netherlands from Italy through France. The new printing presses not only served the demand for popular literature, both from medieval sources and from the pens of the reformers; they were also the means of spreading the esoteric poetry and learning of the humanists. Chapbooks, containing prose versions of medieval romances and new translations from the French, folk songs and Rederijkers verse; the new psalm translations by Pieter Datheen (Dathenus, *c.* 1531–90), Philips van Marnix van Sint Aldegonde (*q.v.*) and others, Reformation propaganda in the form of pamphlets such as Marnix's *Biencorf der H. Roomsche Kercke* (1569) and the marching songs, the *Geuzenliederen*, of the Calvinist revolt against Spain (one of which, the "Wilhelmus," became the national anthem); the first sonnets, the first dissertations in the vernacular and the first grammars of the Dutch language—the very abundance of the flow as well as its diversity displays the restlessness of an age of change, in social and political patterns, religion, art and learning.

The new iambic metres and the first echoes of classical antiquity came to the Netherlands in the odes, sonnets and translations of Jan van der Noot and of the first northern poet of the Renaissance, Jan van Hout (1542–1609). Carel van Mander (1548–1606), painter and poet, introduced scholarly prose writing in his well-known *Schilderboeck* (1604), though, of course, the noble Latin prose of Erasmus (*q.v.*) had been famous throughout Europe for nearly a century.

Van der Noot's *Het Bosken* (1570 or 1571), a collection of Petrarchan sonnets in the manner of Pierre de Ronsard, was published in London, where he was then an exile on account of his participation in an insurrection in 1567. Indeed, in the wresting of the tiny Dutch republic from a European empire many Dutchmen suffered, none more so than the moderates who could appeal to neither side for protection. Dirck Volkertszoon Coornhert (1522–90) was one of a number of Erasmian moderates whose outspoken views cost him his freedom. Humanist poet, doctrinal pamphleteer, translator and moral philosopher, he is justly remembered for his stoical Christian ethic *Zedekunst dat is Wellevenskunst* (1586). Montaigne and the Bible are his mentors, but the supple and lucid, even entertaining, style is his alone and in a work, moreover, of which the subject required a vocabulary that had to be created for the purpose. Indeed, it was Coornhert and his successors, in particular the translators of the Dutch authorized version of the Bible (1637), who laid the foundations of the standard language of today. The importance of the non-Flemish dialects in the compounding of this literary norm was strikingly demonstrated in more recent times, when the 19th-century revival of literary Flemish in Belgium necessitated further efforts toward standardization between north and south.

The Spanish hold on the Catholic south during and after the Eighty Years' War (1568–1648) caused a decline in Brabant and Flanders; by contrast there was a spectacular expansion in Holland, to which artists, intellectuals and financiers had fled from the Spanish armies. The sudden rise of Amsterdam and The Hague as the emergent capitals of an empire and the birth of civic pride in the writers of the Golden Age symbolize the final passing of a medieval age belonging to Ghent, Bruges, Liège and Antwerp.

The Poets of the Golden Age.—Henric Laurenszoon Spiegel, Coornhert's friend and kindred spirit, is the greatest of a generation straddling the old and the new. He was a member of the medieval Egelantier Kamer in Amsterdam and he wrote both for the burgher and for the scholar. His *Nieu Jaar Liedekens* (incomplete first ed., 1609) and *Lieden op 't Vader Ons* (first printed 1723; modern ed., 1957) continued a medieval tradition recast in Renaissance style and re-echoing Erasmian moderation; at the same time his learned *Twespraack van de Nederduytsche Letterkunst* (1584) with its preface by Coornhert was intended to popularize the proper use of a national language. On the other hand,

his unfinished *Hertspiegel* (published 1614) is particularly abstruse because it is a first attempt at philosophizing in the vernacular and in poetry. Only seven of the nine proposed cantos were completed, forming a very personal pendant to Coornhert's *Wellevenskunst*. The dichotomy inherent in the Renaissance—between popular religious revival and humanism (of interest only to the few)—was particularly marked in Holland because of the incompatibility of rigorous Calvinistic principles with the ideals of pagan antiquity. This caused a tense ambivalence in many writers of the 17th century who took both their religion and art seriously, such as Heinsius, Bredero and Vondel. Others, like Jakob Cats and Jacobus Revius, were less concerned about the new learning than they were about the Protestant faith, whereas Hooft was more a humanist than a Christian.

Daniel Heinsius (*q.v.*), a celebrated humanist at Leiden university (though of Flemish extraction) wrote Latin plays which, like those of Hugo Grotius (*q.v.*), were models for Hooft and Vondel. But he also added his considerable authority to the claims of the vernacular by writing a shamelessly Dionysian *Hymnus oft Lofsanck van Bacchus* (1614) and an equally devout *Lofsanck van Jesus Christus* (1615). It was a sign of the times that his fellow Calvinists, such as Revius, saw no incompatibility in the work of the first poet to "launch an arrow of true religion across the country."

In his work (which has great charm and forthrightness) Gerbrand Adriaenszoon Bredero (*q.v.*) gives the impression of having lived, loved and suffered to the full during his short life in the bustle of cosmopolitan Amsterdam. His material is the life of the commoner, his medium the folk song, farce or comedy. His secular songs in medieval style and devotional songs in Renaissance verse tell of a passionate devotion to women and a yearning for religious moderation as taught by Coornhert and Spiegel. His three tragicomedies based on the Amadis novels were not successful, but he wrote three farces which mark the zenith of this medieval genre: *Klucht van de Koe* (1612), *Klucht van den Molenaar* (1613), *Klucht van Symen sonder Soetigheyd* (1612 or 1613). Day-to-day existence in the up-and-coming metropolis of Amsterdam provides material for two comedies, *Het Moortje* (1615, inspired by Terence's *Eunuchus*) and his masterpiece, *De Spaanschen Brabander* (1617).

Amsterdam, the raucous, bustling city of the Spanish Brabantine, was also the home of Joost van den Vondel (*q.v.*). Indeed, as one of many Brabantines entering the capital, he joined the Rederijkers Kamer founded there for southerners, the Wit Lavendel. Like Bredero he was a self-educated man of humble stock and he resolved the conflict between artistic and religious leanings only when he entered the Roman church at the age of 54. This, a courageous act of faith at a time when Catholics were an unpopular minority, is typical of his integrity. His pursuit of truth and perfection lasted right up to the culmination of his work at the age of 80 and led him from a Baptist upbringing to Remonstrant liberalism and onward, from self-taught French to Latin (Seneca) and thence to Greek (Sophocles), deferring as he learned to his "masters," Guillaume Du Bartas, Grotius, Caspar van Baerle (1584–1648) and Geraert Vos (1577–1649). It is a measure of Vondel's indomitable personality that his attitude toward contemporary people and events, of which he was a fearless chronicler, prevails to this day, even where history records a different view. Yet because he does not allow his personality to impose on the scriptural authenticity of his plays, these are too austere and remote to be popular today. Nevertheless in his baroque masterpieces *Joseph in Dothan* (1640), *Lucifer* (1654), *Jephta* (1659) and *Adam in Ballingschap* (1664) he is as great an artist of the Counter Reformation as his contemporary, Rubens.

If Bredero was the noble commoner and Vondel the noble citizen, Pieter Corneliszoon Hooft (*q.v.*) was certainly the noble aristocrat. He was one of the fortunate few in Holland to bring the refinements of the new art from Italy direct. He lavished an Italianate flourish alike on his Petrarchan sonnets, his pastoral *Granida* (1605), his Senecan and Plautian plays, on the studied prose of his letters and his monumental (and unfinished) history of the war against Spain and his art of living. His castle at Muyden became a neo-Florentine centre for the entertainment of artists and scholars attracted by mutual interest in poetry, music and learning and the charm of such gifted young women as the Roemer Visscher daughters.

Anna Visscher (1583–1651), like her father Roemer (1547–1620; Spiegel's contemporary in the Egelantier), versified popular ethics in the manner that was to bring Jakob Cats (*q.v.*) such unmerited fame. Cats' prolix moralizing, pedestrian doggerel and patronizing tone force their way into the literature of his country if only because of the disastrous influence they had on the taste of the middle classes; until, half way through the 19th century, Multatuli (Eduard Douwes Dekker) let fresh air into the smug atmosphere of the Dutch front parlour.

As learned as Hooft but less of a poet, as humorous as Bredero but a more harmonious individual, Constantijn Huygens (*q.v.*) had all the qualities to which the Dutchman of his day might aspire. Of strict Calvinist principles, he was an able if not brilliant diplomat who wrote trenchant, shrewd and witty poetry in his leisure hours (as he called his first volume of moral emblems—*Otia of Ledighe Uren*, 1625) as well as making excellent translations of some of John Donne's poetry.

There were many who attempted to emulate the work of these masters and few who had talent enough to be remembered. Jan Janszoon Starter (1594–1626) rarely attains Bredero's subtlety or feeling in his amorous and jocular poetry contained in *Friesche Lusthof* (1621). Of those who cultivated Vondel's poetic diction the best was Jeremias de Decker (1609–66), who in his *Rym-Oefeningen* (1656) does sometimes convey deep and moving feeling. Hooft's prose writing provided a model for Geeraert Brandt (1626–85) who wrote a very readable, straightforward account of the Reformation and biographies of M. A. de Ruyter, Hooft and Vondel.

But there were also four poets, three of whom were clerics, who contributed religious verse of considerable merit in its own right. The Roman Catholic Joannes Stalpart van der Wiele's *Geestelijke Lofsangen* (1634) contains songs of medieval simplicity and devotion. Jacobus Revius (1586–1658), stern poet of Calvinist orthodoxy, was such a master of the Renaissance forms and the sonnet in particular that he could use them with great effect to express the vigour and sincerity of his dogmatism. By a strange fate Revius, teaching the faith of so many in a language they could understand, was almost unread, whereas Dirk Rafaelszoon Camphuysen (1586–1627), who was removed from his parish because of his unorthodoxy, satisfied a widespread demand for personal, devotional poetry in his *Stichtelyke Rymen* (1625).

Equally popular were the introspective collections of mystical poetry (*e.g.*, *Jesus en de Ziel*, 1678) by the ascetic Jan Luyken (1649–1712). He was a layman who had started by writing hedonistic songs in *Duytse Lier* (1671) containing love lyrics as fine as any in this country.

Writers of the Late 17th and 18th Centuries.—If the transformation of the amalgamated Amsterdam Kamers into a theatre and thence into the embryo of a university had been symbolic of the advance in art and learning, the appearance in 1669 of the first literary society (*dichtgenootschap*) must be regarded as an omen of a decline at this time which was to last right through the 18th century. Material well-being sapped the vitality of a nation, which slipped into an ignoble era of emasculate flirtation with its heroes of the past and fashionable French contemporaries. This was the heyday of what later generations dubbed "pen-lickers and tipplers in powdered wigs." Even where real talent was evident in the one poet, Hubert Poot (1689–1733), this was prostituted by the delusion of his day that rococo flourish and prescribed form were the criteria of true poetry. And prose, which had worthy antecedents in the august style of Hooft and Vondel, the less ornate writing of Coornhert and Huygens and the homespun ship's journals of William Bontekoe (Journael . . . van de Oost-Indische Reyse, 1646), consisted in the 18th century almost exclusively of translations and bombastic disquisitions. It is significant that Justus van Effen (1684–1735) wrote in French before he made his name as the founder of *De Hollandse Spectator*

(1731–35). The simple style in his pedagogic, moralizing essays makes a welcome contrast to the work of his contemporaries, and his descriptive realism links his name with other popular writers of the Dutch domestic scene, Cats, Elisabeth Wolff-Bekker and Agatha Deken and Nicolaas Beets.

Elisabeth Wolff-Bekker (1738–1804) was more than a realist, however. She was a highly intelligent woman with a nice sense of humour, in her unorthodoxy the child of rationalism, in her romanticism the precursor of the 19th century. She had made a name as an essayist and poet before her association with Agatha Deken (1741–1804), a close friend with some talent, though less spirit. The work for which they are most famous is the epistolary novel *Sara Burgerhart* (1782), dedicated to "Dutch young ladies" and proudly announcing "Not translated" on the title page. This is the first Dutch novel and in its remarkable realism and intricate composition it improves on Richardson, on whose writings it was modeled. The eight-volume *Willem Leevend* (1784–85) has a similar purpose of educating the young in moral virtue and here, too, the original didactic intention recedes behind the authors' creative genius.

By the end of the 18th century there were a number of poets, Hieronymus van Alphen (1746–1803), Rhijnvis Feith (1753–1824), Jacobus Bellamy (1757–86) and Antony Staring (1767–1840), who were reacting against flaccid neoclassicism, but only Staring achieved more than a naïve or melancholy echo of German sentimentalism. He had a keen awareness of beauty in nature and was sufficiently original to avoid the banalities then in circulation. Staring is an undemonstrative poet with the descriptive talent of Cats and something of Huygen's subtlety. He was, in fact, too pure an artist for his contemporaries, who preferred the self-appointed leadership of Willem Bilderdijk (*q.v.*). Bilderdijk's turgid excesses almost smother a real spark of genius, yet where his feeling is true his poetry carries conviction despite its rhetoric. In fact his Protestant zeal had repercussions in the "Reveil," a spiritual movement which gave the impetus to the literary revival of the 1830s.

The Reveil and De Gids.—Jacob Geel's essays in *Onderzoek en Phantasie* (1838) set a new standard in philological and philosophical criticism. Yet he, like Staring, was almost swept aside by the growing wave of romanticism. At the same time, the reactionary freethinking of the new Enlightenment roused the dormant militancy of the Calvinist church, which realized the danger to its entrenched position. Bilderdijk and his disciple Isaäc da Costa (1798–1860) had vociferously reminded the nation of its divine mission and the historical novel abroad (particularly the work of Chateaubriand and Scott) provided an ideal form for a specifically Christian national romanticism. When in 1826 David van Lennep (1774–1853) published a paper calling for Dutch novels modeled on Walter Scott, his son Jacob van Lennep (*q.v.*) promptly responded with a medieval story, *De Pleegzoon* (1833). He was a prolific writer of poetry, novels, drama, libretti, translations (of Byron, Scott, Shakespeare), history and literary criticism, though the only work of his that is now read is a romantic rather than historical novel, *Ferdinand Huyck* (1840). Far more important, however, was *Hermingard van de Eikenterpen* (1832) by Aarnout Drost (b. 1810), published two years before his death at 24. In this sensitive and moving story of missionary evangelism in 4th-century Holland, the modern novel suddenly made its appearance, despite an archaic use of language and romantic lapses into naïve characterization. During his short life Drost also started a new literary journal which was, like his novel, true to the spirit of the "Reveil." Though *De Muzen* (1834) only ran for less than a year, it attracted to its staff the historian R. C. Bakhuizen van den Brink (1810–65) and the future leader of the literary revival, E. J. Potgieter (*q.v.*). These two men continued the campaign to improve critical standards in *De Gids* (1837 *et seq.*), soon to be known as the "Blue Butcher" because of its merciless treatment of complacency. It was Potgieter who stated the requirements of the historical novel and Anna Bosboom-Toussaint (1812–86), who put them into effect by transposing the universal Christian idealism of Drost's book to the national Protestant faith of the Golden Age. She even reproduced Drost's archaic language but improved greatly on his technique and characterization in her diffuse novels which include a ten-volume cycle set in the Holland of the Leicester administration. Her best-known book, *Majoor Frans* (1874), is not a historical novel since it belongs to a less romantic era, one of liberal politics and female emancipationists. One other historical novel had an effect out of all proportion to its literary value. Hendrik Conscience's *De Leeuw van Vlaanderen* (1838) brought southern literature out of an obscurity that had lasted for nearly 300 years, for it aroused a national consciousness in Flanders which matured in the Flemish revival. (*See* BELGIAN LITERATURE: *Flemish.*)

Nicolaas Beets (*q.v.*) was and still is undoubtedly the most popular writer of his period. His valueless collections of poems (*e.g., Korenbloemen,* 1853) were very popular during his lifetime and he was fêted as the national Protestant poet of his day. His valid claim to fame rests solely on the sketches in his *Camera Obscura,* published under the pseudonym "Hildebrand" in 1839, which reveal a power of observation almost as shrewd as that of Dickens, whom he admired. But Dickensian humanity is all too often lacking in the bright young theologian who, having "stripped the language of its Sunday suit," somewhat incongruously maintains a supercilious attitude toward the middle classes. His patronizing tone irritated Potgieter, whose subtler humour never had the appeal of the work of Beets or of Johannes Kneppelhout (1814–85), a fellow-student at Leiden who wrote *Studententypen* (1839–41) and *Studentenleven* (1841–44). But Potgieter's quest for originality in his prose and poetry tends to deprive his style of simplicity and clarity. His great talent is never in doubt; his genius frequently is. Such was the duration of Potgieter's dominant influence that whereas Geel was discredited when Potgieter planned *De Gids* and the romantic movement, Geel's successor Busken Huet became Potgieter's fellow critic toward the end of his life when skepticism was undermining romanticism.

Conrad Busken Huet was a progressive who, like several of his generation, left the church rather than uphold conformity. An admirer of French sophistication and the critical tenets of Sainte-Beuve and Taine, he adopted sober, personal and frequently merciless standards which at last placed Dutch writing in a truer perspective with western European writing. His essays were collected in the 25 volumes of *Litterarische Fantasiën en Kritieken* (1868–88) and his later work, which gains in composure what it loses in brilliance, is best represented by *Het Land van Rembrandt* (1882–84).

Meanwhile, a furor had been caused by an entirely unknown writer, "Multatuli," whose first book "fell like a thunderbolt from Insulinde [*i.e.,* the East Indies], and set the country ablaze." This was the description of the editor of *De Nederlandsche Spectator,* the classical scholar Carel Vosmaer (1826–88), who by his immediate recognition of the genius of Multatuli was the lone forerunner of the critical theories of the review *De Nieuwe Gids* ("The New Guide"). Multatuli was the pseudonym of Eduard Douwes Dekker (*q.v.*), whose *Max Havelaar* (1860), a masterly satire of Dutch exploitation of the Dutch East Indies, suddenly revealed the full poignancy of a language which had too long been insipid or artificially flavoured. As quixotic as his *Woutertje Pieterse* (1865–77), as disharmonious as his *Minnebrieven* (1861), Douwes Dekker's writing vibrates between extremes of sentimentality and anarchy, ambitious arrogance and self-sacrifice, iconoclasm and utopianism. It is not surprising that although poetry as a convention was anathema to him he was greatly admired by the coming generation of reactionaries and Jacques Perk (1859–81) wrote sketches in the humorous style of Multatuli before writing the sonnet cycle *Mathilde* (published posthumously in 1882), which opened a new epoch in Dutch literature.

Renaissance of the 1880s.—Publication of the first number of *De Nieuwe Gids* in 1885 marked the beginning of an important renaissance of literature in the northern Netherlands. *De Nieuwe Gids* differed from *De Gids* in that it pursued an exclusively aesthetic ideal. The leaders of the movement were the poets Willem Kloos and Albert Verwey and the prose writer Lodewijk van Deyssel (*qq.v.*). Kloos sang the beauty that pleases the senses. Verwey passed from impressionistic to symbolical

verse. He also did good work in literary history. Van Deyssel was the violent and lyrical critic of the movement. Frederik van Eeden (*q.v.*), dramatist, poet and prose writer, occupied a special place. His best work in prose is *De Kleine Johannes* (1885), the story of the soul of a child. His *Van de Koele Meren des Doods* (1900) is an important novel about mental disturbance. The poet Hélène Lapidoth-Swarth (1859–1941) stood very near to the movement with her lyrical works written in particularly delicate language full of resonance. Herman Gorter (*q.v.*) acquired the foremost position in Dutch poetry when he published his poem *Mei* (1899). Jan Hendrik Leopold, poet of a tragic individualism, produced work of great sensitivity. Pieter Cornelis Boutens (*q.v.*) gradually acquired a mastery of his poetic form and expressed himself in strongly rhythmic verse, sometimes of an unearthly beauty.

Among the men of the 1880s (*De Tachtigers*) must also be placed Jacobus van Looy (1855–1930), a writer of beautiful prose (*Proza, Gekken, Feesten, Jaapje, Jaap*, the last two of which are autobiographical). The great novelist Louis Couperus (*q.v.*) described the life of The Hague society (*Eline Vere, De Boeken der Kleine Zielen*) and made splendid imaginative reconstructions of antiquity (*De Berg van Licht, Antiek Toerisme, Herakles, De Komedianten, Iskander*). The movement of the 1880s was mainly individualistic. Immediately afterward came a group of authors whose feelings were more social. The dramatist and writer of sketches, Herman Heijermans (*q.v.*), wrote social dramas which are among the greater triumphs of the Dutch stage. The novelist Israel Querido (1872–1932) was a typical Dutch naturalist. In addition may be mentioned the novelists Carel and Margo Scharten-Antink and some women novelists: Augusta de Wit, Ina Boudier Bakker, Top Naeff and Carry van Bruggen.

20th-Century Writers.—After the intoxication of the soul and the senses in the revival of the 1880s most of the writers of the early 20th century turned from this pronounced individualism to a socialistic or ethical vein. The language became sober once more. In prose, reasonableness and wisdom were stressed more than beauty and colour. This sentiment found expression in Albert Verwey's magazine *De Beweging* ("The Movement," 1905–19). Another important reaction to the 1880s was that of the idealistic prewar socialists such as Herman Gorter and the powerful lyrical poet Henriette Roland Holst van der Schalk.

Some of the most significant poets of the early 20th century were Adriaan Roland Holst (1888–), who, like W. B. Yeats, constructed his own mythological world; J. C. Bloem (1887–), who wrote poetry of longing and disillusion; P. N. van Eyck (1887–1954), poet and essayist; Martinus Nijhoff (*q.v.*), whose work seems to catch the crystal clear morning light of a Dutch interior by Vermeer; and Victor Emmanuel van Vriesland (1892–), an erudite essayist and poet steeped in the French symbolist tradition.

The principal prose writer of the period of neoromanticism was Arthur van Schendel, who in his most mature writing created the same scenic and especially moral world found in Rembrandt's paintings. Aart van der Leeuw (1876–1931) was a subtle poet and prose writer of an idyllic romanticism. Anthonie Donker (1902–) wrote reflective verse of a melancholic nature.

World War I produced three great poets, Jan Slauerhoff (1898–1936), Hendrik de Vries (1896–) and especially Hendrik Marsman (*q.v.*) who, under the influence of German expressionism, attempted to break with all tradition. Jan Greshoff (1888–), poet and essayist, has his proper place among the younger generation grouped around the literary magazine *Forum*, established in 1932 by Menno ter Braak (*q.v.*), a brilliant cultural philosopher and independent thinker, and Edgar du Perron, eminent polemical essayist and novelist of great force, leaders of a movement of writers who wanted in literature less surface, fewer beautiful words and greater sincerity.

Between World Wars I and II, a period of anxiety and mental stress, the influence of Sigmund Freud became strongly marked in irrational poets such as Gerrit Achterberg (1905–1962) and Eduard Hoornik (1910–) but was most clearly noticeable in the prose, poetry and essays of the extremely subtle, astonishingly gifted Simon Vestdijk (1898–), the most important and prolific Dutch writer of the mid-20th century. The work of the novelist Frans Bordewijk (1884–) moves between the two opposites of chaotic fear and severe discipline. Among other popular novelists mention should be made of A. M. de Jong (1888–1943), Antoon Coolen (1897–1961), A. den Doolaard (1901–), Johann Fabricius (1899–), Albert Helman (1903–), Clare Lennart (1904–), Aar van de Werfhorst (1907–) and Theun de Vries (1907–).

World War II and the resulting occupation of the Netherlands released a new creative force in Dutch poetry especially. Poets such as Leo Vroman (1915–), J. B. Charles (1910–), Hans Lodeizen (1924–50), Guillaume van der Graft (1920–), Lucebert (1924–), Paul Rodenko (1920–), Remco Campert (1929–), Hans Andreus (1926–), Simon Vinkenoog (1928–) and Ellen Warmond (1930–) made use of the innovations which had been developed especially in France and the United States. Important as well were more traditional poets such as Bertus Aafjes (1914–) and M. Vasalis (1909–). The background of the literary work of most of the young novelists, often working in an existentialist vein, such as Gerard Kornelis van het Reve (1923–) and Willem Frederik Hermans (1921–), is ferociously pessimistic. Anna Blaman (1906–60), Adriaan van der Veen (1916–), Pierre H. Dubois (1917–), Hella S. Haasse (1918–), Bert Schierbeek (1918–), Alfred Kossmann (1922–) and Harry Mulisch (1927–) are also representative of this postwar generation. Reminiscences of earlier times in the former Dutch East Indies appeared in the novels and stories of Marie Dermout (1888–) and H. J. Friedericy (1900–62). Humour was represented by Annie M. G. Schmidt (1911–), S. Carmiggelt (1913–) and A. Koolhaas (1912–).

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(P. K. K.; A. v. D. V.; GD. W. Hs.)

DUTCHMAN'S-BREECHES (*Dicentra cucullaria*), a North American plant of the fumitory family (Fumariaceae),

ROCHE

DUTCHMAN'S-BREECHES (DICENTRA CUCULLARIA)

known also by various local names, as butterfly-banners, boys-and-girls, eardrops and soldier's-cap, native to woods from Nova Scotia to South Dakota and southward to North Carolina and Kansas. It is a smooth, delicate plant, rising from a granulated bulb, with the slender-stalked, finely dissected leaves appearing to spring from the surface of the ground. In shape the irregular flowers, about $\frac{3}{4}$ in. broad, resemble a pair of baggy trousers, whence the popular name. The flowers are white or pinkish, tipped with yellow, and hang tremulously from a slender stalk, 5 in. to 10 in. long. This plant, closely related to the bleeding heart (*q.v.*), blossoms abundantly in early spring, and is one of the most dainty of North American wild flowers.

DUTCH METAL. A variety of brass, in which the proportion of zinc is high, giving the alloy a yellow colour, simulating

gold. The proportions of copper and zinc in dutch metal range from 88:12 to 85:15, the colour becoming paler with the higher zinc content. Dutch metal is used in bronzing, and in the preparation of imitation gold leaf, its great ductility lending itself to the purpose. Gilding with dutch metal costs less than one-third the price of real gilding, but the work rapidly tarnishes unless coated with a lacquer. *See* BRASS.

DUTCH WARS, a general title which includes the three naval wars fought between England and the United Provinces of the Netherlands (1652–54; 1665–67; and 1672–74) and the first of the three great wars of Louis XIV, namely the Franco-Dutch War (1672–78), of which the third Anglo-Dutch War was a part.

THE FIRST DUTCH WAR, 1652–54

The Thirty Years' War (*q.v.*) was a confusion of many issues, religious, political and dynastic, both between states and within them. During it the United Provinces were engaged from 1621 in warfare against Spain, still ruler of the southern Netherlands, and they acted generally in support of the Protestant and French cause against the Roman Catholic and Habsburg, securing final recognition of their independence at the peace of Westphalia in 1648. English participation in the European wars, however, was both inconsistent and unsuccessful and ceased altogether after 1630. Then, for two decades, internal political crises and civil wars cut England off from the main stream of continental history. During this period the English developed new attitudes governing the conduct of their foreign policy, and these proved to be of profound significance in European history.

Most important among the new attitudes were (1) the replacement of the traditional national hostility toward Spain by a new dislike of the Dutch, born of envy for their commercial prosperity; and (2) the assertion, first by Charles I, but later much more widespread, of English sovereignty over the Narrow seas round the south and east coasts of England. Behind these national and royal prejudices lay a real commercial rivalry, existing especially in the East Indies and over the herring fishery in the North sea. It brought about the Navigation act passed by the Long parliament in 1651, requiring goods imported into England to be carried only in English ships or, if coming from Europe, in those of the country of origin. The immediate cause of the First Dutch War, however, was rather the accumulation of a series of irritations between the two countries. Some were purely diplomatic and went back to the actions of the English and Dutch governments in the Thirty Years' War and the English Civil Wars respectively. Others, more recent, were the result of the conflict which arose between the English claim to exercise sovereignty in the Narrows and the Dutch insistence on the freedom of the high seas, during the unofficial war which had started between England and France in 1650.

A victory for the Dutch might have been expected in the two crowded years of naval engagements which made up the war in view of the great superiority of their merchant marine. In fact, however, the contribution of armed merchantmen to warfare at sea was diminishing in face of the development of specially built and professionally manned warships, and the superior numbers of the Dutch merchant marine proved something of a handicap, since they required the services of considerable numbers of warships for their protection. The Commonwealth government in England had doubled the size of the navy between 1649 and 1651, and the new warships were larger than those of the Dutch and carried heavier armament. The English had a further advantage in their geographical position which lay across the Dutch trading routes.

Operations.—In the spring of 1652, the Dutch admiral Maarten Tromp took a strong fleet into the channel to protect the returning trade. Neither country was anxious to appear as the aggressor, but a collision occurred with the English squadron under Robert Blake on May 29 (new style; 19, old style) off Dover. Nehemiah Bourne came up later with a squadron from the Downs to assist Blake, whereupon Tromp withdrew to the French coast.

Blake was now ordered north to destroy the Dutch herring fisheries, which he succeeded in doing, and also, if possible, to intercept the Dutch East Indiamen, said to be returning by the north of Scotland, as well as to harry their Baltic trade. Tromp was ordered to follow, and, after a delay through contrary winds, he sighted Blake's fleet off the Shetlands on Aug. 4 (N.S.; July 25, O.S.). There both fleets were scattered by a storm and returned to harbour—Tromp, however, in company with the fleet from the East Indies which had rounded the north of Scotland in the middle of the storm.

Meanwhile M. A. de Ruyter successfully convoyed the outward-bound Dutch Mediterranean fleet through the channel, forcing the English squadron under Sir George Ayscue into Plymouth. Blake, after refitting, appeared at the mouth of the channel, but De Ruyter succeeded in passing him and joining the main Dutch fleet off Bruges, bringing with him several homeward-bound merchantmen. Cornelis de Witt, who had replaced Tromp after the loss of the herring fleet, was now ready to go over to the offensive, but in a two-day battle fought in the Kentish Knock on Oct. 8–9 (N.S.; Sept. 28–29, O.S.) was defeated by Blake with heavy loss, many of his captains refusing action toward the close, being jealous of De Witt on personal and political grounds.

The Dutch now decided that a successful attack on the English fleet was to be their first aim; Tromp was recalled and given command of a much strengthened fleet for this purpose, with the secondary task of escorting the outward-bound East Indiamen through the channel. Blake was at the same time much weakened by having a squadron detached from his ships for the Mediterranean, where superior Dutch strength had completely eclipsed English trade. When Tromp appeared off Dungeness, therefore, he was superior to Blake by at least two to one, and in a general engagement on Dec. 10 (N.S.; Nov. 30, O.S.) Blake was defeated and withdrew to the Thames. Tromp was then able to escort his convoy unmolested and to exercise undisputed mastery in the channel.

A considerable reorganization and re-equipment was now carried through in England, and in Feb. 1653 Blake took a strong fleet down the channel in order to intercept Tromp, who was known to be about to conduct a homebound convoy of merchantmen through the channel. A stubborn engagement was begun on Feb. 28 (N.S.; 18, O.S.), and Tromp was only just able to prevent his retreat from becoming a rout, passing Cap Gris-Nez three days later only after suffering heavy losses.

The Dutch were now faced with the problem of protecting their trade without command of the channel, and Tromp, when refitted, decided to escort the outbound ships through the North sea, planning also to meet a homebound convoy off the north of Scotland. In all this he succeeded, and so was able to put to sea next time unencumbered by merchantmen. He sought out and engaged the English fleet, now commanded by George Monck and Richard Deane in the absence of Blake (who had been wounded in the previous engagement), off the Gabbard shoal on June 11 (N.S.; 1, O.S.). A furious battle raged for three days, ending near the Dutch coast. For the first time, the English fleet showed a definite superiority, recent fighting instructions having strictly enjoined them to maintain a line-ahead formation and so to develop their broadside fire to the utmost. Deane was killed, but Blake joined in with reinforcements on the second day, and the Dutch fleet was decisively defeated. Blake and Monck at once established a blockade of the Dutch coast which completely disorganized Dutch trade. Tromp at last succeeded in breaking out from his anchorage in the Wielings on Aug. 4 (N.S., July 25, O.S.) and effecting a junction with De Witt's squadron blockaded in the Texel, but in the battle which followed on Aug. 10 (N.S.; July 31, O.S.), the fiercest engagement of the war, he was again defeated and lost his life. However, with the approach of winter, the English lifted the blockade in order to prepare for the coming spring.

The Treaty of Westminster (1654).—As it happened, no further operations of any importance took place, for the war was ended by the treaty of Westminster in April 1654. The Dutch conceded the honouring of the English flag in British seas and agreed to pay an indemnity for English merchant losses in the far east and for the massacre at Amboina. Other provisions, designed

to discourage Dutch support for the exiled Stuarts and to exclude the house of Orange from public office in the United Provinces, proved unimportant or ineffectual. The real significance of the war lay in the emergence of English naval power as something separate from English mercantile interests. This was to make England a great power for the next three centuries.

THE SECOND DUTCH WAR, 1665–67

In 1660 Charles II was restored in England, but popular sentiment was as strong as ever against the Dutch and the new regime pursued just as aggressive a commercial policy as had that of Cromwell. Though the king himself, his minister Edward Hyde, earl of Clarendon, and even some important trading interests such as the East India company had doubts about the advantages likely to be secured from a second Dutch war, popular enthusiasm and the support of those politicians who sought to take advantage of it brought about a renewal of the conflict, and war was declared on March 4 (N.S.; Feb. 22, O.S.), 1665.

Already, early in 1664, Capt. Robert Holmes had seized Goree and other trading centres on the African Guinea coast, while an expedition under Capt. Richard Nichols captured New Amsterdam (renamed New York) in August. The Dutch replied by sending De Ruyter from the Mediterranean to recapture Goree and reduce the English West African forts (Oct. 1664). Later, he crossed the Atlantic and attacked Barbados.

After war was declared, it was the English fleet which first put to sea—under the duke of York (afterward James II), assisted by Prince Rupert and Edward Montague, earl of Sandwich. It cruised for a period off Texel in May 1665, but it had returned temporarily to reprovision when news came that the Dutch had set sail under Jacob Opdam and were prepared to seek out the English fleet even in the Thames. The duke of York set sail at once and, on June 13 (N.S.; 3, O.S.), won a decisive victory off Lowestoft, Opdam being blown up in his flagship. A misunderstanding, however, allowed the remains of the Dutch fleet to escape under Cornelis Tromp to Texel.

The English failed to follow up this early success. An enterprise in August against the Dutch ships in the neutral port of Bergen, planned with the connivance of the king of Denmark, was frustrated, and soon afterward De Ruyter was able to reach port with the Indies and Smyrna convoys. Sandwich, who had been placed in command after the duke of York's return from the battle of Lowestoft, did succeed in capturing a convoy of nine East Indiamen, but his action in distributing part of his prize amongst his flag officers and himself led to his being superseded by Monck, now duke of Albemarle.

At home in England, not only was the money granted by parliament for the war running out, largely because of mismanagement, but most of the life of the country was paralyzed by the last outbreak of the plague, which reached its peak in Sept. 1665. Both factors reduced the momentum acquired by the victory at Lowestoft, and in addition England's diplomatic position was deteriorating. The Dutch states-general had concluded a somewhat dubious alliance with France in 1662, by which each party had agreed to come to the aid of the other in any war in which it was not the aggressor. At first, the French contented themselves with suggesting terms of peace, but English attempts to enforce nonintervention through a Spanish alliance proved barren. England's one ally was the bishop of Münster, Bernhard von Galen, who, in return for a small subsidy, invaded Holland from the east, but French forces, sent after France's formal declaration of war in Jan. 1666, compelled his withdrawal. No other allies were anxious to incur France's displeasure, and England began the operations of 1666 entirely isolated.

Though the French fleet under François de Vendôme, duc de Beaufort, did not proceed beyond Lisbon, intelligence reached London warning of its advance toward the channel, and accordingly Prince Rupert was detached with a third of the main fleet to meet it. Consequently, Albemarle was faced by a much superior Dutch fleet put to sea under De Ruyter. Nevertheless, after some debate, he began what is known as the Four Day's battle on June 11 (N.S.; 1, O.S.), 1666, sending word for Rupert to rejoin him with all speed. He concentrated his attack on the Dutch rear under Tromp, but was unable to achieve anything decisive before the remainder of the Dutch ships belonging to the van and centre came up and inflicted heavy losses on his own rear. Next day, therefore, he began a well-executed retreat, now outnumbered two to one. On the third day he was at last rejoined by Rupert and so was able to join battle again on the fourth day on a more equal basis, though still inferior to the Dutch by the amount of his loss on the first day. A fierce and somewhat confused engagement then took place with losses on both sides, and at the conclusion both were content to withdraw to their own harbours. Repairs were soon effected, and the two fleets faced one another again on almost equal terms off the mouth of the Thames on Aug. 3 (N.S.; July 24, O.S.). The St. James's fight (St. James's day, July 25, O.S.) was entirely an English victory, secured with very little loss. The English fleet now proceeded to blockade the Dutch coast, and a special squadron under Sir Robert Holmes burned about 150 merchantmen anchored in the Vlie channel on Aug. 18 (N.S.; 8, O.S.). The Dutch now called for more active French assistance, and Beaufort received orders to meet De Ruyter in the channel. The latter, however, was engaged and compelled to retreat into Brest. After this, further English operations were disorganized by the Great Fire of London (September).

In the West Indies, the French played a more prominent role, capturing the English settlement on St. Kitts (April 1666), Antigua (Nov. 1666) and Montserrat (Feb. 1667). A strong force was then sent out under Sir John Harman, which defeated the Franco-Dutch fleet off the island of Nevis on May 30 (N.S.; 20, O.S.), 1667, and played havoc with the French trade. In England, meanwhile, the cost of the war, added to the economic burden imposed by the Plague and the Great Fire of London, induced a readiness for peace, and negotiations were begun, first with France, then with the United Provinces. Accordingly, a risk was taken, and no preparations were made for fitting out a fleet for the coming year. The Dutch were equally keen for peace but saw an opportunity to deliver a substantial final blow against their enemy first. On June 22 (N.S.; 12, O.S.), 1667, taking advantage of the laying-up of the English fleet, De Ruyter sent a squadron under Adm. W. J. van Gent up the Medway while he himself stood guard off the Thames. The state of the defenses was deplorable, and several warships were destroyed in Chatham dock, others being captured, among them the flagship "Royal Charles." This episode was considered in England to be a national disgrace and did much to undermine confidence in the government and its foreign policy.

The Peace of Breda.—Peace was made at Breda on July 31 (N.S.; 21, O.S.), 1667. England recovered the West Indies possessions taken by France, promising in return not to engage in any anti-French alliance for a year. The English moreover kept New York, but the United Provinces retained their other colonies and secured a relaxation of the Navigation laws in their favour, being allowed henceforth to carry any goods from the Spanish Netherlands or Germany into England. The commercial rivalry between England and Holland was therefore still unresolved, and a third war seemed inevitable. Before it took place, however, an altogether different diplomatic situation had evolved in Europe out of Louis XIV's search for prestige. Commercial considerations thenceforward diminished in the sight of both parties, though they never disappeared altogether.

THE FRANCO-SPANISH WAR OF DEVOLUTION, 1667–68

For a period after the treaty of Westphalia, France had been preoccupied with the difficulties of a royal minority, the distractions of civil war and the continuing war against Spain. Eventually, with the attainment by Louis XIV of his official majority, the suppression of the Fronde and the treaty of the Pyrenees with Spain (1659), France was once more ready to become involved in Europe.

For a period, no particular issue invited France's close attention, but the death of Philip IV of Spain in 1665 left the Spanish dominions in the hands of the sickly epileptic Charles II, who seemed unlikely at that time to live long or produce heirs. Louis

XIV therefore took the initiative by advancing the altogether spurious claims of his wife, Philip IV's daughter, to inherit immediately certain territories in the Spanish Netherlands (*see* DEVOLUTION, WAR OF), winding up his commitments in the Second Dutch War to that end. The French army under Marshal de Turenne advanced into Flanders in May 1667 and easily secured its objectives. Louis then turned to diplomacy in order to secure a speedy peace with concrete gains. In Jan. 1668 he and the Holy Roman emperor Leopold I concluded a treaty in which they agreed to partition the Spanish dominions between themselves on the Spanish king's death and in which it was also stipulated how much territory in the meantime France was to annex in the Netherlands. The French had also tried to win English support for their claims, but a new ministry in England turned instead to the Dutch. Despite their mutual distrust, an alliance was concluded between the two maritime powers on Jan. 23 (N.S.; 13, O.S.), 1668, to which Sweden adhered later, thus forming the Triple alliance.

The Peace of Aix-la-Chapelle.—The allies sought to contain the French advance by persuading Spain to agree to moderate terms and by supporting Spain in war if this proved of no avail. The settlement envisaged was much the same as that on which Louis XIV and the emperor had agreed (though the maritime powers were not to know this), and so peace was soon concluded at Aix-la-Chapelle in April 1668, though not before the prince de Condé had overrun Franche-Comté with a French army. The latter province was returned to Spain, but France retained Bergues, Furnes, Armentières, Oudenaarde, Courtrai, Lille, Douai, Tournai, Binche, Ath and Charleroi.

THE WAR OF 1672–78

The towns gained by Louis XIV at Aix-la-Chapelle were intended as a foundation for further gains in Flanders, so that he would be in a strong position to insist on a partition of the Spanish dominions advantageous to France at some time in the future. He was to engage in fact in a further war within four years, but this time against the United Provinces. Its cause lay partly in the colonial and commercial rivalry of the Dutch, which was as great with France as with England, partly in the French king's preoccupation with his personal prestige. He resented more than anything being opposed by a country that was republican, Protestant and bourgeois and also had reason to be alarmed at the steadily growing hostility of the Dutch, which had been aroused by both the tariff and the foreign policy of France.

France and England Against the Dutch.—Diplomatic action was made the forerunner of military attack. France concluded treaties with Brandenburg in 1669, with Bavaria in 1670 and with Sweden in 1672, while the emperor, for the time being, remained bemused by the secret partition treaty of 1668. More important was the detachment of England through the secret treaty of Dover (*q.v.*) in June 1670. There were still strong commercial motives for England's engaging in a commercial war with the United Provinces, and these were urged in England by Anthony Ashley Cooper, earl of Shaftesbury; also the English government was genuinely anxious lest the strength and success of the Dutch should persuade France to partition the Spanish Netherlands with them. However, it was Charles II's personal political and religious ambitions which were used by Louis XIV to secure English support for a war in 1672, and in consequence English foreign policy was to a great extent governed by considerations of the subsidies paid by Louis XIV and by Charles II's apprehension lest his diplomatic folly and religious treason of 1670 be revealed. So it was that, though the naval strength forged in two Dutch wars already entitled England to the rank of a great power in Europe, this rank was not attained until after the Glorious Revolution of 1688–89.

The imminence of war led the Dutch in Feb. 1672 to appoint as captain-general for a year William III, prince of Orange, whose family had been excluded from office in the United Provinces since his father's death in 1650. The administration of the grand pensionary, John De Witt, was totally unprepared for war and almost powerless to resist the double attack which developed by land and sea. The English and French fleets arranged to combine under the duke of York, and an attempt by De Ruyter in April to forestall their junction failed. The allies, however, were suffering from hasty preparation and went to Solebay (Southwold bay) on the Suffolk coast to complete their complements and stores. Early in the morning of June 7 (N.S.; May 28, O.S.), 1672, they were surprised by De Ruyter. Sandwich with the Blue squadron routed the opposing Dutch squadron, though he himself was drowned and his flagship burned; but when the French in the van turned south and were unable to play an effective part in the action, the duke of York in the centre was very hard pressed, and only the arrival later of the ships of the Blue squadron prevented complete disaster, after which De Ruyter drew off. The losses were fairly considerable on both sides, and the result could be counted as a draw, except for the fact that the English and the French, who with their superior numbers had expected a decisive success that would have made possible an invasion of the Dutch coast, were completely disappointed. The Dutch could be satisfied with what they had achieved.

On land, however, the French had it all their own way. The army under Louis XIV himself, assisted by Turenne, Condé and Vauban, moved down the Meuse from Charleroi unopposed and thence, masking the powerful Dutch fortress of Maastricht, crossed the Rhine at Düsseldorf and marched down it through the friendly territory of the archbishop of Cologne to the Dutch frontier, which was crossed at Tolhuis on June 12, 1672. Meanwhile, in the north, the marshal duc de Luxembourg (François Henri de Montmorency-Boutteville), in co-operation with the forces of Cologne and Münster, marched against Groningen. William of Orange could offer no substantial resistance; Utrecht surrendered on June 26 and the fall of Amsterdam seemed imminent. The states-general therefore asked for terms, but those offered were so severe and humiliating that it was everywhere agreed that the war must be continued at all costs. The dikes were cut and the sluices opened, and the countryside around Amsterdam was extensively flooded. Johan de Witt and the republican party were swept from power; and, by what was little short of a revolution, De Witt and his brother Cornelis (*q.v.*) being assassinated by the mob, William of Orange was made stadholder.

In autumn 1672, the war spread to the middle Rhine. The German princes began to show hostility toward the French. Frederick William of Brandenburg, "the Great Elector," had concluded an alliance with the Dutch in April and a defensive alliance with the emperor in June, the latter considering himself freed from his commitments to Louis XIV in view of the French action in Holland. Condé was therefore despatched to Alsace, and Turenne to Westphalia, where by energetic operations continuing into the winter he was able to maintain Münster and Cologne in the war against all the emperor's efforts and to drive Frederick William's army across the Weser. Profiting meanwhile from this diversion of the French effort, William of Orange attempted a bold stroke against Charleroi (Sept.–Dec. 1672), but without success. Then, with the arrival of winter, Luxembourg made a bold attempt to capture Leiden and The Hague by marching a corps from Utrecht across the frozen inundations, but a sudden thaw imperiled his force and he had to make a painful retreat along the dikes to Utrecht. Condé meanwhile failed to make any headway against the defenses of Amsterdam.

At sea, the duke of York was unable either to bring De Ruyter out to give battle or to intercept the Dutch Indies convoy. Without full command of the sea, he could do nothing to assist operations on land. Therefore, in Sept. 1672, the English abandoned all further action for the year. The winter in England witnessed a parliamentary crisis. Though a supply of money was voted, an act was also passed excluding all Roman Catholics from public office. The duke of York was accordingly removed from his command and replaced by Prince Rupert in 1673.

In April 1673, an English fleet was assembled to assist the landing of an expeditionary force in Zeeland, but, with De Ruyter as active as ever, the plan had to be set aside until the French ships under Jean, comte d'Estrées, should arrive and De Ruyter be brought to battle. The combined fleet then arrived off Ostend on June 2 (N.S.; May 23, O.S.) and five days later prepared to

move in to attack De Ruyter with fireships in the Schooneveldt channel. Before this plan could be fully implemented, the Dutch admiral came out unexpectedly and engaged Rupert at a disadvantage, inflicting serious damage on him and then returning to his anchorage at night. Rupert retired again to the Oyster bank off Ostend and was renewing his supplies when, a week later on June 14 (N.S.; 4, O.S.), De Ruyter again emerged unexpectedly from the Schooneveldt and inflicted considerable losses on Rupert, who had to withdraw to the Nore.

The European Coalition.—Brandenburg having signed a separate peace with France at Vossem in June 1673, delegates now assembled at Cologne to make a second attempt at a settlement, but the French and English demands remained as stiff and unacceptable as ever. Very soon, however, the whole situation changed, and the Dutch war became a general European conflict. In Aug. 1673 the emperor, the king of Spain and the states-general allied themselves together, the two former agreeing to send troops to help the latter. These three powers, with the addition of Lorraine, constituted the grand alliance of The Hague, directed against Louis XIV, which was signed in Jan. 1674.

On land, Louis XIV had begun the campaigns of 1673 with the siege and capture of Maastricht on June 30 (N.S.; 20, O.S.). Turenne then advanced to the Main at Aschaffenburg to await the imperial army from Bohemia, but was outmaneuvred by Raimund Montecuccoli and forced to undertake a difficult and costly retreat down the Rhine in September. Montecuccoli crossed the Rhine at Mainz and advanced on Trier, whither Turenne was forced to withdraw. Then Montecuccoli turned north to meet William of Orange, who had evaded Condé's weak army in Holland and marched rapidly on Coblenz. Together they besieged and captured Bonn on Nov. 12 (N.S.; 2, O.S.), thus isolating Louis from his German allies, Cologne and Münster, who were compelled to make peace.

At sea, a combined Anglo-French fleet was again fitted out in the second half of 1673, with orders to appear off the Schooneveldt and then proceed north to the Texel, in the hope of luring De Ruyter into the more spacious waters there for a decisive engagement that would at last open the way for a landing on the coast. The plan nearly worked, but a change of wind enabled De Ruyter to return to the Schooneveldt. However, in August he was ordered to put to sea to protect the homecoming Indies fleet, and Rupert came upon him off Kijkduin on Aug. 21 (N.S.; 11, O.S.). The French van again became separated from the English centre and rear, so that De Ruyter once more enjoyed a superiority, but the exchanges were still even, and the failure of the comte d'Estrées to support Rupert turned a probable victory into another indecisive encounter that the Dutch could regard with satisfaction. Supply shortages prevented the Anglo-French fleet from being got ready for sea again until it was too late for any substantial operations to be begun on land, and so in September the French fleet was ordered to Brest and the English ships to be laid up for the winter.

The Treaty of Westminster (1674).—Charles II soon saw that he could continue no longer with the Dutch War and the French alliance in face of the growing hostility of the house of commons, which had been recently reinforced by the inadequacy —or even, it was thought, treachery—of the French fleet as an ally at sea. The treaty of Westminster, signed on Feb. 19 (N.S.; 9, O.S.), 1674, conceded that Dutch ships would salute the English flag, as a mark of respect only, in the waters between Norway and Cape Finisterre and ordered an indemnity to be paid by the Dutch of 500,000 crowns, but brought few other advantages except those which accrued from the neutrality now followed by England for the next four years while the rest of Europe remained at war.

The French War Continued, 1674–78.—After 1673, the war had a new character. The French armies had to abandon the United Provinces (where they had been able to enjoy free quarter), but still Louis XIV determined to keep to the offensive, striking wherever possible against Spanish territory. Condé, with inferior forces, successfully held a combined Dutch and Spanish army under William of Orange along the frontier of the Spanish Netherlands and inflicted the first of many defeats suffered by that prince at Seneff on Aug. 11, 1674. The losses suffered by both sides, however, were considerable and the engagement was strategically indecisive, the Dutch being able to capture Grave in October. Another army under Louis XIV's personal direction invaded Franche-Comté, which it overran in six weeks, Besançon being reduced with Vauban's assistance in nine days.

Turenne, opposed on the Rhine by Alexandre-Hippolyte, prince de Bournonville, Montecuccoli's successor in command of the imperial forces, and threatened also by another army under Charles IV of Lorraine and Aeneas Sylvius Caprara advancing toward the Neckar valley, resolved to attack before they could effect a junction. He therefore crossed the Rhine at Philippsburg early in June and defeated Caprara at Sinsheim on June 16, 1674, and Charles of Lorraine at Ladenburg on July 7. After that, having systematically devastated the Palatinate so that it could not support an army operating through it that year, he withdrew into Lorraine. Bournonville, however, moved south and crossed the Rhine at Strasbourg to invade Alsace. He met Turenne in an indecisive battle at Enzheim on Oct. 4 and then, after being reinforced by the troops of Frederick William of Brandenburg, who had allied himself with the emperor again in July, overran the whole of Alsace. Turenne retired before him, and the allies withdrew into winter quarters in November.

Turenne, however, had determined upon a winter campaign. Collecting his forces in Lorraine, he marched south behind the Vosges to enter Alsace near Belfort. Taken by surprise, the allies were defeated at Mulhouse, at Colmar and at Turkheim (Dec. 1674—Jan. 1675). The last engagement was decisive and the imperial forces were compelled to evacuate Alsace entirely, at which Turenne at last retired into winter quarters.

Montecuccoli again commanded on the Rhine in 1675, the Brandenburg army having been withdrawn to meet an attack by Sweden from Pomerania. Turenne obtained an advantage over him after a prolonged period of maneuvre, designed by both commanders to obtain control of enemy territory for the support of their army, but he was killed by a cannonball at the battle of Sasbach on July 27. Subsequently, the French retreated over the Rhine, while a second French army under François de Créquy was defeated on the Moselle and lost Trier to Charles of Lorraine. Condé was thereupon withdrawn from Flanders, where earlier he had taken Liège and Limburg. He succeeded in forcing Montecuccoli back across the Rhine. This was his last campaign, for he retired at its conclusion. France thus lost the services of both Turenne and Condé in one year.

A revolt had broken out against Spanish rule in Sicily in 1674, and a French expeditionary force sent to support it had captured Messina. The Spanish government thereupon appealed to the Dutch for naval assistance, and De Ruyter was sent out with a squadron in the latter half of 1675. He engaged the French admiral, Abraham Duquesne, who was bringing reinforcements, on Jan. 8, 1676, but without success. Later, De Ruyter joined in an attempt to recapture Messina, but this failed, and he was himself mortally wounded off Augusta on April 22. Dutch attempts to employ their fleet in the channel and on the Atlantic coasts after the withdrawal of England from the war were similarly unsuccessful.

In 1676, William of Orange failed in an attempt to capture Maastricht, but the imperial army captured Philippsburg on Sept. 17. Thereupon the French devastated the country between the Meuse and the Moselle in the same way and for the same reason as Turenne had devastated the Palatinate in 1674. This tactic was a classic of 17th-century military operations and was particularly effective in depriving enemy cavalry of their supplies of forage.

Louis XIV began 1677 with the capture of Valenciennes on March 17. William of Orange was defeated in trying to relieve St. Omer (April 11) and was equally unsuccessful in the summer. Créquy outmaneuvred Charles V of Lorraine, Charles IV's son and heir, on the Rhine throughout the summer and finally defeated him at Kochersberg on Oct. 7, capturing Freiburg on Nov. 14.

The End of the War.—Military success, however, was becoming less and less relevant to the outcome of the war. Louis XIV's original aim of humiliating the Dutch had failed when the French armies had had to be withdrawn from the United Provinces and could now never be realized because the rest of Europe would not allow it. Instead he now faced nearly all the rest of Europe in a hostile alliance. The war moreover put a heavy burden on France's economy, and there were revolts against war taxation in Normandy and Brittany. The United Provinces were equally ready for peace, and the threat of England's re-entry into the war, this time on the Dutch side, encouraged both belligerents to come to terms lest England should become the arbiter of their affairs. Fighting continued in Flanders while peace was being negotiated during most of 1678. The French captured Ghent and Ypres in March, and Luxembourg defeated William of Orange near Mons on Aug. 14. On the Rhine, war went on into 1679, for the emperor was unwilling to make peace while he still saw a chance of winning gains in Alsace. Créquy, however, twice defeated his forces in 1678, at Rheinfelden on July 6 and at Gengenbach on July 23. The series of treaties constituting the peace of Nijmegen (*q.v.*) was completed in 1679.

CONCLUSIONS

If the significant result of the three Anglo-Dutch naval wars was the establishment of English naval power, with all that that was to mean in European and in world history, the lesson to be drawn from the first of Louis XIV's three great wars concerned the immense superiority of French military resources, even against a general European coalition. The emergence of England as a great power in Europe, however, was eventually to turn the balance against France in the War of the Grand Alliance and in the War of the Spanish Succession (*qq.v.*).

BIBLIOGRAPHY.—Apart from the general histories of Europe and of the belligerent states covering the second half of the 17th century, and the lives of the sovereigns, statesmen and commanders mentioned in the text above (*see* the several biographies in this Encyclopædia), naval histories are especially valuable for the Dutch Wars. *See* for instance S. R. Gardiner and C. T. Atkinson (eds.), *Letters and Papers Relating to the First Dutch War*, Navy Records society, 6 vol. (1899–1930); H. T. Colenbrander (ed.), *Bescheiden uit vreemdre archieven omtrent de groote Nederlandsche zeeoorlogen* (1919); C. de La Roncière, *Histoire de la marine française*, vol. v (1920); R. C. Anderson (ed.), *Journals and Narratives of the Third Dutch War*, Navy Records society (1946); Sir H. Richmond, *The Navy as an Instrument of Policy, 1558–1727* (1953). For diplomatic history *see* particularly F. A. M. Mignet, *Négociations relatives à la succession d'Espagne*, 4 vol. (1835–42); and F. A. Westergaard (ed.), *The First Triple Alliance . . . 1668–72* (1947). (I. F. B.)

DUTCH WEST INDIA COMPANY, a company founded by letters patent from the Netherlands states-general dated June 3, 1621. The purpose for which the company was formed was to regulate and protect the contraband trade already being carried on by the Dutch in the American and African possessions of Spain and Portugal, and to establish colonies on both continents and their islands. By the terms of the charter the company was to be composed of five boards or branches, established in Amsterdam, Zeeland, the Meuse (Rotterdam), the North Department (west Friesland and Hoorn), and Groningen. Each was to be represented on the general governing board according to the importance of the capital contributed by it. Thus Amsterdam, which contributed four-ninths of the capital, had eight directors on the board; Zeeland, which subscribed two-ninths, had four; the other three departments, which each contributed one-ninth, had two each.

The company was granted the monopoly of the trade with America and Africa and, between them, from the Arctic regions to the Straits of Magellan, and from the Tropic of Cancer to the Cape of Good Hope. The company proposed to use its monopoly on the coast of Africa in order to secure the cheap and regular supply of Negro slaves for the possessions which it hoped to acquire in America. The trade was thrown open by the voluntary action of the company in 1638. The general board was endowed with ample power to negotiate treaties and make war and peace with native princes; to appoint its officials, generals and governors; and to legislate in its possessions subject to the laws of the Netherlands. The states-general undertook to secure the trading rights of the company, and to support it by a subvention of 1,000,000 florins (about £100,000). In case of war the states-general undertook to contribute 16 vessels of 300 tons and upward for the defense of the company, which, however, was to bear the expense of maintaining them. In return for these aids the states-general claimed a share in the profits; stipulated that the company must maintain 16 large vessels (300 tons and upward) and 4 "yachts" (small craft of 50 to 100 tons or so); and required that all the company's officials should take an oath of allegiance to the Netherlands as well as to the board of directors and that all dispatches should be sent in duplicate to the government and to the board.

The history of the Dutch West India company is one of less prosperity than that of the Dutch East India company. In early days the trade was not sufficient to meet the expense of the armaments raised against Spain and Portugal. The company was never able to secure the control of the supply of slaves from Africa.

For the already existing colony of New Netherland, formally constituted as a province of the company in 1623, *see* NEW YORK: *History;* NEW YORK (CITY): *History.*

In the West Indies the company gained a valuable footing among the islands. It occupied St. Eustatius in 1634, Curaçao with Bonaire and Aruba in 1634 and 1635, Saba in 1640 and St. Martin in 1648. Apart from their own products these islands could also serve as a means of smuggling slaves into the Spanish colonies. The greatest achievement of the company's fleets was the famous capture of the Spanish silver fleet by Piet Hein off the coast of Cuba in 1628; the sale of the booty yielded some 12,000,000 florins and enabled a 75% dividend to be declared. But the greatest effort was made in Brazil. After a first unsuccessful occupation in 1624 of Bahia, which was immediately retaken by a combined Spanish and Portuguese armament, the company obtained a firm footing in Pernambuco in 1630. The conquest of much of Brazil which followed lasted until the last footing at Recife was recaptured by the Portuguese in 1654. The most prosperous period of the Dutch rule in Brazil was during the tolerant and liberal administration of Count John Maurice of Nassau-Siegen, from 1636 to 1644; but the expense proved to be beyond the company's financial resources, and the states-general did not give adequate support, while the Portuguese planters were never reconciled to their new rulers.

The company resigned all claim on Brazil in 1661, and by the treaty of Breda in 1667 gave up New Netherland to England: but this last treaty gave to the company some compensation in Surinam (Dutch Guiana). The resources of this colony were not, however, developed by the original company, which became so embarrassed that it was dissolved in 1674 and reconstructed in 1675. The newly formed company continued to exploit the Dutch possessions in the Caribbean until 1791, when it was taken over by the state, only to be swept away altogether in 1794 with the conquest of the United Provinces by the French Revolutionary armies.

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DU TOIT, JAKOB DANIEL (pseudonym, TOTIUS) (1877–1953), Afrikaans poet, pastor, biblical scholar and compiler of an Afrikaans Psalter, was born at Paarl, Cape Province, Feb. 21, 1877, son of the Rev. S. J. du Toit, who has been called father of the movement for Afrikaans. He was educated in Pretoria, Rustenburg and Daljosafat, studied at the theological seminary at Burgesdorp and passed his final examination for the ministry in 1899.

On the outbreak of the South African War he joined the Boer forces as chaplain. In 1900 he went to the Free university, Amsterdam, Neth., where he received his doctor's degree in theology in 1903, and then entered the ministry. From 1911 he was professor of theology at the University of Potchefstroom, Transvaal; on retirement in 1949 he was elected chancellor. He died in Pretoria, July 1, 1953.

Du Toit was responsible for the greater part of the transla-

tion of the Bible into Afrikaans, completed in 1932. His Afrikaans Psalter (1936) is regarded as one of the finest poetic achievements of its kind in Dutch, Flemish or Afrikaans. The Calvinism and patriotism confirmed in him by the circumstances of his childhood and training are revealed at a high artistic level in his finest volumes of poetry, the patriotic poems *Trekkerswee* (1915) and the personal lyrics in *Passieblomme* (1934) and *Skemering* (1948). These and other volumes, including *By die Monument* (1908), *Verse van Potgieter's Trek* (1909), *Wilgerboombogies* (1912), *Rachel* (1913) and *Uit donker Afrika* (1936), also show the poetic influence of the Flemish poet and priest Guido Gezelle.

See C. M. van den Heever, *Die digter Totius* (1932), and an anthology with introduction, *Keur uit die gedrigte van Totius* (1949).
(A. J. Ce.)

DUTRA, EURICO GASPAR (1885–), Brazilian soldier, president of Brazil, 1945–51. Dutra was born on May 18, 1885, in Cuiabá, Mato Grosso state. He was commissioned a second lieutenant in the cavalry in 1910 and had routine assignments and promotions for the following 22 years. Uninterested in politics during this period, Dutra consistently supported the established government. Thus he opposed the successful revolution led by Getúlio Dornelles Vargas in 1930 but defended the Vargas regime during the 1932 São Paulo rebellion. From that date Dutra rose rapidly. As commanding general of army troops in Rio de Janeiro, he suppressed the brief communist revolt in 1935. From 1936 to 1945 Dutra was minister of war, in which position he was instrumental in establishing the Vargas dictatorship in 1937. Dutra influenced the decision to support the Allies in World War II and was principally responsible for organizing the Brazilian Expeditionary force that fought in Italy, 1944–45. Selected as the administration's presidential candidate, he led the *coup d'état* in Oct. 1945 that overthrew the dictatorship when Vargas attempted to forestall elections. Dutra was elected president of Brazil on Dec. 2, 1945 and served until Jan. 31, 1951. His administration witnessed the full restoration of democratic, constitutional processes in Brazil. *See* Brazil: *History*. (R. E. P.)

DUTT, MICHAEL MADHU SUDAN (Michael Madhusudan Datta (1824–1873), Indian poet and dramatist, the first great poet of modern Bengali literature (*q.v.*), was a dynamic, erratic person, and an original genius of a high order. Born at Sagardari, Bengal, on Jan. 25, 1824, he was educated at the Hindu college, Calcutta, the cultural home of the western-educated Bengali middle class. In 1843 he became a Christian. From 1848 until 1856 he lived in Madras, then returned to Calcutta, where he lived busily and happily for six years. The period 1862–67 he spent in England and France, returning to India to die in Calcutta six years later, on June 29, 1873, in utter poverty.

His early compositions were in English, but they were unsuccessful and he turned reluctantly at first to Bengali. His principal works, written mostly between 1858 and 1862, include prose drama, long narrative poems and lyrics. His first play, *Sarmishtha* (1858), based on a *Mahabharat* episode, was well received. In 1860, he wrote *Ekei ki Bale Sabhyata* and *Buro Saliker Ghare Ro*, two popular but not outstanding social satires; and in 1861, *Padmabati*, a version of the *Judgment of Paris* in Indian guise, and *Krishnakumari*, a Rajput story. His poetical works are *Tilottamasambhab* (1860), a narrative poem on the story of Sunda and Upasunda; *Meghnadbadh* (1861), his most important composition, an epic on the *Ramayan* theme; *Brajangana* (1861), a cycle of lyrics on the *Radha-Krishna* theme; and *Birangana* (1862), a set of 21 epistolary poems on the model of Ovid's *Heroides*. In Europe he worked at *Caturdaspadi Kabitabali*, a collection of 102 sonnets; and later in Calcutta wrote a prose narrative based on the *Iliad*, *Hektarbadh* (1871); and an unfinished play, *Maya-Kanan*.

Madhu Sudan experimented ceaselessly with diction and verse forms and it was he who introduced *amitraksar* (a form of blank verse with run-on lines and varied caesuras), the Bengali sonnet—both Petrarchan and Shakespearean—and many original lyric stanzas. His diction ranged from the lyric smoothness of the *padavali* to the sonorousness of Milton, who was his model for *Meghnadbadh*. He loved the "grand mythology" of ancient India. For him it was "full of poetry," and from it came most of his subjects.
(T. W. Cl.)

DUTTON, CLARENCE EDWARD (1841–1912), U.S. geologist and pioneer seismologist who developed and named the principle of isostasy (*q.v.*), was born at Wallingford, Conn., on May 15, 1841. He graduated from Yale university at the age of 19 and in 1862 entered the U.S. army as first lieutenant. After many periods of inactive service he became a major in 1890 and retired in 1901.

In 1865 Dutton began to study geology under James Hall (*q.v.*) and his assistant, R. P. Whitfield. In 1875 he joined the U.S. geographical and geological survey of the Rocky mountain region (the Powell survey) and spent ten years in the plateaus of Utah, Arizona and New Mexico. There he investigated the causes of volcanic action, of uplift and sinking, and of movements which twist, fold and break rocks of the earth's crust. Dutton believed that lavas were melted by radioactive heat and that weight of overlying rocks forced them to the surface. The latter idea was an outgrowth of his studies of basaltic eruptions in southern Utah.

As a member of the U.S. Geological survey, Dutton studied the Charleston, S.C., earthquake of 1886. In 1889 he discussed it in a report of 323 pages. It advanced a new method of determining the depth of earthquake focuses and measured with unprecedented accuracy the rate at which earthquake waves traveled. In 1904 he published a semipopular treatise, *Earthquakes in the Light of the New Seismology*. He died in Englewood, N.J., on Jan. 4, 1912. (M. A. F.; C. L. Fe.)

DUTY, a term loosely applied to any action or course of action which is regarded as morally incumbent, apart from personal likes and dislikes or any external compulsion. Such action must be viewed in relation to a principle, which may be abstract in the highest sense (*e.g.*, obedience to the dictates of conscience) or based on local and personal relations. That a father and his children have mutual duties implies that there are moral laws regulating their relationship; that it is the duty of a servant to obey his master within certain limits is part of a definite contract, whereby he becomes a servant engaging to do certain things for a specified wage. Thus it is held that it is not the duty of a servant to infringe a moral law even though his master should command it. For the nature of duty in the abstract, and the various criteria on which it has been based, *see* Ethics.

From the root idea of obligation to serve or give something in return, involved in the conception of duty, have sprung various derivative uses of the word; thus it is used of the services performed by a minister of a church, by a soldier, or by any employee or servant. A special application is to a tax, a payment due to the revenue of a state, levied by force of law. Properly a "duty" differs from a "tax" in being levied on specific commodities, transactions, estates, etc., and not on individuals; thus it is right to talk of import duties, excise duties, death or succession duties, etc., but of income tax as being levied on a person in proportion to his income. *See* also Tariffs.

DUUMVIRI (Duoviri) in ancient Rome, an official term for a college of two magistrates.

The following colleges are attested in Rome: *Duumviri perduellionis* were the judges appointed by the chief magistrate in the early criminal procedure for trying offenses against the state. *Duumviri sacris faciundis* were the two priests who originally had charge of the books of Sibylline oracles and the matters involving worship in the Greek manner arising from them; they were increased in number to 10 (*decemviri*) in 367 B.C. and by Sulla to 15 (*quindecimviri*). *Duumviri navales* were officers appointed to have charge of equipping a fleet and were elected by the people from 311 B.C. onward. None is named after 178 B.C. *Duumviri aedi locandae* and *duumviri aedi dedicandae* were two colleges, sometimes composed of the same men for the same temple, the one to let the contract for construction and the other to perform the dedication. *Duumviri viis extra urbem purgandis* formed a minor magistracy for cleaning the streets outside the city and were replaced under Augustus by the *curatores viarum*.

In the colonies and *municipia* (*see* Municipium) *duumviri iure dicundo* was frequently the title of the two chief magistrates.

Their duties included especially the administration of justice. Those who took the census and revised the roll of decurions every five years were known as *duumviri iure dicundo quinquennales.*

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DUUN, OLAV (1876–1939), Norwegian novelist, who, after Knut Hamsun and Sigrid Undset, is the outstanding name in 20th-century Norwegian literature. He was born in Namdalen, in the north of Norway, Nov. 21, 1876, and worked as a folk-school teacher until 1926, when he retired to Holmestrand, on the Oslo fiord. He died at Tönsberg, Sept. 13, 1939. His many novels, written for the most part in a language strongly influenced by his regional dialect, analyze the psychological and spiritual characteristics of peasant life. His masterpiece is a series of novels, *Juvikfolke* (1918–23), describing the development of a peasant family through four generations. It has been translated as follows: *The Trough of the Waves* (1930), *The Blind Man* (1931), *The Big Wedding* (1932), *Odin in Fairyland* (1932), *Odin Grows Up* (1934) and *Storm* (1935).

See R. Thesen, *Mennesket og Maktene* (1945); D. Haakonsen, *O. Duun* (1958). (D. A. H.)

DU VAIR, GUILLAUME (1556–1621), French lawyer and writer, the master of a prose style of exceptional purity and felicity, whose blend of Christianity and Stoicism had great political, philosophical and literary influence, was born in Paris, March 7, 1556. He became clerk-counselor of the *parlement* of Paris in 1584, at a time of great political disturbance, and his conciliatory influence was soon highly valued. As deputy for Paris to the estates of the League, he was informed of the Spanish marriage intrigues, and his most famous political discourse, *Suasion de l'arrest pour la manutention de la loi Salique,* delivered in the *parlement* in 1593, was designed to counteract them. This, and his many other services in the cause of peace, earned the gratitude of Henry IV. In 1596 he was sent to England to negotiate a league against Spain and on his return was sent to restore order as governor of Provence. He became in 1599 first president of the *parlement* of Aix, and in 1616, for a short time, keeper of seals. He died at Tonneins (Lot-et-Garonne), Aug. 31, 1621. From 1617 he was bishop of Lisieux; it is not known when he took orders.

Du Vair devoted his leisure to learning. As a moralist and Christian philosopher, his outstanding works were *Manuel d'Epictète,* which was probably read by Descartes, Corneille and Pascal; *La Sainte Philosophie;* and *La Philosophie morale des Stoïques,* translated into English by Charles Cotton (1664). The philosopher Pierre Charron drew freely on these works. The most beautiful of Du Vair's philosophical writings is *De la constance et consolation ès calamités publiques,* written during the siege of Paris (1593) and translated into English as *A Buckler Against Adversitie* (1622). As a literary critic, he was the author of a treatise *De l'éloquence française et des causes pourquoy elle est demeurée si basse.* Malherbe, who often visited him in Provence, and other men of letters, for instance, Peiresc, greatly admired his writings and learned much from his conversation.

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DUVAL, CLAUDE (1643–1670), a famous highwayman, was born in France at Domfront, Normandy, in 1643. He entered domestic service in Paris when he was 14, went to England in attendance on the duke of Richmond at the time of the Restoration, and soon became a highwayman notorious for the daring of his robberies and for his gallantry to ladies. After some time he was obliged to retire to France, but he soon returned to England and was eventually captured in London while drunk.

He was hanged at Tyburn on Jan. 21, 1670. His body was buried in Covent Garden church under a stone with the following epitaph:

> Here lies Du Vall: Reader, if male thou art,
> Look to thy purse; if female, to thy heart:
> Much havock has he made of both; for all
> Men he made stand, and women he made fall.

See the anonymous *Memoirs of Monsieur Du Vall* (1670), ascribed to William Pope, reprinted in *Harleian Miscellany,* vol. iii, pp. 308–316 (1809).

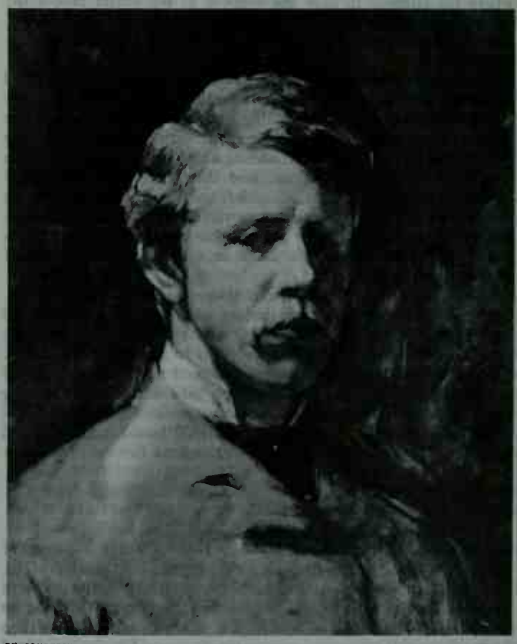
DUVEEN, JOSEPH DUVEEN, 1ST BARON, OF MILLBANK (1869–1939), international art dealer, was born in Hull, Yorkshire, on Oct. 14, 1869. He was the son of Sir Joseph Joel Duveen (1843–1908), of Dutch-Jewish descent, who established the family art business in London in 1877. With an inherited flair, great boldness that several times resulted in litigation, a keen sense of art values and an insight into the psychology of rich clients, Joseph Duveen, as a young man, began to buy and sell on an unprecedented scale.

Before 1914 he had established a monopoly of old masters on both sides of the Atlantic. His principal headquarters were in New York, and he will long be remembered as the dealer who largely built up the collections of U.S. millionaires such as Benjamin Altman, Henry Huntington, Joseph E. Widener, Henry C. Frick, John D. Rockefeller and Andrew W. Mellon. It can fairly be claimed that he changed American taste in directing buyers to the greatest Italian, Dutch, French and English masters, most of which are now represented in U.S. museums.

For his services to British art, for the Duveen wing at the Tate gallery in London and for adding a gallery to the British museum to house the Elgin marbles, he was knighted in 1919, made a baronet in 1926 and raised to the peerage in 1933. He died in London on May 25, 1939. His *Thirty Years of British Art* was published in 1930.

See S. N. Behrman, *Duveen* (1952), an amusing but unfair biographical sketch. (ST. PN.)

DUVENECK, FRANK (1848–1919), U.S. painter, sculptor and art teacher, who helped awaken American interest in European naturalism, was born at Covington, Ky., Oct. 9, 1848. A



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"SELF PORTRAIT" BY FRANK DUVENECK. IN THE CINCINNATI ART MUSEUM

pupil of Wilhelm Dietz at Munich, he was a great admirer of Frans Hals, Rembrandt and Rubens. An exhibition in Boston in 1875 first attracted attention to his work.

Many young American artists, including John Twachtman, John W. Alexander and William Merritt Chase, studied under him at Munich and Florence between 1878 and 1888, and at Cincinnati, O., where he was dean of the art academy for many years after 1888. The Cincinnati museum owns the largest collection of his works. His best work in sculpture, a memorial to his wife, is in the English cemetery in Florence. He died in Cincinnati, Jan. 3, 1919.

(D. H. W.)

DUVERGIER DE HAURANNE, JEAN (1581–1643), abbot of St. Cyran, one of the fathers of the Jansenist movement in France, was born of wealthy parents at Bayonne and studied theology at Louvain. After taking holy orders he settled in Paris, where he became known as a man of extraordinary erudition. His friendship with Cornelius Jansen, a young champion of Augustinianism, led him to oppose the Louvain Jesuits who stood for scholasticism. The two retired to Duvergier's home at Bayonne, where he became a canon of the cathedral and Jansen a tutor in the bishop's seminary. There they remained from 1611 to 1616, intently studying the fathers. Eventually Jansen went back to Louvain, while Duvergier became confidential secretary to the bishop of Poitiers, where he met Richelieu. In 1620 he was made sinecure abbot of St. Cyran, and was thereafter generally called M. de St. Cyran.

Western Touraine being the headquarters of French Protestantism, St. Cyran's learning was turned against the Huguenots. He began to dream of reforming Catholicism on Augustinian lines, and thus defeating the Protestants by their own weapons. They appealed to primitive antiquity; he answered that his church understood antiquity better than theirs did. They appealed to the spirit of St. Paul; he answered that Augustine had saved that spirit from etherealizing away, by coupling it with a high sacramental theory of the church. They flung practical abuses in the teeth of Rome; he entered on a bold campaign to bring those abuses to an end. Before long, his reforming zeal necessitated his removal to Paris, where his attempt to gain the support of influential people led to his friendship with the Arnauld family and, from 1635 onward, to his taking control of the convent of Port Royal. (*See* ARNAULD; PORT ROYAL.)

Jansen was now attacking the principles of scholastic method (as exemplified in his day especially by the Jesuits, who he thought had corrupted theology) by writing a book on Augustine, the great master of an older theological method. St. Cyran attacked the Jesuits' hand-to-mouth utilitarianism, which had played havoc with traditional church institutions, and their defiance of episcopal authority, in his publication under the pseudonym of Petrus Aurelius (1633). This work so annoyed Richelieu, now the powerful and extremely Erastian prime minister, that St. Cyran was imprisoned until Richelieu's death in 1642. St. Cyran himself died in Paris on Oct. 11, 1643.

St. Cyran's character has been always something of a puzzle. Many excellent contemporary judges were profoundly impressed by him; others, as one of them said, went away bewildered by this strange *abbé*, who leaped from one point to another in incoherent phrases. Grace of expression he had none; perhaps no man of equal spiritual insight ever found it so hard to make his meaning clear. On the other hand, Jansenism, considered as a practical religious revival, is altogether his work. Without him there would have been no Pascal—no *Provinciales* and no *Pensées*. *See* also JANSENISM.

See C. A. Sainte-Beuve, *Port-Royal*, 5th ed., 6 vol. (1888); J. Orcibal, *St-Cyran et son temps, 1581–1638*, 2 vol. (1947–48).

(X.; N. J. A.)

DUVEYRIER, HENRI (1840–1892), French explorer of the Sahara, was born in Paris on Feb. 28, 1840. At the age of 19, having already learned Arabic, he began a journey in the northern parts of the Sahara which lasted nearly three years. In 1864 he published *Exploration du Sahara: les Touareg du nord*. After 1870 he made several other journeys in the Sahara. He also examined the Algerian and Tunisian *shats* (shallow saline lakes) and explored the interior of western Tripoli. Duveyrier devoted special attention to the customs and speech of the Tuareg, and to the organization of the Senussi.

In 1881 he published *La Tunisie*, and in 1884 *La Confrérie musselmane de Sidi Mohammed Ben Alî-Es-Senôusi et son domaine géographique*.

See C. Maunoir and H. Schirmer, *Sahara, Algérien et Tunisien*, with a biography of Duveyrier by C. Maunoir (1905).

DU VIGNEAUD, VINCENT (1901–), U.S. biochemist and winner in 1955 of the Nobel prize in chemistry, was born in Chicago, Ill., on May 18, 1901. He was educated at the University of Illinois, Urbana (B.S. 1923, M.S. 1924), and at the University of Rochester (N.Y.) school of medicine (Ph.D. 1927). Awarded a National Research council fellowship, he then studied at Johns Hopkins university school of medicine, Baltimore, Md., the Kaiser Wilhelm institute in Dresden and the University of Edinburgh medical school. He served on the staff of the biochemistry department of the University of Illinois (1929–32) and was head of the department of biochemistry at George Washington university, Washington, D.C. (1932–38), before becoming head of the department of biochemistry at Cornell university (Ithaca, N.Y.) medical college.

Du Vigneaud's researches were centred mainly around studies of insulin, elucidation of the structure of biotin, transmethylation, neogenesis of methyl groups, transulfuration, metabolism of amino acids, synthesis of penicillin and determination of the structures and synthesis of the posterior pituitary hormones, oxytocin and vasopressin. It was for his work on these two hormones that he was awarded the Nobel prize, their synthesis being, as the Royal Swedish Academy of Science acknowledged, "a historic feat in biochemistry."

Du Vigneaud also received many other honours, including the Nichols, Chandler and Willard Gibbs medals and the Passano, Lasker and Osborne-Mendel awards, and was elected a member or honorary member of the leading scientific societies in the United States and of many abroad. (R. As.)

DVINA, NORTHERN (SEVERNAYA DVINA), a river of the north European part of the U.S.S.R., is formed by the confluence of the rivers Sukhona and Yug at Veliki Ustyug. The river then flows north for about 37 mi. as the Lesser Northern Dvina (Malaya Severnaya Dvina) to its confluence with the Vychegda at Kotlas. Thereafter, as the Northern Dvina proper, it flows northwest into the Dvina gulf of the White sea, where it forms a delta with five main distributaries. The Northern Dvina is 466 mi. long, but its basin covers 140,000 sq.mi. Many of its headstreams and tributaries are rivers of great size, the largest being the Sukhona, 348 mi., and the Vaga, 340 mi., on the left bank, and the Yug, 305 mi., Vychegda, 689 mi. and Pinega, 484 mi., on the right. The volume of flow of the Northern Dvina is large, the annual average discharge being 124,661 cu.ft. per second. Almost half the water supply comes from snow-melt, bringing a marked maximum flow in spring. At the Pinega confluence a maximum of more than 1,000,000 cu.ft. per second has been recorded. Widespread floods accompany the snow-melt. Freeze-up begins in October, although a firm ice cover is not established until early November. The breakup of the ice begins in early April on the upper reaches and early May at the mouth. The Northern Dvina flows across a low plain, broken by lines of morainic hills. The basin is covered by dense coniferous forest and widespread sphagnum bogs. Only along the flood plains are there open meadows.

The river is navigable for 342 mi.; considerable lengths of its tributaries are navigable, although there are many sandbanks on the Lesser Northern Dvina. Since early times this river system has been the main way of communication throughout northern Russia, for fur hunters and, later, colonists. Monasteries and towns were established at confluences and at portages with other river basins. Notable among these was Archangel (*q.v.*), which was founded in 1583 and supplanted the older port of Kholmogory. The river, which is connected to the Mariinsk waterway via the Sukhona, retains its importance and there are regular passenger and cargo services. The major freight is timber, cut on a large scale throughout the basin and rafted to the sawmilling centres along the

Dvina. The most important of these are Veliki Ustyug, Kotlas and, above all, Archangel, the largest sawmilling centre of the Soviet Union, where the sawmills line the river bank for many miles. Archangel is a major timber exporting port and one of the western terminal ports of the Northern Sea route. At the western side of the delta is the port of Severodvinsk, formerly Molotovsk.

(R. A. F.)

DVINA, WESTERN (Zapadnaya Dvina), a river of the Union of Soviet Socialist Republics, rises in the Valdai hills, issuing from the small Lake Dvinets. It flows south and southwest into the Belorussian Soviet Socialist Republic and below the town of Vitebsk swings northwestward into the Latvian S.S.R. (where it is known as the Daugava), to enter the Gulf of Riga. The largest river of the Soviet Union draining to the Baltic, it is 634 mi. long and the area of its basin is 32,900 sq.mi. Most of its tributaries are small, the larger ones being the Mezha, Kasplya, Luchesa, Ulla and Disna on the left bank and the Drissa and Aiviekste on the right.

Apart from the morainic hills along the upper reaches of the Dvina, where the valley is deep and the banks are steep, the river flows through broad lowlands, often with wide swampy areas and many lakes. Boulders of glacial origin cause rapids in the upper course, but the river is navigable from a point between the town of Zapadnaya Dvina and the Mezha confluence, although further rapids below the Disna confluence are a hindrance. Ice begins to form in late November and the freeze-up is complete by early December in the upper reaches and mid-December in the lower. Ice-melt begins in early April and lasts 5–10 days. At this time widespread flooding occurs, because of the melting of the snow, which provides about 46% of the river's water. Midsummer is a period of low water. The average annual discharge is 24,014 cu.ft. per second.

From earliest times the Western Dvina has been an important routeway and towns along its banks are among the oldest in Russia. Polotsk (*q.v.*), founded in the 9th century, is one of the first for which there is documentary evidence. The Western Dvina, connected in its upper reaches by easy portages to the basins of the Dnieper, Volga and Volkhov, formed part of the great trade route (the "Water Road from the Varangians to the Greeks") of Kievan Russia (*see* Kiev). Between 1797 and 1804 the Dvina, by way of its tributary the Ulla, was linked by a system of canals to the Berezina and so to the Dnieper. This system, always small and suitable only for rafting timber, has now fallen into disuse. The Dvina is still used for navigation, with passenger services from Riga to Daugavpils (Dvinsk). Much timber is floated to the sawmilling and timberworking centres of Vitebsk, Polotsk and Daugavpils. The largest city on the river is Riga (*q.v.*), on the right bank, a few miles above the mouth; it is the capital of the Latvian S.S.R., and has long been a major port, famous in the past for its export of ship timbers and naval stores. The Kegums hydroelectric plant, southeast of Ogre, supplies power for industry.

(R. A. F.)

DVORAK, ANTONIN (1841–1904), the first Czech composer to achieve world-wide recognition, was born at Nelahozeves, a small village on the Vltava north of Prague, on Sept. 8, 1841. Bedrich Smetana, his senior by 17 years, had already laid the foundations of the Czech nationalist movement in music, but it was left to Dvorak to develop and extend it in an impressive series of works which quickly came to rank in popularity with those of his great German contemporaries.

His father was a humble innkeeper and butcher, and Dvorak was undoubtedly influenced by the amateur music-making which he heard and contributed to at the inn. He soon became an accomplished violinist, and in 1857 a perceptive local teacher, A. Liehmann, recognizing his unusual talent, persuaded his father to send him to the Organ school in Prague. After a two-year course Dvorak worked as an orchestral viola player, organist and teacher in order to keep himself while engaged on his first serious compositions. The numerous and varied works of this period show that his earlier leanings toward Beethoven and Schubert were becoming increasingly tinged with the influence of Wagner and Liszt. In Nov. 1873, at a time when a few successful concerts of his works had begun to make his name well known in Prague, he married Anna Cermakova, and thus began an unusually happy family life. In 1875 he was awarded a state grant by the Austrian government, and this brought him into contact with Brahms, with whom he formed a close and fruitful friendship. Brahms not only gave him valuable technical advice but also found him an influential publisher in Fritz Simrock, and it was with his firm's publication of the Moravian duets (1875) for soprano and contralto and the Slavonic dances (1878) for piano duet that Dvorak first attracted world-wide attention to himself and to his country's music. The admiration of the leading critics, instrumentalists and conductors of the day continued to spread his fame abroad, which naturally led to even greater triumphs in his own country. In 1884 he made the first of ten visits to England, where the success of his works, especially his choral works, was a source of constant pride to him. In 1890 he enjoyed a great personal triumph in Moscow with two concerts arranged for him by his friend Tchaikovsky. The following year he was made an honorary doctor of music of Cambridge university. In 1892 he accepted the post of director of the National Conservatory of Music in New York, but, much as he found to interest and stimulate him there, he soon came to miss his own country and he finally returned to Bohemia in April 1895. The final years of his life saw the composition of two string quartets, five symphonic poems and his last three operas. He died in Prague on May 1, 1904, from a stroke of apoplexy.

Few composers have achieved such widespread and, as far as can be judged, lasting popularity so quickly as Dvorak. The reasons for this lie in a gift of melody only surpassed by Schubert's and in the delightfully fresh Czech character of his music which offered a welcome contrast to the heavier fare of some of his contemporaries. He was also fortunate in flourishing at a time when Smetana and the Russian nationalists had made nationalism in music an important new trend. Again his technical fluency and abundant melodic inspiration helped him to create a large and varied output. All his mature symphonies (known as No. 1 to 5, though there are four earlier ones) are of a high quality although only the sombre No. 2 in D minor (1885) is thought to be as satisfactory in symphonic design as it is musically. No. 5 ("From the New World," 1893) still retains its immense popularity, largely due to the mistaken though understandable belief that what in reality are characteristically Czech themes are Negro spirituals, but in fact it is inferior to No. 1 (1880) and 4 (1889) and less characteristic of its composer. Of the four concertos, only that in B minor for cello, op. 104 (1895), can safely be called a classic; indeed its success began a revival of interest in this instrument as a concerto solo.

In spite of the fact that the medium is sometimes overstrained, Dvorak's chamber music is also of a high quality. The Piano Quintet in A, op. 81 (1887), is one of the glories of chamber music, and the String Quartets, op. 51 (1879), 105 (1895) and 106 (1895), the Sextet, op. 48 (1878), and the "Dumky" Trio, op. 90 (1891), also rank high. The choral works, so popular when they first appeared, have suffered the fate of most late-19th-century choral music, yet the *Stabat Mater* (1877) and *Te Deum* (1892) deserve to be placed among the better examples of their kind. Opera was the one medium that proved recalcitrant to Dvorak's genius—a fact which he felt keenly and contended with all his life. Only in his last years did he write two that achieved more than local success—*Cert a Kaca* ("The Devil and Kate," 1898–99) and *Rusalka* (1900); *Rusalka* has even achieved a certain popularity, though this is more on account of its lyrical than dramatic qualities. Many of Dvorak's most attractive works, however, are to be found in the miscellaneous less ambitious works—the Slavonic Dances and other piano duets, the *Scherzo Capriccioso*, Symphonic Variations and Carnival Overture for orchestra, the "Gypsy Songs" and the Bagatelles (for string trio and harmonium, op. 47).

Dvorak's chief faults and limitations are his overdiscursive and repetitive manner, occasional lapses of taste, and the weakness of design in his larger works. He has also been charged with false exploitation of the simple and naïve charm of his work. Such shortcomings, however, amount to little in the light of the astonishing fertility of his melody and the simplicity and directness

with which he achieves his ends. As might be gathered from his music, Dvorak had an attractive personality; he was a humble and deeply religious family man of simple tastes and a great lover of nature.

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DVUR KRALOVE NAD LABEM (KÖNIGINHOF), a town of northeast Bohemia, Czech., 24 km. (15 mi.) N. of Hradec Kralove on the left bank of the Elbe, near its emergence into the plain country of Polabi. Pop. (1961) 15,010. The name means "the court of the queen on the Elbe," and recalls the founding of the city by King Wenceslas II at the end of the 13th century and the gift of the settlement to his queen, Elisabeth. It was the scene of a major Austrian defeat by the Prussians in 1866. The town received some publicity in the 19th century when a Bohemian librarian, V. Hanka, claimed to have discovered a Czech manuscript (rukopis Kralovedvorsky) in a church steeple there; it later proved to be a forgery. The town is a centre of the cotton, linen and jute industries.

DWARF, a word generally used to describe an extraordinarily small individual of a race of normal stature (*see* also DWARFISM AND GIGANTISM; PYGMY; LEPRECHAUN).

In Scandinavian and Teutonic Folklore.—The term dwarf denoted a species of fairy (*q.v.*) inhabiting the interiors of mountains and the lower levels of mines. Dwarfs were of various types, all of small stature, some being no more than 18 in. high and others about the height of a two-year-old child. In appearance they were sometimes beautiful, but more usually they resembled grave old men with long beards and, in some cases, humped backs.

The mountain dwarfs were organized in kingdoms or tribes, with their own kings, chieftains and armies. They lived in subterranean halls, believed to be full of gold and precious stones. They were principally famous for their skill in all kinds of metalwork and the forging of magical swords and rings, but they were also credited with profound wisdom and secret knowledge, having power to foresee the future, assume other forms and make themselves invisible. In the Eddaic lays Thor's hammer and Odin's spear are their handiwork and in the *Volsunga Saga* and the *Nibelungenlied* (*q.v.*) dwarfs guard hoards of gold. (*See* also EDDA.)

Many legends show them as kindly beings, generous to those who pleased them, but revengeful when offended. The Swiss dwarfs or "earth-men" sometimes helped in agricultural work, found straying animals and put out firewood or fruit for poor children to find. In Scandinavia and Germany also they were friendly to men, but occasionally they stole corn, teased cattle and abducted children and young girls. Services rendered to them were often repaid by gifts of gold from their hoards; but those who stole their treasures either met with great misfortune thereafter or found the gold turned to dead leaves when they reached home.

Mine-dwelling dwarfs were usually more capricious and spiteful than their mountain brothers. They could be heard moving about the lower levels and were sometimes seen by miners, who took care to placate them by gifts of food. If these were withheld or if their movements were too curiously observed, they retaliated by igniting fire-damp, breaking tools or pulling down the roof. When pleased, they often helped in the work or gave warning of impending danger by tapping. In England the mine-dwarf tradition survives in legends of the "Knockers" who inhabit mines in Cornwall and Staffordshire and behave in much the same way as their continental cousins. (*See* also BROWNIE; ELF.) (C. S. HE.)

In History.—Household dwarfs were kept by the early Pharaohs and still abounded at the courts of the Ptolemies. They played no part in Homeric and classical Greece but flourished in imperial Rome where slave children were sometimes stunted to increase their price. They functioned in medieval Europe and during the Renaissance their vogue increased and individual dwarfs became famous. Although they might be served in mock pies at banquets, they were treated kindly and sometimes had their own servants. Isabella d'Este designed part of her palace for them and remembered two in her will. Velasquez has familiarized us with the appearance of the dwarfs of Philip IV of Spain.

In the 18th and 19th centuries, the tsars and noblemen of Russia kept innumerable dwarfs. Elaborate dwarf weddings were celebrated at court and in 1710 a dwarf couple spent their wedding night in the tsar's bedchamber. In 1715 the funeral procession of a favourite dwarf was headed by ecclesiastics followed by 24 pairs of male and female dwarfs arranged in sizes, the tsar and his ministers bringing up the rear.

Dwarfs occasionally held responsible positions, but were primarily entertainers and often served as household fools (*see* FOOL). In western Europe household dwarfs were still heard of in the 18th century; but the institution declined and dwarfs such as Charles Stratton ("Gen. Tom Thumb") who won money and reputation in the 19th century belong to a different category.

Abnormality can excite awe as well as ridicule. The pygmy Dangas, who entertained some of the early Pharaohs, came from Puanit near "the land of ghosts" and could "dance the god"; medieval Irish dwarfs were sometimes credited with poetic and supernatural powers; a 19th-century traveler noted that African dwarfs were regarded as wizards; a traveler in 20th-century Spain saw a dwarf's hump touched for luck.

See also references under "Dwarf" in the Index volume.

(E. E. H. W.)

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(C. S. HE.; E. E. H. W.)

DWARFISM AND GIGANTISM are terms which designate conditions of size outside (below or above) the range of the normal variation of living organisms. Such abnormal variants are found among plants as well as among animals, including man. The terms usually refer to comparisons within one species but, especially in evolutionary studies, may apply also to the relative sizes of related species and genera. In speaking of dwarfs and giants the allusion ordinarily is to size of the organism as a whole, but parts and organs may be affected selectively or preferentially. Entirely proportionate dwarfism or gigantism is, in fact, an exception rather than the rule. As in all development of living beings, interactions between the environment and the hereditary endowment are of prime importance; yet, in different circumstances the contributions of these two sources of variation differ greatly in extent.

Gigantism and dwarfism, titans and midgets have fascinated men since the dawn of recorded history and probably long before. "What he often sees," said Cicero of man, "does not excite his wonder, even though he knows not the cause of it. But if a thing happens that he has not already seen, he regards it as a prodigy." The belief was common that "there were giants in the earth in those days" (Gen. vi, 4). Many peoples traced their origin to giants. There are legends of the Titans who made war against the Olympian gods. Polyphemus and Goliath, Gargantua and Rübezahl, Gog and Magog are among the more famous representatives of the many legends that had giants for heroes. J. G. Frazer in *The Golden Bough* gave an account of the Norse legend about the giant who had no heart in his body as an example of the widespread primitive belief in the external soul. The manifold roles of dwarfs in myths and legends are too well known to call for comment. In poetry, romance and satire, giants and dwarfs, Brobdingnagians and Lilliputians, continue to serve as a measure of human stature and human frailty. Sculptors and painters also have often fashioned dwarfs—in ancient Egypt, at Pompeii and Herculaneum, in engravings by Tiepolo and portraits by Velázquez, among many others—and many of these works of art are of considerable cultural as well as medical-historical interest. (*See* also DWARF; GIANT.)

Dwarfism.—In man and other higher animals four principal kinds of dwarfism may be distinguished: (1) Racial dwarfism, represented by groups of diminutive individuals whose physiological bodily functions are quite normal. (2) Dwarfism due to genetic changes (mutations) arising in the progenies of normal parents; the primary effect of such mutant changes may be on an endocrine gland (*e.g.*, the pituitary) or more directly on cellular

functions related to growth. (3) Dwarfism produced by metabolic disturbances due to organic disease. (4) Dwarfism determined by forces of the environment with which the hereditary constitution of a particular organism is unable to cope.

All these categories of dwarfism are encountered in man. For anthropological purposes the lower limit of "normal" height of adult men has, and of necessity in a somewhat arbitrary manner, been set at 4 ft. 11.1 in. (150 cm.); any group with a lesser mean height for males is considered as composed of dwarfs. By this criterion dwarf populations exist in central Africa, the Andaman Islands, the Philippines and New Guinea. The pygmies of central Africa are frequently used as the prototype of such racial dwarfism. Height among these pygmies varies down to 4 ft. 3 in. for men and to 4 ft. for women.

The Bushmen of the south African Kalahari desert, though somewhat taller than pygmies, are also dwarfs. The natives of the Andaman Islands in the Indian ocean and the Negritos of the Philippines and New Guinea are other dwarf populations. No demonstrable relations have been found among these dwarf groups of Africa, Asia and Oceania. Their peculiarities presumably arose by mutation and may have been fixed by isolation. (*See* also PYGMY; BUSHMAN; NEGRITO.)

Among several types of hereditary dwarfism occurring in populations of normal stature, the commonest is known as achondroplasia, or chondrodystrophia fetalis. It is a form of disproportionate dwarfism in which the extremities are greatly reduced in length, shortness of the legs being the principal or sole cause of wanting stature. This disproportion is congenital. Adult body height approximates that of normal children aged nine years. In many achondroplastic persons the root of the nose is depressed and the antero-posterior diameter of the pelvis is reduced; other skeletal peculiarities are often associated. There is much variation in the severity of achondroplasia. In the presence of the most extreme symptoms death occurs before, during or shortly after birth, but the life expectancy of other affected individuals is normal. The pathological processes that produce achondroplasia remain unknown. All physiological functions appear to be normal, except that (with rare exceptions) achondroplastic women, because of the shallow pelvis, can give birth only by Caesarean section. Intelligence is normal. Most court jesters were men afflicted with achondroplasia; so are many circus clowns. Achondroplasia occurs whenever one of the two germ cells that give rise to an individual contains the relevant hereditary factor; it is a dominant genetic trait. It has been found that about one birth in every 10,000 represents an achondroplastic individual. The majority of achondroplastic children are born to normal parents, evidently as a consequence of a mutation in the gonads of one of them. Several additional hereditary disturbances of skeletal growth produce disproportionate dwarfing; *e.g.*, dyschondroplasia (Ollier's disease).

In other forms of hereditary dwarfism the bodily proportions remain relatively if not altogether normal. In this group are found the smallest individuals on record; these are the midgets or ateliotic dwarfs, the lowest authentic stature on record being 30.7 in. for an adult male. Some of these dwarfs are already below normal size at birth (primordial dwarfism), but in others the retardation of growth becomes effective in the course of the first two years of life. Midgets remain sexually immature. The nature of the inborn errors of growth in this kind of dwarfism is obscure, but abnormalities of pituitary function probably play a role in at least part of the cases.

Dwarfing may occur as a consequence of varied metabolic or functional disturbances, such as chronic nephritis (renal dwarfism), fibrosis of the pancreas (intestinal dwarfism), brain pathology (dyscerebral dwarfism) and subnormal thyroid activity (endemic cretinism, myxedema [*qq.v.*]). Some mental defects are also associated with dwarfism (*e.g.*, mongolism). Finally, dwarfing (such conditions as rickets; *q.v.*) may be a consequence of nutritional inadequacies and deficiencies.

Among other mammals and among birds the varieties of dwarfism show a spectrum very similar to that found in man. Among many domestic animals are found dwarf races or breeds: ponies, African dwarf goats, toy dogs, Bantam fowl. In the Dexter breed of cattle the genetic factors for reduced body size are responsible for the occurrence of monsters, known as bulldog calves. In several breeds of beef cattle a mutation for dwarfism, associated with other defects, is responsible for serious losses to breeders. Several mutations to dwarfism have been reported in mice. In one of these, size is normal at birth, but begins to lag at about two weeks of age, producing an adult size one-quarter to one-third of normal; both sexes are sterile and the life expectancy is poor. This form of dwarfism is inherited as a recessive trait; *i.e.*, both parents must transmit the mutated gene before it can come to expression in the progeny. The primary effect of the mutation is an abnormality of pituitary activity, all consequences of which (dwarfism, sterility, etc.) can be overcome by proper hormone medication. In poultry hereditary dwarfism has been encountered in association with defective activity of the thyroid. Deficiencies and metabolic disturbances are often responsible for underdevelopment, and breeders refer to such animals as runts.

The situation in plants is similar to that in animals. On the one hand dwarfism occurs as a consequence of changes in the hereditary endowment; on the other hand stunting of growth is produced by forces of the environment which impose their effects upon the genetic constitution. Mutant forms, such as dwarf roses, often have considerable horticultural value. Hereditary dwarfism (*e.g.*, in maize) frequently is brought about by interference with the synthesis or with an abnormal rate of destruction of essential hormonelike growth substances (auxins, gibberellins), compounds which in some instances can be provided extraneously and then support normal growth. The emergence of a dwarf form of pigweed was ascribed to the selective effect of the regular mowing of meadows. Climatic and nutritional conditions are more often instrumental in the selection of dwarf varieties (mountains, sea shore), but dwarfing also may occur as a direct adaptation to an unfavourable environment. The production of dwarf plants for ornamental purposes, known as *bonsai* (*q.v.*), which originated in China, was brought to a high degree of perfection by Japanese horticulturists.

Gigantism.—Gigantism is much rarer among recent organisms than dwarfism. In man the conventional definition of a giant is a height exceeding 6 ft. 6.7 in. (200 cm.) in men and 6 ft. 1.6 in. (187 cm.) in women. The giantess Marianne Wehde had a height of 8 ft. 4.4 in. (255 cm.), and hers appears to be the maximum recorded stature on which reliance can be placed, though claims for other giants go as high as 9 ft. 3 in. The commonest form of gigantism in man is brought about by hyperactivity of the pituitary gland, frequently as a result of benign tumours of the pituitary. As a consequence of such glandular disturbances in adolescents longitudinal bone growth may continue long beyond its normal time of cessation. In older persons pituitary gigantism is often limited to a special enlargement of the hands, feet and jaws (acromegaly; *q.v.*). Another form of gigantism is produced in men by early castration.

The history of evolution offers many interesting aspects of dwarfism and gigantism. One of the most peculiar among these is the nearly universal occurrence of a trend toward gradually increasing body size, a fact known as Cope's rule. This trend culminated in the real giants of evolutionary history, including the mighty dinosaurs and equally impressive mammals. Human evolution did not escape this trend. Suggestively large skeletal fragments (*Meganthropus*) have been found in Java, and molars of tremendous dimensions were located in China and ascribed by some investigators to a human stock (*Gigantopithecus*), probably of Pleistocene times. According to F. Weidenreich, "it may not be too far from the truth if we suggest the Java giant was much bigger than any living gorilla and that the Chinese giant was correspondingly bigger than the Java giant—that is, one and one-half times as large as the Java giant, and twice as large as a male gorilla." (*Apes, Giants and Man,* The University of Chicago Press, 1946. Copyright 1946 by The University of Chicago.) A fully grown male gorilla weighs upward of 400 lb. It is clear that evolution, with the extreme specialization that produced dinosaurs and similar forms of gigantism, had led into a one-way street from which there was no escape, but it is not certain that the Javanese and Chi-

nese giants became extinct for similar reasons.

See also references under "Dwarfism and Gigantism" in the Index.

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DWARKA (Sanskrit DVARAKA, also DVARAVATI, "city of many gates," also known as Jagat or Jigat), a municipality of Jamnagar (formerly Halar) district in Gujarat, India, lies on the west coast of the Okhamandal peninsula in the northwest of the Kathiawar peninsula, 115 mi. W. of Rajkot. Pop. (1961) 11,912. According to legend Dwarka was the capital of Krishna (*q.v.*), who founded it after his flight from Mathura (Muttra). Its consequent sanctity makes it one of the seven great places of pilgrimage for Hindus and most of its revenue is derived from the pilgrim traffic. The original temples were destroyed in 1372 by Mahmud Shah Begada of Gujarat. (J. B.-P.)

DWELLING: *see* HOUSE DESIGN; RESIDENTIAL ARCHITECTURE.

DWELLINGS, PRIMITIVE. Human shelter, like clothing, is a nonbiological adaptation to external conditions. Man is physically ill-adapted to withstand the rigours of climate, but his intelligence and dexterity provide compensation by enabling him to manipulate the external world to fit his needs. All land animals except the hoofed mammals regularly make use of shelter if only for the period of rearing their young. Their shelters are fixed by instinct; in contrast, human dwellings are diverse products of invention and cultural tradition. Housing provides shelter from the elements, protection from human enemies and predatory animals, security for infants and a place for social intercourse.

It is presumed that beginnings of construction among protohumans resembled the crude nests of apes—those of chimpanzees in trees, the heavier gorilla more often on the ground. The earliest fully evolved humans of Paleolithic times had their abodes in the mouths of caverns and under rock overhangs. They probably also built elsewhere in the open, but little is known of such perishable structures. By the time of the Neolithic period, dwellings were constructed much like those of modern primitive peoples. (*See* ARCHAEOLOGY: *Prehistory;* LAKE DWELLINGS.)

Adjustment to climatic conditions was sometimes incomplete. The half-open lodges of Indians in northwest Canada and the brush huts of Fuegians at the southern tip of South America afforded poor protection against frigid weather. The wandering life of these peoples permitted no more substantial construction and they were inured to hardship. Adaptations also involve availability of materials and their utility. The Eskimo snow house and the Congo palm-thatched hut are obvious examples. In spite of abundance, limitations may exist: mud, though often used as building material, is impractical where rainfall is heavy. Adaptations are not made anew by each individual; rather, the selection of materials and the form of house are dictated primarily by traditional building practice.

In addition to dwellings, primitive peoples often had public buildings and auxiliary storehouses whose construction was sometimes quite elaborate and according to different principles.

Furnishings of dwellings were simple: possessions were few and mostly necessities. Bed places, hearth, cooking utensils, mortar and storage receptacles comprised the lot among most peoples. Facilities for sanitation were rare. Offal scattered about was scavenged by animals, domestic or wild. Latrines were established at cliff edges at Maori (New Zealand) hilltop villages, and on many Oceanic atolls it was obligatory to use the beach between low and high water.

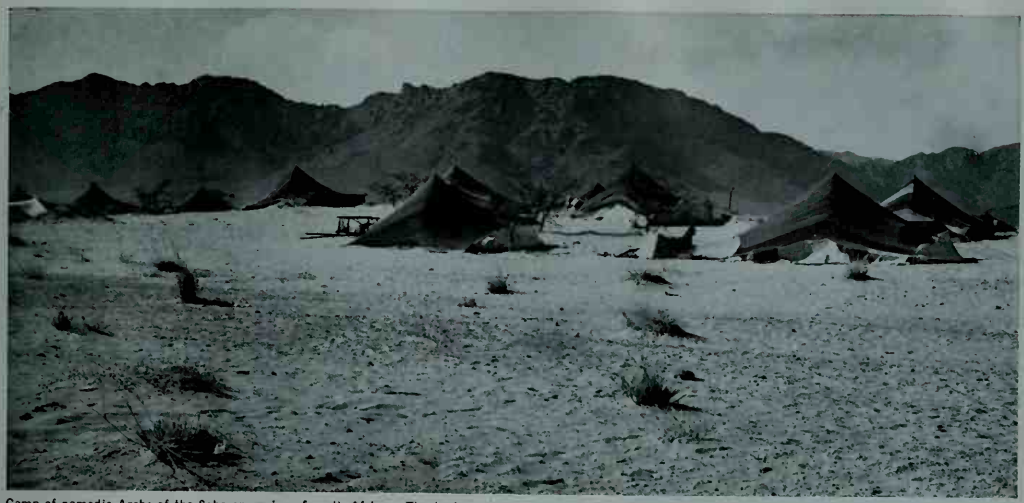
Africa.—Primitive habitations in each continent were primarily of a few widespread forms. In Africa, houses in the Sahara oases followed Mediterranean style (rectangular, mud or stone walls, flat roofs), while those of the seminomads (Tuareg and Tebu) showed adaptations to more southern forms, with the nomadic Arabs using their characteristic cloth tent.

South of the Sahara two forms predominated: one circular-walled and conical-roofed, the other rectangular-framed and gabled. From the western Sudan eastward and southward toward the Cape of Good Hope was a round house with the roof conical or drawn in beehive fashion. In this semiarid region clay or mud was often utilized for walls, thatch of grass or palm leaves for roofs. Hausa dwellings (western Sudan), clustering in towns, had grass-thatched conical roofs on low walls. The roof framework was sometimes put together on the ground and bodily lifted into place, whence it could be readily transferred to other walls when the first ones rotted. Alternatively there were small rectangular houses, mud-walled, with roofs gabled, flat or conical. Ambitious houses bore modeled decoration or incised designs. Upper Nilotic villages were straggling clusters of conical-roofed houses raised on platforms to avoid dampness and wild beasts. An east African village was typically a ring of houses occupied by the wives and relatives of a chief with a surrounding wall of stone or thorns within which cattle were driven at night. The large conical-roofed structure of the Ila (Northern Rhodesia) had atop its centre pole a wooden disk from which rafters descended to the walls of closely planted posts, with the interior clay coated and the exterior thatched with grass like the roof. A sleeping compartment was set off by a row of clay grain bins. The beehive-shaped house prevailed in the northeastern and southeastern coastal districts.

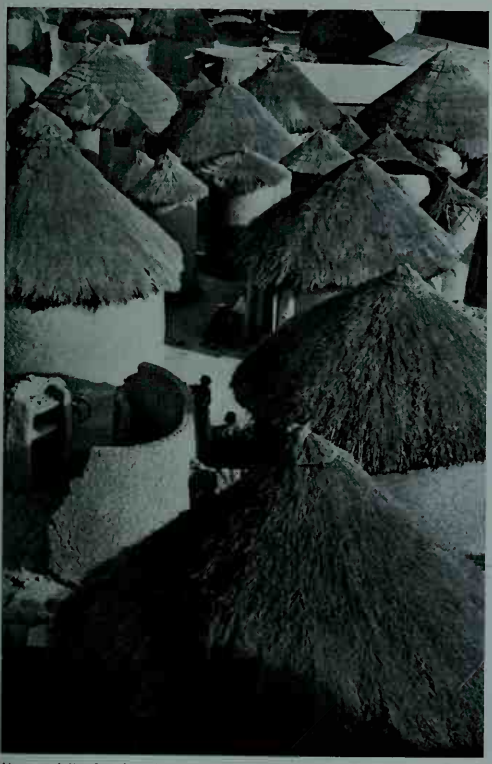
The second general African type, the rectangular gable-roofed house, was built throughout the forested Congo and Guinea coast, with those of the Congo generally smaller. House walls among the Kuba (Bushongo) of the lower Congo had decorative patterns formed by the lashings holding the palm thatch in place. Southward and eastward, rectangular houses formed a hybrid with the conical roofs of east Africa. Pile dwellings were constructed along water courses of the Congo and Zambesi. In desertic southwest Africa the cattle-raising Hottentot, obliged to move from one water hole to another, made an easily transported low-domed hut of sewn reed mats over a frame of pliable poles. The shelters of the roving Bushmen in the Kalahari desert were mere semicircular windbreaks or rock overhangs.

Asia.—Habitations of natives in northern and central Asia had an east-west zonal distribution corresponding to the northern tundra with its reindeer herding and to the central forest and steppe with its mixed-herding economy. A conical tent was in use in the tundra from the Yukaghir (northeast Siberia) westward to the Lapps (northern Scandinavia) and in the forests from the Tungus (Amur river) to the Kalmy (north Caspian sea). This Eurasiatic occurrence may have been historically linked with the conical tent of North America. The more northerly peoples made tent covering of unsewn reindeer skins, carrying their poles and cover as they followed roaming herds in the treeless land; those of the southern Siberian forests could afford to abandon their bark-covered tents to rebuild at new pastures. Both types were often banked with snow or earth; the Bashkir (Ural district) plastered their houses with dung and straw. In the Altai-Lake Baikal region the Buryat alternated skin and bark covering in winter and summer, and their southern neighbours, the Northern Mongols, substituted the felt-mat covering of the steppe-desert zone. A cylindrical tent (yurt) with a conical or domed roof prevailed throughout central Asia from Mongolia to the Black sea, the conical-roofed in the east among Mongolic tribes, the domed among Turkic tribes to the west. Where Altai-Tatars of the forest made a cylindrical wall of posts, the commonest wall frame was a joined lattice with pliable poles bent for the roof, covered with overlapping felt mats, the whole easily collapsible for transportation. But yurts were also carried bodily on wagons by tribes of the Black sea area, as they were by the Scythians of the 5th century B.C.

In northeastern Siberia the maritime Chukchi and Koryak built semisubterranean timbered, earth-covered houses, those of the Koryak being distinguished by a funnellike contrivance over the roof entrance to deflect drifting snow. Herdsmen inland made a skin replica of these large houses, ill-adapted for sled transport. In Tibet there was contrast between the yak-cloth tents of the nomadic Drupa and the clustering stone-walled, flat-roofed houses of the settled population. The former were rectangular, with a low gable having a smoke outlet along the ridge. The shapeless-appearing Arab tent had a standard form: roughly rectangular,



Camp of nomadic Arabs of the Saharan region of north Africa. The tents are usually made of strips of cloth woven from goat's or camel's hair, and vegetable fibres



Houses of the Senufo tribe, Ivory Coast. The cylindrical walls are made of mud, the conical roofs of thatched grass

Circular-walled hut made of woven reed with a thatched conical roof; Jerma dwelling near Niamey, Republic of Niger

Shelter of the nomadic Isa tribe of Somalia, a portable, low-domed tent of reed mats supported by a hemispherical framework of curved poles

DWELLINGS OF AFRICA

PHOTOGRAPHS, (TOP, BOTTOM LEFT) MARC & EVELYNE BERNHEIM—RAPHO GUILLUMETTE, (CENTRE RIGHT, BOTTOM RIGHT) E. AUBERT DE LA RÜE

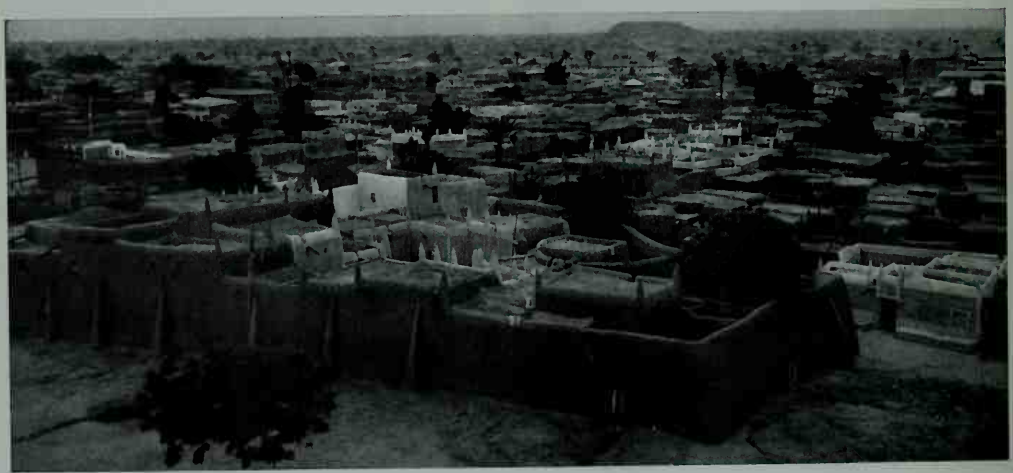
DWELLINGS, PRIMITIVE

Rectangular houses with thatched gable roofs and reed walls elevated on piles above the lagoon in the village of Ganvié, Dahomey

Beehive-shaped dwelling made of clay with incised wall designs, Lagone river area, Republic of Cameroon

Pondo round houses with thatched conical roofs and clay walls, the Ciskei territory, Cape province, Republic of South Africa

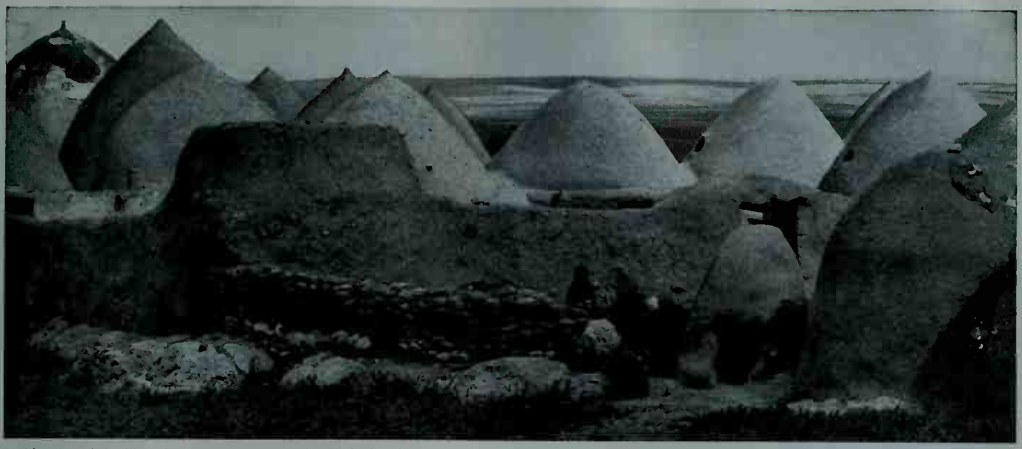
Kuba tribesmen building a rectangular gable-roofed house of palm thatch in the lower region of the Congo river, Democratic Republic of the Congo



Flat-roofed, mud-walled Mediterranean style houses in the old section of Kano, Nigeria. The Fulani and Hausa inhabit this type of dwelling

DWELLINGS OF AFRICA

BY COURTESY OF (CENTRE LEFT) REPUBLIC OF SOUTH AFRICA GOVERNMENT INFORMATION OFFICE, NEW YORK, (CENTRE RIGHT) BELGIAN GOVERNMENT INFORMATION CENTER; PHOTOGRAPHS, (TOP LEFT) MARC & EVELYNE BERNHEIM—RAPHO GUILLUMETTE, (TOP RIGHT) AVA HAMILTON, (BOTTOM) MARILYN SILVERSTONE—NANCY PALMER AGENCY



Beehive-shaped dwellings in an Arabian village in the Syrian desert. Made of dried mud or clay, they are designed to serve as protection from the strong desert winds

Pile dwellings of bamboo-frame construction with thatched roofs and siding, Luzon Island in the Philippines

Portable home of the nomadic Drupa of Tibet, a rectangular tent made of woven yak-hair cloth stretched over a framework of poles. The gable-shaped top has a narrow opening through which smoke escapes

Tribesmen of India building a rectangular gable-roofed house, the frame of which is made of bamboo poles lashed together with vine ropes

Low-walled house of frame construction, slightly elevated from the ground, with a high horned roof, a communal dwelling of the Bataks in western Sumatra

DWELLINGS OF ASIA

PHOTOGRAPHS, (TOP) PATELLANI—PIX FROM PUBLIX, (CENTRE LEFT) EWING GALLOWAY, (CENTRE RIGHT) HARRISON FORMAN, (BOTTOM LEFT) VIDYAVRATA/FLO (BOTTOM RIGHT) MARC RIBOUD—MAGNUM

DWELLINGS, PRIMITIVE

Fijians building a house of thatched reed leaves. The main support is heavy bush timber over which a framework of bamboos and reeds is laid and fastened by vines

Polynesian hut built on a round stone base, Upolu Island, Western Samoa. Protective mat curtains woven out of coconut palms hang between the wall poles which support the thatched conical roof

Circular house with a low-domed thatched roof, characteristic dwelling of the mountain tribes in the Baliem valley, New Guinea

Polynesian hut with gable roof of thatched leaves supported by a semicircular framework of timber poles; Futuna Island, Hoorn Islands

Melanesian hut constructed of bamboo poles and thatched palm leaves; Kanaka dwelling, Espiritu Santo Island in the New Hebrides

Polynesian pile dwelling of frame construction with latticework siding of coconut fibres and thatched roof drawn in a gable; Raiatea Island, Society Islands

DWELLINGS OF THE PACIFIC OCEAN AREA

BY COURTESY OF (TOP LEFT) FIJI PUBLIC RELATIONS OFFICE, PHOTOGRAPH, ROB WRIGHT; PHOTOGRAPHS, (TOP RIGHT, CENTRE RIGHT, BOTTOM LEFT AND RIGHT) E. AUBERT DE LA RÜE, (CENTRE LEFT) AUTHENTICATED NEWS

Tepee of the Blackfoot tribe, Montana, a characteristic dwelling of the Plains Indians, consisting of decorated hide stretched over a tripod of poles against which other poles are propped

Model of a long house, a communal dwelling of the Iroquois people of the northeast. The house was a rectangular shape covered by a barrel vault roof made of bark panels held down by poles

Hogan of the Navahos, a nomadic tribe of the southwest. Dirt heaped on the roof and used as chinking between the logs made the dwelling rainproof

A round house of stones with a conical thatched roof, a typical dwelling of the Indians in the highlands of northern Mexico

Pueblo of the Taos Indians, New Mexico. The square rooms are made of adobe and set one upon the other to form a pyramid, with ladders used to reach the upper levels

Alaskan Eskimos building an igloo with carved blocks of snow. The blocks are laid in an upward spiral to form a dome

DWELLINGS OF NORTH AMERICA

BY COURTESY OF (TOP LEFT) U.S. DEPARTMENT OF THE INTERIOR, (TOP RIGHT) MUSEUM OF THE AMERICAN INDIAN, (BOTTOM RIGHT) NEW MEXICO STATE TOURIST DIVISION; PHOTOGRAPHS, (CENTRE RIGHT, BOTTOM LEFT) EWING GALLOWAY, (CENTRE LEFT) E. AUBERT DE LA RÜE

DWELLINGS, PRIMITIVE

Oval community house of the Yagua tribe of northeastern Peru. Sections of plaited palm leaves are tied to a lashed-pole framework. Palm screen at right serves as the door

Typical dwellings of the Amazon river region near Iquitos: rectangular houses with palm-thatched gabled roofs. These houses rest on pilings driven into the river

Hut of the Oyampi Indians on a bank of the Oyapock river, French Guiana. The structure is basically a platform with a gabled roof and one wall serving as a windbreak

Another platform dwelling in the Amazon region of Brazil. Pilings serve as support for the flooring and as a frame for the roof. A notched tree is used as a ladder

Construction of a house in Guatemala with adobe, sun-dried clay bricks, a principal building material of arid and semiarid regions throughout the world

Lashing palm fronds to pole supports to make a thatched roof over a house in Colombia

DWELLINGS OF CENTRAL AND SOUTH AMERICA

BY COURTESY OF (TOP LEFT) WENNER-GREN FOUNDATION FOR ANTHROPOLOGICAL RESEARCH—PAUL FEJOS, (BOTTOM RIGHT) STANDARD OIL CO. (N.J.); PHOTOGRAPHS, (TOP RIGHT) HANS MANN, (CENTRE LEFT, CENTRE RIGHT) E. AUBERT DE LA RÜE, (BOTTOM LEFT) H. ARMSTRONG ROBERTS

its haircloth cover was supported by poles on the median line, paired with others at the open front, and guyed by taut ropes. The short rear wall was a hanging valance; the higher front might be closed with a curtain in cold weather. A cloth partition sometimes set off the women's compartment. Southeast Asia was in general an area of rectangular, timber- or bamboo-framed houses, with thatched or lattice sides. The Lolo (Yi) of southwest China interwove bamboos in patterns for their walls. The similar habitations of the Lamet (northern Vietnam), raised on piles, had a veranda at each gable end. Berths were ranged along one side, each with a hearth to furnish a smudge against mosquitoes. Houses throughout Malaysia were of much the same type, with local variations, and frequently set on piles. Most were small, but in inland Borneo a building might house an entire village; in central Sumatra such houses had elaborately carved and painted gable ends. Exceptional were the beehive-shaped huts found in outlying sections, as in the Lesser Sunda Islands.

Oceania.—In Oceania, houses were most commonly rectangular with thatched gable roofs. These were the products of guilds of house builders in Polynesia and Micronesia. In both areas timbers were accurately fitted, and lashings of coconut fibre (sennit) were commonly interlaced in ornamental patterns. While in some islands indoor hearths provided light and warmth, cooking was in a small detached hut. Polynesian dwellings were almost always raised on stone-faced or paved platforms. Hawaii, Marquesas and New Zealand houses were square; in Easter Island they were elongated with pointed ends. Variation appeared in central Polynesia (Samoa, Tonga, Society Islands), where round additions at opposite ends produced an elliptical ground plan which in Samoa often approached a circle. Mat curtains, hung between wall posts, provided protection. Fiji showed by far the greatest variations in house form. Micronesian structures were frequently divided by partitions, which were lacking in Polynesia except for temporary bark-cloth (tapa) curtains. Melanesian houses were less well made: timber frames were cruder and often the frame, even of large houses, consisted of poles set along opposite long sides and brought together in a pointed arch. Wooden floors were raised on posts separate from the house frame; on these, earth-filled boxes functioned as hearths. Circular houses in the mountains and large communal dwellings on the southeastern coast marked New Guinea variants. In contrast, the hunting, roving peoples of Australia and Tasmania pitched camp near water holes, making a lean-to of boughs or bark that rested against a pole set on two forked sticks, backed against the prevailing winds.

North America.—Regional distinctiveness also characterized the dwellings of North American Indians. Different winter and summer forms were built by natives from the Atlantic to the Mississippi. In the north the winter dome-shaped house (wigwam) was small, framed of flexible poles and thickly covered with overlapping mats or bark. In the south, as among the Chickasaw and Choctaw, walls and roof were distinct; the timbers were shaped and notched; at the centre, four tall posts supported a hexagonal cribwork from which rafters reached to the wall plates; the houses were thatched, clay-plastered inside and out and partitioned into two rooms. The summer lodge of the east was rectangular with a gable roof; the covering of mats or bark was held down by poles which duplicated the inner framework. Along the middle Atlantic coast, the roof was a half-cylinder (barrel vault). Platform beds lined the walls in both domed and gabled houses. An open pavilion served as a summer house near the Gulf. Both winter and summer houses were usually small. The Iroquois long house was rectangular, lengthened as needed for additional families: partitions marked off family spaces, while down the centre was a line of family hearths. Transitional forms appeared among the Natchez and other tribes on the lower Mississippi, where domed roofs were supported on rectangular bases, the walls heavily clay-coated. Farther west the larger circular Wichita houses, framed of supple poles, resembled giant beehives neatly thatched with grass.

Conical tents were typical of the plains and interior Canada. The Plains Indian tent (tepee or tipi, the Dakota name) had a tripod or four-pole foundation supporting other poles; on this was tightly stretched a decorated, semicircular, fitted hide cover. Wings at the apex prevented a downdraft at the smoke hole. After the introduction of the horse (17th–18th centuries) had facilitated transportation, larger tepees were made by the central tribes. During the summer hunt, tepees were pitched in a great circle, each family in its allotted place. Sedentary tribes of the eastern plains (Hidatsa, Pawnee) built large earth-covered lodges with a circle of wall posts, four higher centre posts, rafters extending from centre posts to wall and a tunnellike entrance. Inside were family compartments and a pen for horses. On the summer hunt, Hidatsa used tepees pitched in camp-circle fashion. Northward in Canada was a small bark- or mat-covered tepeelike structure, its covering often extending for but two-thirds of its height and hence not much more than a windbreak. Only mats were carried to new locations since poles were available everywhere. The earth-covered lodge used by tribes of southern British Columbia resembled that of the eastern plains but with different timbering and often a roof entrance. Along the middle Columbia, the winter house was a large gable set on the ground, usually with rounded ends. In summer, tribes there used the conical forms. The Athapaskans of northwestern Canada had merely double lean-tos, like two halves of a gable face to face, with a fireplace between—again a bare shelter from the weather.

The Eskimo snow house (igloo or iglu), built at sealing grounds, was characteristic only of the Arctic coast between the Mackenzie river and Baffin Island. Carved blocks of snow were laid in an upward spiral to form a domed house with a low tunnel entrance, a platform of snow inside forming a sleeping and lounging place. For inland travel in summer a rudimentary skin tent was carried. Eastward in Greenland and Labrador, houses were roughly of this domed shape but with walls of stone and sod, arched above by whale ribs or large stone slabs. Westward, the Alaskan Eskimo made a squarish house of logs with a pyramidal roof.

Gable-roofed rectangular houses on the coast from Alaska southward were often very large, accommodating several families. These were framed of heavy timbers between which riven planks were set vertically or horizontally with others for roofing. The circular doorway at a gable end could be closed by a sliding panel. Totem poles and painted heraldic devices decorated such house fronts. A wide platform ran along the walls, either built up or produced by a square excavation at the centre. Plank houses with a single pitch, shedlike, were also built in southern British Columbia and western Washington. At the southern end of the plank-house range in northwest California, the Yurok and Hupa built without the timber frame, placing crude planks vertically in the ground and resting roof planks on a ridgepole and the walls.

In the central valley of California, northern tribes (such as the Maidu) had a semisubterranean house, its conical roof, with brush and earth covering, extending to the edges of a shallow pit. These of the San Joaquin drainage (Yokuts) had elongated elliptical houses, mat-covered, with numerous posts holding up the ridge, and partitioned into family quarters. In the coastal areas and Sierra foothills were varieties of small conical, bark- or brush-clad huts. These aligned with the crude conical or subconical dwellings (wickiup)—with a base of four crooked branches covered with brush—of the semidesert country from Idaho to Arizona and New Mexico. Local variations appeared: on the eastern border some Shoshone used skin covering in imitation of the plains tepee; in northern Arizona, Navaho heaped dirt over their subconical house to render it raintight. A semicircular windbreak was the sole shelter of tribes in central Nevada. Yuman tribes of the lower Colorado built a rectangular low structure with a double-pitched (gambrel) roof, the whole covered with sand. In the Gila drainage, Maricopa and Pima dwelt in dirt-clad flattened domed houses; four or six centre posts supported stringers to which encircling poles were tied.

The architecture of Pueblo tribes of northern New Mexico and Arizona differed markedly from that to the north. Their houses were blocks of square masonry-walled rooms ranged in a single line, or stepped up to two to four stories—each level set back from the lower—or rising in pyramid fashion. Western pueblo walls were of sandstone blocks, the eastern more commonly of sun-dried bricks or lumps of adobe. Entrance to the lowest story was by

way of a roof hatchway, reached by a ladder which could be drawn up for security. The strongly built flat roofs of lower stories provided access for residents above. (*See* also CLIFF DWELLINGS; ADOBE.) To the south, in the northern Mexican highlands, houses were often of stone or mud wattle, square and, less frequently, round, with occasional buildings of more than one story. Flat-roofed houses were more common to the west, but arched or domed thatched roofs occurred. Mat-covered houses, mostly rectangular and gable-roofed, were in use in coastal Sinaloa. Through most of central Mexico and southward to Yucatan, the habitations of common folk—whether Aztec, Maya or lowly Chinantec—were rectangular, often with rounded ends, with wattle walls daubed with mud or built of undressed stone, and with a four-sided (hip) roof with a short ridge, heavily thatched. The more pretentious establishment of a chief was a group of such houses around a patio, with walls plastered a rich red and with red cement floors.

South America.—Subsistence, climate and availability of materials influenced dwellings in South America as elsewhere. Sedentary Andean cultivators built permanent structures of stone or adobe, whereas Amazonians, whose fields were exhausted in a few years, constructed dwellings whose life was brief. In the Andean zone and the adjacent coast, villages comprised several walled compounds, placed irregularly, within which were small stone- or adobe-walled houses surmounted by gabled thatched roofs. Within were low clay stoves, shelves or wall niches for storage and sometimes a raised bed. The dwellings of nobles were larger and more elaborately furnished. But the Chibcha (Colombia) built the gable-roofed house of Amazonian type. Throughout the forests of the Amazon and Orinoco and in the West Indies, thatched frame construction was employed: a rectangular gabled structure, or a large gable resting on the ground or a round house with conical roof. Villages comprised numerous single-family dwellings or a few large communal houses; within the latter each family had its assigned, but not partitioned, space where its hammocks were slung.

Through the pampas and Patagonia the shifting population employed windbreaks and lean-tos, covered with brush, grass or skins. Among the Fuegians there was a beehive-shaped or conical structure, with bark, turf or skins covering it. After the introduction of the horse (17th century), the skin tent (toldo) tended to supplant brush construction, some tents being very large but still of open-sided pattern.

See also references under "Dwellings, Primitive" in the Index.

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DWIGHT, the family name of a group of U.S. educators, clergymen, lawyers and authors.

TIMOTHY DWIGHT (1752–1817), U.S. educator, minister and writer, was one of the most influential intellectual leaders during the first decades of the new American republic. He was born at Northampton, Mass., May 14, 1752. His father, Timothy Dwight, a merchant, was a graduate of Yale; his mother, Mary, was the third daughter of Jonathan Edwards. After the son's graduation from Yale in 1769 he taught in a grammar school at New Haven; he was a tutor in Yale college from 1771 to 1777 and a chaplain for a year in a revolutionary regiment. From 1778 until 1783 he lived at Northampton, teaching, farming, preaching and becoming active in politics. From 1783 until 1795 he was pastor of the Congregational church at Greenfield, Conn., where he opened a coeducational academy which at once acquired a high reputation.

From 1795 until his death on Jan. 11, 1817, he was president of Yale college. By his judicious management, remarkable ability as a teacher and force of character he won great influence and did much to raise the standard of the institution and set the pattern for the "New England type college" in other parts of the country. He became such a powerful leader of conservative Federalism after the French Revolution that he was sometimes referred to as "Pope" Dwight. Dwight was also well known as an author and as a young man had been associated with the Hartford, or Connecticut, wits, a group of writers that endeavoured to establish an American literary tradition; the group included Joel Barlow and John Trumbull (*qq.v.*). In verse Dwight wrote an ambitious epic in 11 books, the *Conquest of Canaan,* virtually finished in 1775 but not published until 1785, and interpreted by analogy as a patriotic work, with Washington corresponding to Joshua; a satire, *The Triumph of Infidelity* (1788), directed against Hume, Voltaire and others; *Greenfield Hill* (1794); and a number of minor poems and hymns. Many of his sermons were published posthumously in *Theology Explained and Defended* (5 vol., 1818–19), to which a memoir of the author by his two sons, W. T. and Sereno E. Dwight, is prefixed, and in *Sermons by Timothy Dwight* (2 vol., 1828), which had a large circulation. Probably his most important work, however, is his *Travels in New England and New York* (4 vol., 1821–22), which contains much material of value concerning social and economic New England and New York during the period 1796–1817.

THEODORE DWIGHT (1764–1846), lawyer, editor and author, a brother of President Dwight, was born at Northampton on Dec. 15, 1764. Reared on a farm by his mother after his father's death in 1777, he turned to the study of law after an injury prevented him from doing farm work. He read law with his uncle Pierpont Edwards of New Haven, Conn., and was admitted to the bar in 1787, and practised first at Haddam and then at Hartford, from 1791 to 1815. He also edited the *Hartford Courant* and the *Connecticut Mirror.* He shared his brother's political views, wrote and spoke much on Federalism and wrote a good deal of verse, mainly occasional. He served in the U.S. house of representatives, 1806–07 and as member of the council from 1809–15. In 1814 he was secretary of the Hartford convention, which was critical of the administration's conduct of the War of 1812. In 1815 Dwight moved to Albany, N.Y., where he founded the *Daily Advertiser,* and in 1817 to New York city, where he founded the *New York Daily Advertiser,* in whose management he was active until he retired to Hartford in 1836. He died in New York city, June 12, 1846.

SERENO EDWARDS DWIGHT (1786–1850), the fifth son of President Dwight, was born in Greenfield, Conn., graduated at Yale in 1803, and was a tutor there, a lawyer, a preacher and president of Hamilton college (Clinton, N.Y.). His publications include *Life and Works of Jonathan Edwards* (10 vol., 1830); *The Hebrew Wife* (1836); and *Select Discourses* (1851), to which was prefixed a biographical sketch by his brother, William Dwight (1795–1865), who was also a lawyer and a Congregational preacher.

THEODORE WILLIAM DWIGHT (1822–1892), a grandson of President Dwight, was a jurist and educator, a prominent figure in political and social (notably prison) reforms. He was born July 18, 1822, in Catskill, N.Y., a cousin of Theodore Dwight Woolsey and of Timothy Dwight (1828–1916). He graduated at Hamilton college in 1840 and studied law for one year at Yale. After teaching law, history, civil polity and political economy at Hamilton, he accepted in 1858 an invitation from Columbia university to teach law, upon his own condition that he found a law school. For many years he himself was the school; he did not retire from it until about a year before his death, in Clinton, N.Y., June 28, 1892.

A man of broad culture, Dwight used the Socratic method of teaching. For several years he was a nonresident professor of law at Cornell and at Amherst. An able jurist, he frequently acted as referee in difficult questions and engaged in other legal and judicial work. He published in 1867 a *Report on the Prisons and Reformatories of the United States and Canada* (with E. C. Wines); favoured indeterminate sentences; drew up the bill for the establishment of the Elmira reformatory; and organized the State Charities Aid association. He edited Sir Henry Maine's *Ancient Law* (1864); was associate editor of the *American Law Register* and legal editor of *Johnson's Cyclopaedia,* and published *Charitable Uses: Argument in the Rose Will Case* (1863).

TIMOTHY DWIGHT (1828–1916), also a grandson of President Dwight, was a preacher and educationalist, born at Norwich, Conn., Nov. 16, 1828. Educated at Yale, Bonn and Berlin, he

was professor in the Yale Divinity school from 1858 to 1886, was licensed to preach in 1861, and from 1886 to 1899 was president of Yale, which during his administration prospered greatly. He was also a member from 1872 to 1885 of the American committee for the revision of the English Bible, was an editor from 1866 to 1874 of the *New Englander*, which was much like the later *Yale Review;* and in addition to his translating and editorial work he published numerous magazine articles and a collection of sermons, *Thoughts of and for the Inner Life* (1899). He died on May 26, 1916.

BIBLIOGRAPHY.—For the elder Timothy Dwight, *see* Charles E. Cunningham, *Timothy Dwight* (1924) and Leon Howard, *The Connecticut Wits* (1943). For the younger Timothy Dwight, see *Timothy Dwight: Memorial Addresses,* issued by Yale university; also, for a full record of his scholastic life, *see* his *Memories of Yale Life and Men, 1845–1899* (1903). (LN. H.; X.)

DWIGHT, JOHN (d. 1703), the first distinguished English potter, was born about 1637. He took the degree of bachelor of civil law at Christ Church, Oxford, in 1661 and was appointed in that year registrar and scribe to the diocese of Chester. In 1665 he moved to Wigan and at some time between 1671 and 1674 to Fulham, London, where he worked until his death in 1703.

In 1671 Dwight took out his first patent for making "transparent earthenware, commonly knowne by the names of porcelaine or china" and "stoneware, vulgarly called Cologne ware." Between 1693 and 1696 he was involved in lawsuits with 19 other potters, over infringements of his stoneware patent.

Dwight's most important wares are a series of finely modeled stoneware busts and statues, including busts of Prince Rupert of the Rhine and Charles II, a recumbent half figure of his daughter, Lydia, and various classical figures. The modeler of these works is unknown. Useful wares attributed to Dwight's pottery include rough stoneware bottles similar to contemporary Rhenish *bellarmines,* thinly potted stoneware mugs, gray stoneware bottles decorated with marbled bands and applied reliefs and red stoneware mugs with similar applied decoration. Dwight did not make porcelain and the partly translucent nature of some of his stoneware must have led him to mistake it for that material. The Fulham pottery remained in the hands of Dwight's descendants until 1862.

See W. B. Honey, *European Ceramic Art* (1952); F. H. Garner, *Transactions of the English Ceramic Circle,* no. v (1937). (J. E. LE.)

DYCE, ALEXANDER (1798–1869), Scottish editor of Shakespeare and other Elizabethan dramatists, was born in Edinburgh on June 30, 1798. As an Oxford undergraduate he edited S. Jarvis' *Dictionary of the language of Shakespeare* and, after serving as a curate in Cornwall and Suffolk, settled in London and devoted himself to literature. In addition to completing William Gifford's *James Shirley* (1833) and revising his *John Ford* (1869), he edited the works of George Peele, John Webster, Robert Greene, Thomas Middleton, Beaumont and Fletcher and Marlowe. These editions consolidated interest in Shakespeare's contemporaries aroused by Charles Lamb's *Specimens of English Dramatic Poets* (1808). Dyce's edition of Shakespeare (pub. 1857; rev. 1864–67) was supplemented by *Remarks on Mr. J. P. Collier's and Mr. Charles Knight's Editions of Shakespeare* (1844), *A few notes on Shakespeare* (1853) and *Strictures on Mr. Collier's New Edition of Shakespeare* (1859), each work characterized by scrupulous care and integrity.

An industrious editor of the poets, Dyce published many 17th- and 18th-century works, "specimens" of *Poetesses* and *Sonnets* and, most important, an edition of John Skelton (1843) which revived interest in this 16th-century poet. A founder of the Percy society (1840), he also published works for the Camden and Shakespeare societies. He died in London on May 15, 1869. (G. A. O.)

DYCE, WILLIAM (1806–1864), Scottish painter and pioneer of state art education, was born at Aberdeen on Sept. 19, 1806. At 16 he graduated M.A. of Marischal college, Aberdeen, but later studied at the Royal Scottish academy, Edinburgh, and the Royal Academy schools, London. One of the first British students of early Italian painting, he visited Italy in 1825 and 1827–28, meeting in Rome the German Nazarene (Pre-Raphaelite) painters. He exhibited regularly at the Royal Academy, being elected associate of the Royal Academy in 1844 and academician

"RELIGION," FRESCO BY WILLIAM DYCE PAINTED ABOUT 1845. IN THE QUEEN'S ROBING CHAMBER AT THE HOUSE OF PARLIAMENT, LONDON

in 1848. In 1830–37 in Edinburgh he practised portraiture for a livelihood, using a direct technique traceable to that of Sir Henry Raeburn. But his Italian studies led him, anticipating the English pre-Raphaelites, to a primitivist simplicity and repose in his painting. Impressed also with the importance of a basic relationship between painting and architecture and design, he became deeply interested in art education. In 1840 he was appointed secretary and director of the new government school of design at Somerset house, London. Although he largely failed to influence manufacturers' patterns, his training of teachers of design was important.

Successful in the houses of parliament fresco competition (1844), he painted the "Baptism of Ethelbert" in the house of lords (1846) and the "King Arthur" series (1848 ff.; unfinished) in the queen's robing room. For the prince consort he undertook frescoes at Osborne (the "Neptune") and in the Buckingham palace summerhouse; he decorated the church of All Saints, Margaret street, London, to the specification of the Anglo-Catholic Cambridge Camden society, in a more consciously primitivist style (1858–59). Typical of his early portraits is the child study "Contentment" (Maconochie Welwood collection; R.A. 1832); later easel pictures include "Pegwell Bay" (National gallery, London; R.A. 1860) and "George Herbert" (Guildhall, London; R.A. 1861). Dyce died at Streatham, Surrey, Feb. 14, 1864.

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DYCK, SIR ANTHONY VAN: *see* VAN DYCK, SIR ANTHONY.

DYER, SIR EDWARD (1543–1607), English courtier and poet whose reputation rests on a small number of certainly ascribed lyrics of great dexterity and sweetness, was born at Weston, Somerset, in Oct. 1543. Educated at Oxford, he went to court under the patronage of the earl of Leicester, was a friend of Sir Philip Sidney on whose death he wrote an elegy showing personal grief and a typical morbid melancholy, was employed on missions to the Netherlands (1584) and Denmark (1596) and was knighted in 1596. He died in London in May 1607. His contemporary reputation as a poet was high, but little of his work, published anonymously or under initials in collections, is certainly identifiable. His handling of metre and language, his tendency to antithesis and his power to convey a personal mood in memorable words are exemplified in his best-known poem "My mind to me a kingdom is."

See R. M. Sargent, *At the Court of Queen Elizabeth: the Life and Lyrics of Sir Edward Dyer* (1935) which corrects numerous errors in earlier accounts of his life and includes his poems, with notes on their ascription.

DYER, SIR JAMES (1512–1582), English judge who began the modern system of case reporting, was born at Roundhill in Somersetshire. He studied at Oxford, according to tradition at Broadgates hall (where Pembroke college now stands), but took no degree. He was called to the bar by the Middle Temple at some time before the year 1537, when his name first appears on his own reports. He was elected to parliament for Cambridgeshire in 1547 and became a sergeant-at-law and was knighted in 1552. In 1553 he was chosen speaker of the house of commons. He took part, as one of the counsel for the prosecution, in the trial of Sir Nicholas Throckmorton in 1554 on charges of complicity in the Wyatt rebellion; and two years later was made a judge in the court of the common pleas. From 1559 until his death in 1582 he presided over that court as chief justice. He died at Great Staughton, Huntingdonshire, on March 24, 1582.

Dyer acquired a great reputation as a judge for both integrity and learning. His case reports begin at 4 Henry VIII and end in the year of his death. They were written in law French and were first translated into English by John Vaillant of the Inner Temple (1794). (R. G. M. B.)

DYER, JOHN (1699–1757), British poet, born in 1699 and baptized on Aug. 13 at Aberglasney, Camarthenshire, is chiefly remembered for "Grongar Hill," a short descriptive and meditative poem in the tradition of Sir John Denham's *Coopers Hill* and Alexander Pope's *Windsor-Forest*. The poet describes the view from a hill overlooking the vale of Towy and uses this as a starting point for meditation on the human lot:

> A little rule, a little sway,
> A sunbeam in a winter's day,
> Is all the proud and mighty have
> Between the cradle and the grave.

The description owes much to Dyer's studies as a painter, and to a considerable extent portrays the countryside in terms of classical landscape. *The Ruins of Rome* (1740) again combines both description and meditation. Dyer's longest work is *The Fleece* (1757), a blank verse poem in four books on the tending of sheep. It is one of the many 18th-century attempts to imitate Vergil's *Georgics* in English verse. The interest of the poem lies partly in perceiving the skillfulness of the imitation and partly in seeing how Dyer elevates an essentially unpoetic subject by his choice of language and turn of euphemism. Dyer died in Coningsby, Lincolnshire, in 1757, and was buried on Dec. 15. (Jn. C.)

DYER, REGINALD EDWARD HARRY (1864–1927), British general, remembered for his severe handling of the riots at Amritsar, India, in 1919, was born at Murree, in the Punjab, on Oct. 9, 1864, the son of a brewer, and educated at Middleton college, County Cork. He joined the army in 1885, and served in the Burma campaign in 1886–87, in the Waziristan blockade in 1901–02 and against the raiding Sarhad tribesmen during World War I. He was brigade commander at Jullundur when, in April 1919, serious rioting broke out in parts of the Punjab. (*See* India-Pakistan, Subcontinent of: *History*.) Martial law was proclaimed and Dyer hurried to Amritsar, where mobs had killed Europeans and beaten and left for dead Miss M. Sherwood, a missionary. All meetings were prohibited. When a large meeting was held in the Jallianwalla Bagh, an enclosed space, Dyer went there with a small force and opened fire without warning. He used 1,650 rounds, killing 379 people and wounding probably three times as many more. He also took other severe measures, including the "crawling order" that Indians passing along the lane in which Miss Sherwood had been beaten must go on hands and knees. A committee was appointed in 1919, under Lord Hunter, to investigate these matters, and criticized Dyer for opening fire without first ordering the crowd to disperse and for continuing to fire even when the crowd tried to disperse. Dyer's claim that he had intended to produce a "moral effect" throughout the Punjab was condemned by the committee as also was the "crawling order."

Sir Michael O'Dwyer, the lieutenant governor, thought that Dyer's severity had averted a general revolt in the Punjab. However, it alienated many Indians who had been otherwise well disposed to British rule, and was seized upon as a weapon by the Congress party. Dyer was removed from his command and returned to England. There was some feeling that he had been victimized, some expressions of sympathy were voiced in parliament and subscriptions were raised for a fund on his behalf. This further alienated opinion in India. He died on July 23, 1927, at Long Ashton, Bristol. It was later suggested that Dyer, not realizing the crowd had no exit, had feared that they were about to rush him, and that his subsequent evidence that his severity had been deliberate was mere bravado.

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DYES AND DYEING. Colourants are either dyes or pigments, depending upon whether they do or do not have affinity for the material to which they are applied, but conventionally they are classified as dyes or pigments according to their main usage. This article discusses the history, theory, machinery and methods of dyeing. For a discussion of pigments, *see* Paint; Pigment, Animal; Plant Coloration.

HISTORY

The oldest direct evidence on colourants is the use of red ochre in Stone Age burials. The first man-made colourant for which there is any evidence is carbon black (lampblack), which is still widely used. Synthetic inorganic colourants, such as Egyptian blue, were being made by 3000 B.C., but no organic colourant was synthesized before P. Woulfe in 1771 produced picric acid by treating indigo with nitric acid.

Painting and staining preceded dyeing proper, and probably the dyeing of skins and leather preceded the dyeing of textiles. Archaeological evidence shows that dyeing was a widespread industry in Egypt, India and Mesopotamia by 3000 B.C. and that even by then the processes used were complex. The methods inherited from those civilizations remained in use with little change until well into the middle of the 19th century. The dyes were largely the same; two of them, indigo and alizarin (*qq.v.*), are still in commercial use, though they are no longer obtained from indigo and madder plants, their original sources, but from chemicals derived from coal tar.

In 1856 William Henry Perkin (*q.v.*) discovered the synthetic organic dye mauve. Until then almost all dyes had come from natural sources, either vegetable or mineral. (Minor exceptions were picric acid and pittacal, made from beechwood tar; the solvent dye aurin was obtained by F. Runge in 1834 by heating phenol with oxalic acid in concentrated sulfuric acid but it found no commercial application at that time.) After 1856 natural dyes were completely displaced (except for logwood and, in the United States, annatto) by synthetic organic dyes; inorganic dyes were almost entirely abandoned and new methods of dyeing were invented. In 1856 only a dozen or so dyes were available; they fell into three classes: mordant, vat and substantive. By the 1960s there were several thousand chemically distinct dyes in 13 dyeing classes.

The earliest documents on dyeing are tablets unearthed in Mesopotamia. Classical Greek and Roman authors provide further sources but give no details of the processes used and are often difficult to understand. Egyptian tomb paintings of *c.* 3000 B.C. show clothing of various colours. Mummy cloths of that date have been found to be dyed yellow with either safflower obtained from *Carthamus tinctorius* or with iron buff obtained by treating the cloth with a solution of an iron salt and then with alkali, which precipitates an iron oxide on it. Such cloths have been found containing blue stripes dyed with indigo. Scarlet was obtained by the early Egyptians by first mordanting the cloth (*i.e.*, impregnating it with a metallic hydroxide) and then dyeing it with kermes, an extract obtained from the female kermes, a scale insect. By 3000 B.C. wool was being dyed blue, red and green in Babylonia. It seems probable that use of indigo and madder (found also in Egypt whereas no record of it has been found in Mesopotamia) was first developed in India. The word "safflower" is derived from the Akkadian; its use as a dye may thus have begun in Babylonia. The use of various plants and barks containing tannin, in conjunction with an iron salt as mordant, probably is

also extremely old and widespread.

Woad, the blue dye of the ancient Britons, may have originated in Palestine, where it grows wild and where its use is very old; it reached Britain only shortly before Julius Caesar's time.

The most famous dye of antiquity was tyrian purple, a vat dye obtained from certain shellfish. It may have been used in Crete as early as 1600 B.C., but the great centre where it was used industrially was Tyre. The use of shellfish to provide dyes survived the Roman empire. When the Spaniards arrived in Central America they found the natives there used the same source. Whether these were independent discoveries or whether the knowledge was slowly transmitted westward remains undecided.

The dyes common in the Mediterranean area at the beginning of the Christian era continued in use in many cases into the 20th century. They included the vat dyes woad, indigo and tyrian purple; the mordant dyes kermes, madder, dyer's broom and Persian berries; the substantive dyes safflower and turmeric; and the inorganic dye iron buff. There are records of brazilwood from Ceylon being imported into Florence in the 12th century. The first such imports may have occurred at a much earlier date. America became a plentiful source of dyewoods; Brazil owes its name to the copious supplies of brazilwood and related dyewoods found there. But the two most important new products from the new world were logwood and cochineal; the latter, like the kermes it speedily replaced because of its much greater strength, was derived from an insect. It remained for E. Bancroft in 1784 to discover the use of quercitron bark.

In western Europe woad was used for blues, blacks (in conjunction with madder) and greens (from old vats), but gradually it was replaced by indigo despite fierce opposition from the many woad growers, who constituted a widespread village industry, and from governments that believed the use of indigo resulted in inferior cloths (early primitive European methods of applying it did weaken the fibres). The use of logwood, too, was long opposed by governments, partly because they were reluctant to import foreign products but mainly because the logwood blues are fugitive and the blacks obtained by it (before chromium mordants came into use) were much inferior to the woaded and maddered blacks.

The dyeing industry in medieval Europe was stringently controlled by the dyers' guilds and companies and was constantly watched by governments. But the work of dyers was much more difficult to control than that of other crafts—a good deal of the trade was small-scale cottage industry—and the regulations were constantly evaded. The change from strict control of those materials that had to be used to the modern method of stipulating which tests the dyed material must meet was perhaps marked by J. B. Colbert's regulations for the French dyeing industry brought out in 1671; Colbert's rules had a lasting effect on the whole European dyeing industry.

During the 18th century research workers abandoned the old amalgam of tradition and experience in favour of the new scientific system. This change is evident from works like C. L. Berthollet's *Eléments de l'art de la teinture* (1791) and Bancroft's *Experimental Researches Concerning the Philosophy of Permanent Colours* (1813); the latter remains the best survey of the dyes and dyeing methods available at the end of the 18th century. He was the first author to condemn publicly the use of certain dyes as not being fast enough. Consequently a system of standard tests to determine the fastness of dyeings was introduced by Dufay de Cistenay.

Governments tried to make their dyeing industries as self-sufficient as possible. Thus in Great Britain, Cuthbert Gordon's discovery of the preparation of cudbear from native lichens removed the centuries-old need to import orseille, or archil. Also, until the revolt of the American colonies Great Britain granted a substantial customs preference on indigo from Carolina against that from India.

From the late 17th century onward the work of scientists and research workers made the methods of dyeing simpler and more precise as regards the matching of colours. The range of colours was extended by the introduction of new metals as mordants (*e.g.*, tin as a mordant for cochineal in the early 17th century gave the scarlet used by the British army), since most natural mordant dyes give different colours with different mordants. In 1830 bichromate (dichromate) was introduced as a mordant; by 1840 it was well established and has since become almost the only mordant used. The terms "chrome dye" and "mordant dye" have become nearly synonymous.

Meanwhile, picric acid, aurin and pittacal had been produced in 1771, 1834 and 1835, respectively. The first of the man-made organic dyes appeared in 1856 when Perkin discovered mauve and J. Natanson discovered the substance later called fuchsin or magenta. Perkin set to work to find out how mauve could be used as a dye and how it could be made commercially. To sell his product he had to go around to the dyers and show them how it was to be used and, in so doing, he invented "technical service." Thenceforward the dyeing industry relied on the dyemakers' research and technical service.

Dyers in 1856 had no knowledge of the use of basic dyes (a dye in which the colour is a base; mauve was the first synthetic example) for only one basic dye, berberine, is found in nature. Mauve dyed silk so rapidly that it was almost impossible to obtain even dyeings and it would not dye cotton at all. Perkin overcame the first of these difficulties by applying the dye from a soap bath that slowed the rate of dyeing and so gave even results—a method that is still in use. Then more or less simultaneously with R. Pullar he invented the standard method of applying basic dyes to cotton, which is to mordant the cotton with tannic acid and a metallic oxide and then dye it.

In 1858 the French firm of Renard Frères of Lyons and in 1860 the English firm of Simpson, Maule & Nicholson began to make fuchsin, the substance discovered by Natanson, selling it as fuchsine and magenta, respectively. This dye, because it gave a brilliant colour unobtainable with any natural dye, had a much greater success than mauve, which could be matched by the natural dye cudbear. Mauve was made and used for less than ten years, but fuchsin is still in commercial use. Many of these brilliant basic dyes were soon on the market. The fact that they were not very fast to light gave rise to the lasting though unfounded prejudice that natural dyes are much faster than synthetic ones. In fact, no natural dye is as fast as many modern synthetic dyes.

In 1858 P. Griess, working at Burton upon Trent, Staffordshire, discovered the diazo, or diazonium, compounds. They are obtained by treating an amine with nitrous acid and combining the product with amines and phenols to give coloured azo compounds. The first commercial azo dye, aniline yellow, was produced in 1863 but because of its technical defects had a brief commercial life. The first important dye made as a result of Griess's discovery was Manchester brown (made by Roberts, Dale & Co., Manchester), commonly known as Bismarck brown because of the overwhelming supremacy achieved by the German dye-making industry from 1870 to 1914. Since diazo compounds are unstable at ordinary temperatures they had to be kept ice cold and for many years could be made only during the winter.

In 1862 E. C. Nicholson made the first synthetic acid dye (a dye in which the colour is an acid) by treating rosaniline blue with sulfuric acid. The product was called Nicholson blue, or alkali blue. Some years elapsed before commercial acid dyes were made. Wool dyers prefer them whenever the fastness required (especially to washing and wet processing) permits, because these dyes are easily applied and matched in colour. In 1740 indigo carmine or indigo extract, which is now recognized as a blue acid dye, was obtained when indigo was treated with sulfuric acid. It has poor fastness but is still in commercial use, although it is now made from synthetic indigo. As new classes of dyes were discovered, new ways of applying them to wool, cotton or silk had to be worked out.

In 1834 Runge had noticed that when aniline was oxidized a black precipitate was formed; in the making of mauve, based on such a process, a black precipitate was the most abundant product of the reaction. It was called aniline black and later (1862) became valuable as a pigment in calico printing. F. C. Calvert and

his colleagues showed in 1860 that aniline hydrochloride printed on cloth impregnated with potassium chlorate yielded emeraldine prints that became very dark, almost black, when oxidized. J. Lightfoot in 1863 so perfected this process that he is considered to be the inventor of aniline black dyeing; the cloth is impregnated with a mixture of aniline hydrochloride, an oxidizing agent and a catalyst and then aged (*i.e.*, exposed to a warm damp atmosphere) to yield an intense black. The resulting fine fast black on cotton was unobtainable by any other means until the advent of the sulfur and vat dyes; moreover, the process could be run continuously.

In 1888 H. Erdmann discovered that organic bases (among them aniline) dyed hair and fur if applied and then oxidized. But fur requires a special treatment ("killing") to prepare it for dyeing and as a consequence the first such fur dyes did not appear on the market until 1895. At this time, commercial amounts of hydrogen peroxide, the agent used to oxidize the organic base, became available. Most fur dyes and many hair dyes now in use belong to the oxidation base class. In the early 1950s a process was developed for rendering aniline black soluble in water so that it could be applied in solution to cloth and then precipitated inside the fibres in an insoluble form.

In 1869 C. Graebe and C. Liebermann synthesized alizarin (*q.v.*), the first synthesis of a naturally occurring dye. The madder plant was rapidly displaced, for the synthetic product, besides being cheaper, was of standard strength and composition and thereby greatly eased the dyers' work. Later alizarin red S, the first of the afterchromé dyes, was obtained by treating alizarin with sulfuric acid; the afterchromes give on wool the highest fastness to light and to wet processing. These dyes are applied as acid dyes (they are sometimes called acid-mordant dyes) and the dyeings are treated with a mordant, nearly always sodium dichromate; afterchroming always causes increased fastness to wet processing and may or may not result in a colour change.

Fluorescein, a fluorescent dye, was obtained in 1871 by A. von Baeyer, who condensed resorcinol with phthalic anhydride and thus led to the discovery in 1887 by the Badische Anilin und Soda Fabrik (B.A.S.F.) of the brilliant and fluorescent bluish-pink rhodamines, dyes that remain in widespread use. Such discoveries not only gave rise to new dyes but also broadened the field of chemicals, known to the colour chemist as intermediates, from which dyes can be prepared.

In 1873 cachou de Laval, the first of the sulfur dyes, was produced by heating sawdust with sulfur and caustic soda (sodium hydroxide). This dye becomes soluble in water when treated with alkaline sodium sulfide. Cotton placed in the solution absorbs the reduced dye, and when the dyed cotton is exposed to air the dye is reoxidized to its insoluble form. Thus for the first time cotton could be simply and cheaply dyed brown fast to washing. At the end of the 19th century a black followed, and later appeared most other colours except a true red.

The early azo dyes were important because of their affinity for wool. In 1884 P. Böttiger discovered congo red, which dyed cotton directly without the mordanting of the fibre necessary with earlier dyes. These direct dyes eventually became the largest class of dyes in commercial production. The first direct cotton dyes had poor fastness to both light and washing, but this was gradually improved.

In 1868 Baeyer set to work on the synthesis of indigo and in 1880 the B.A.S.F. began a deliberate search for a commercial method for this synthesis. It was 1897 before the first commercial synthetic indigo was marketed. When it came, the synthetic product was turned out to a standard whereas natural indigo was variable even when from the same producer.

The idea of producing the dye *in situ* in the fibre is very old. This was the usual method of applying the mineral dyes and of dyeing with aniline black (*see* above). Thomas and Robert Holliday, working in Huddersfield, Yorkshire, in 1880 conceived the idea of producing azo dyes *in situ* within the fibre by impregnating it with an alkaline solution of a naphthol and then treating the impregnated fibre with a diazo compound. The chief product by this method was Vacanceine red, obtained by coupling β-naphthol with β-naphthylamine, but the diazotized β-naphthylamine solution had to be kept ice cold. The German firm of Meister, Lucius & Brüning (now known as Farbwerke Hoechst) in 1889 substituted para-nitroaniline for β-naphthylamine and this not only gave a more stable diazo compound but also a dye, para red, that unlike Vacanceine red, did not bleed into oils and waxes. In 1894 means were found of stabilizing the diazo compounds. This method held the field until 1911, when A. Zitscher and A. L. Laska discovered that the anilide of 2,3-hydroxynaphthoic acid had greater affinity for cellulose than had β-naphthol and also yielded much faster reds. This new method quickly replaced the tedious and expensive process of turkey red dyeing (which could take up to three weeks) with a relatively cheap and simple procedure readily completed in one working day. Later the range of colours was extended to yellows, browns and blues.

Somewhat similar to the azoic process was the method of using primuline, invented by A. G. Green in 1887. A direct cotton dye containing a diazotizable group was applied to the fibre, then diazotized and coupled or developed with another compound to yield another colour, usually of improved fastness, especially to washing.

The first metachrome dyes (in which the mordant and the dye are applied simultaneously from the same bath) were introduced about 1900. They offer several technical advantages over either dyeing on a mordant or afterchrome dyeing and are much used, particularly in Great Britain, where wool dyeing demands the highest standards.

In 1901 René Bohn discovered indanthrone, the first of the synthetic vat dyes (excepting synthetic indigo). This was a blue dye, but later research extended the range of colours and also set entirely new standards of fastness for dyeings on cotton, so that it became customary to expect vat-dyed cotton to be faster to light, washing and wear than the natural-dyed article. During the same period the introduction of the acid-alizarin colours set a new standard for the fastness of acid dyeings on wool.

When a mordant dye is applied either by the mordant, afterchrome or metachrome methods, the actual colouring matter in the fibre is the chromium salt or lake of the colour acid. In 1912 appeared the Ergan dyes, which applied the lakes directly to the fibre. Although not very successful, they were the forerunners of the Neolan and Palatine Fast dyes introduced in 1920; these consisted of the metal complexes of certain acid dyes, with one atom of metal to one molecule of the dye. Such dyes, which had to be applied from strong acid baths, yielded dyeings of good fastness to light and of wet fastness exceeded only by that of the mordant dyes. In 1949 the second series (one atom of metal to two molecules of dye) was placed on the market. These dyes are readily applied from a neutral bath and give dyeings of high fastness to all agencies except severe wet processing.

In 1922 M. Bader and C. Sunder found that the leucosulfuric ester of indigo was soluble in water and was absorbed from the solution by both wool and cotton. Treating the fibres so dyed with an oxidizing agent (in the presence of sufficient acid to hydrolyze [split] the sulfuric ester into sulfuric acid and the dye) resulted in very level dyeings of indigo. The principle was soon applied to other solubilized vat dyes; they have come into common use for pale colours and for dyeing packages of yarn and other materials difficult to penetrate.

In 1925 chemists succeeded in stabilizing diazo compounds, which could thus be sold commercially. Azoic dyeing then merely required applying the azoic coupling component, followed by treatment with the diazotized and stabilized diazo component called a "salt" (not to be confused with the chemical term "salt"). These salts need only to be dissolved in cold water to be ready for use; the dyer no longer has to do the diazotizing.

The first man-made fibre, rayon, since it was made of cellulose regenerated from solution, had little effect on the dyemaking and dyeing industries, but the cellulose acetate fibres introduced after World War I could not be dyed satisfactorily by any known method or dye. Then G. H. Ellis discovered that cellulose acetate could be dyed from an aqueous dispersion containing simple aminoazo compounds and sulfated oils. In 1922 Green and K.

Saunders introduced the Ionamines, in which the aminoazo compounds are made water soluble by adding to their structure the *N*-sulfomethyl group, which hydrolyzes off again during dyeing and leaves the parent aminoazo compound to be absorbed by the cellulose acetate fibres. In 1923 J. Baddiley and A. Shepherdson discovered that coloured anthraquinone compounds, when finely dispersed in water, dye cellulose acetate. This is the basis for the modern disperse dyes for which it is essential that the dyes be ground to the correct particle size.

When, after 1937, nylon, polyester, acrylic and other man-made polymer fibres appeared, new dyes (though not new dyeing classes) had to be brought in. New methods were developed, particularly the use of enclosed air-tight machines that allowed dyeing at temperatures of above 100° C.

The phthalocyanines were discovered in 1928. Copper phthalocyanine, the first such compound, was a blue pigment of outstanding fastness and purity of colour; it could not, however, be used to dye textiles. But in 1947 N. H. Haddock and C. Wood found that certain quaternary derivatives of copper phthalocyanine give dyeings of high fastness on cellulosic fibres and subsequently the Farbenfabriken Bayer discovered means whereby copper or nickel phthalocyanines can be formed *in situ* in the fibres.

By the mid-1960s two main new dyeing methods were becoming important. The first was the impregnation of the fibre by substances that (1) are either coloured or combine to form a coloured substance and (2) can be fixed rapidly in the fibre by polymerization or interaction with it. For instance, the reactive dyes, which were discovered in 1956, have little intrinsic affinity for cellulose but are firmly fixed in cotton by mild alkaline treatment, which produces a reaction making the dye a chemical part of the fibre substance.

The second method consisted in adding a dye or pigment to the raw material from which man-made fibres are made; *e.g.*, to the viscose solution when making rayon or to the molten nylon salt when making nylon. At first, inorganic pigments, *e.g.*, carbon black and iron oxide, were used, but they tended to be replaced by organic pigments that are more brilliantly and intensely coloured. The use of fluorescent brightening agents for imparting a whitening effect to textiles was first suggested by Paul Krais in 1929. They are used not only to impart improved whiteness, for which purpose they largely replaced blueing agents, but also to add brightness to delicately coloured dyeings. (*See* also BLEACHING: *Optical Whiteners.*)

As dyemaking developed, new chemicals were brought in for use by the dyer. In the mid-19th century sodium dichromate won a dominant position as the mordant, and in the early 20th century formic acid was introduced into wool dyeing. After World War I many new chemicals were produced as dyeing assistants, *i.e.*, agents to prevent unlevel dyeing.

Apparatus for dyeing cloth changed little until well into the 20th century except that drives became mechanical and stainless steel replaced wood. Use of a bath of molten metal, through which cloth impregnated with dye liquor should be passed, was suggested as early as 1904 but more than 40 years passed before the first commercial machine using this principle was constructed. Continuous methods of dyeing that came into prominence about this time were really very old: aniline black was always applied as a continuous process, as was much warp dyeing. Long runs of cotton (30,000 yd.) are dyed continuously in the United States but no satisfactory method for the continuous dyeing of wool cloth has been developed on a commercial scale. The machine dyeing of tops (sliver or slubbing), of yarn wound on bobbins and of warps wound on rollers was slowly developed and has been a standard process for many years. Improvements in this process, and in most dyeing machines, have been confined to refinements of existing plant without using any new principles; the molten metal machine is a rare exception.

In the early 1930s a method was devised for colouring cloth by applying a pigment dispersed in a solution or dispersion of a synthetic resin followed by drying and rendering the resin insoluble, so that the pigment is bound to the fibre and is fast to washing. This method was gradually improved but was used mainly in calico printing rather than in dyeing. A later development was the application of a dye mixed with chemicals that give a crease-resistant or wash-and-wear finish; dyeing and finishing thus became a single operation.

THEORY OF DYEING

In normal dyeing systems, *e.g.*, those for textiles, paper, leather and fur, there are three main factors: (1) the fibre; (2) the solvent; and (3) the dye.

The Fibre.—In the chemical process of polymerization several molecules of a monomer ("one part") link up to form a bigger molecule, thus producing a polymer ("many part"). All fibres can be considered as linear polymers whose length is great in relation to their width. They may be twisted together into yarns, deriving their strength from interfacial friction between the long, thin fibres. Filaments, such as natural silk and many man-made fibres, differ from most natural fibres only in that they are of almost infinite length.

A fibre is composed of smaller miniature fibres, termed fibrils, bundles of which are joined together to make the large fibre. In turn each fibril is composed of long linear polymers held together in bundles. These polymers are called chain molecules, which suggests a great number of similar links repeated many times along the molecular length. The molecule is held together lengthwise by the strength of the chain links. Laterally, the chain molecules are bound together by electrical attraction, direct linkages or other weaker forces. Fibres differ as to the type of chain link, the strength of the link and the type of cross-linking forces between chains. Dyeing processes must take into account possible chemical attack on any of these links. (*See* also FIBRE.)

In some parts of the fibre the chains may be arranged in perfect order and in others they may be more or less misaligned, the two types of region being known respectively as crystalline and amorphous. The crystalline regions are compact and confer strength on the fibre while the amorphous regions are weak since the chains are not sufficiently parallel for the lateral forces to form a rigid three-dimensional network. It is into the weaker amorphous regions that water or solvent molecules can enter and carry dye into the fibre. These regions also account for the ability of some fibres to take up large amounts of water without feeling damp. Chemical attack occurs in the amorphous regions first, as does any filling of the fibre with synthetic resin; *e.g.*, for crease-resistant or drip-dry finishes.

The properties of a fibre depend largely on the proportion of crystalline to amorphous matter. For strength the fibre must have a high proportion of ordered chains, but easy colouring and finishing require amorphous material. In man-made fibres the amorphous portions can be reduced to a minimum by stretching the newly formed filament before it hardens, thereby pulling the chain molecules into a more parallel arrangement. This makes for strong but brittle fibres. Some natural fibres are highly crystalline and therefore strong, rigid and difficult to dye. The more a fibre swells in water or solvent, the easier it is to dye. When water enters the amorphous regions it further weakens the lateral forces. The water molecules open up the structure for the dye molecules, which usually are larger. In the mercerization of cotton the fibre is treated with a strong caustic soda solution to make it swell irreversibly (*see* also MERCERIZING).

Where natural chain molecules are artificially reassembled, as in viscose rayon, the structure is more open. If stronger lateral forces are brought into the amorphous regions the fibre swells much less, which makes it resistant to shrinkage. Many artificial fibres imbibe little water; to make them easier to dye they must be swelled, often at temperatures above the boiling point of water, to loosen the chains.

When a man-made fibre is spun, a molten mass or syrup is extruded through a tiny hole, called a spinneret, to give a long filament. As the chain molecules pass through the hole, friction against the walls modifies the exterior of the filament; there the chains tend to be better oriented, resulting in a type of skin around the filament. Natural fibres also have a tough outer layer

or skin as a protection. Such a membrane around a fibre is a barrier to dye molecules; the simplest way of breaking it down is to use heat.

The Solvent.—Dyeing processes usually are carried out in water and therefore once could be performed only in areas possessing abundant water of high purity. Modern methods of water treatment have removed this limitation. The solvent dissolves the dye, allows it to travel to and into the fibre, permits leveling (migration from areas of heavy dyeing to areas of lighter concentration) and opens up the fibre structure by swelling. Most water-soluble dyes ionize in solution. The coloured ions may be either positive or negative and, particularly in the cold, exist as large aggregates. The water molecules, when activated by heat, break these aggregates into smaller conglomerates that travel toward the fibre and diffuse through its swollen structure.

Organic solvents are expensive; they are used for applying colouring matters that are insoluble in water or for colouring fibres that are difficult to swell with water. To make such processes economical, much of the solvent must be recovered. Mixtures of organic solvent and water are also used, which obviates the need for swelling in boiling water; this saves fuel and reduces chemical damage to the fibre substance. With hydrophobic fibres it is customary to use carrier compounds in which the dye dissolves more readily than in water. These carriers tend to concentrate around the fibre so that the latter is immersed in a highly concentrated local solution of dye, thus accelerating the dyeing. When fibres tend to dye unevenly the dye may be applied from a solvent.

In some cases no water or solvent is needed. The dye-coated fibre is heated or treated in some other way that turns the dye into a gas whose molecules dye the fibre.

The Dye.—Materials are coloured because they absorb light of certain wavelengths. The lights absorbed by either atoms or molecules is used up as energy within them, causing displacement of wavelengths, and any selective subtraction from the whole range of colours in white light results in the remaining light being coloured.

O. N. Witt in 1876 studied benzene, naphthalene and anthracene and their derivatives. These compounds show absorption bands outside the visible spectrum but if, for instance, a nitro group (NO_2) is introduced, the absorption band moves into the visible region and the compound becomes coloured. Further groups, such as amino (NH_2), must be added to produce a dye; *i.e.*, a coloured compound for which fibres have an affinity. The tailoring of dye molecules still relies on such empirical rules as this: the larger the molecule of a dye, the deeper its colour. Many dyes have a quinonoid structure, which is believed to be what gives them colour. Such structures resonate chemically; *i.e.*, the dye molecule constantly alternates between two closely related structures, using energy that is selectively taken from white light so that colour results. Chemical resonance occurs also in long chains of carbon atoms linked alternatively by single and double bonds. Such structures are present in many dyes. (*See* also QUINONES; RESONANCE, THEORY OF.)

Fluorescent brightening agents are near-colourless dyes that improve the appearance of white materials by absorbing ultraviolet radiation and reemitting it as blue light, although the fluorescence may be extremely pale in colour. Normal natural whites have a very faint tinge of orange; adding blue pigments such as ultramarine gives an apparently more brilliant white because the orange and blue combine to give a gray that is less easily perceived by the eye than the orange. Fluorescent brightening agents add blue also, although not by absorption as with ultramarine but by additional reflection from the invisible ultraviolet; as a result, the total amount of light is increased, giving very brilliant whites.

Many dyes are substantive; *i.e.*, the fibre attracts the dye from the solution. This could be caused by attraction of electric charges of opposite sign or by much weaker forces that operate only very short distances. The groups on the fibre and on the dye should be roughly the same distance apart so that the dye is firmly keyed to the fibre.

Commercial dyes are not pure compounds since they contain inactive materials known as diluents in order to make up a standardized product. In solution most dyes probably exist in large aggregates of large coloured ions associated with smaller uncoloured ions. A rise in temperature causes a breakdown of these aggregates, which act as a store of dye feeding smaller and smaller components to the fibre. But these smaller units are still fairly large and can penetrate only in the swollen amorphous regions of the fibre, though probably not if the aggregate exceeds three dye molecules.

The type of bond that holds dye to fibre depends on their chemical natures. The process of attachment is accompanied by one of detachment so that the dye-fibre system finally reaches an equilibrium. To save time, special methods are used to make attachment predominate and thus exhaust the dye solution. For level dyeing, molecules must migrate from regions of high to those of low dye concentration. A dye may be absorbed quickly but fail to migrate. The dyer's art consists largely in mechanically controlling these properties, and in selecting a dye that balances them against hue, fastness and cost.

DYEING MACHINES

For the dyeing process to approach as closely as possible to equilibrium, and thus ensure proper exhaustion of dye from the liquor, the fibre and dyebath must be in relative motion. The motion also promotes migration and assists in leveling. The turbulence is greater if the liquor is moved through the goods; if the goods are moved through the liquor they tend to carry steady surface layers of dye that must somehow be broken up.

Basically a dyeing machine consists of a container for the dye liquor and includes some device for producing relative movement between fibre and liquor. The machine has devices for replenishing the bath and for loading or unloading the goods. Automatic controls are becoming increasingly common. The containers used to be made of wood, but wood is not easily cleaned of dye and rapidly acquires a rough surface that can damage delicate materials; in addition, the joints often leak and impurities in the wood may disturb the colour or lead to staining. Iron and mild steel can cause rust stains and spoil some dyes. Stainless steel, however, gives a surface that is inert, polished and easily washed down, while the weakness of the welds to corrosive materials has been overcome.

Less commonly used are Monel metal, a naturally occurring alloy of nickel and copper, and Inconel, an alloy of nickel with chromium and iron. Inconel is extremely resistant but expensive. Plastic materials are also used increasingly because of their inertness to most dye liquors; *e.g.*, as polyethylene piping and as resin-bonded glass fibre for carts.

Since it is usually inadvisable to add all the constituents of the dyebath to the liquor at the start, additions must be made during the dyeing process; at such moments the liquor and substrate should be separated completely to avoid uneven dyeing. Many machines allow for this, but where separation is unduly difficult additions to the dyebath can be made if they are made slowly.

Modern machines have robust independent electric motors that are protected against the wet conditions of a dyehouse. The dyebath liquor is circulated by pumps, injectors, or impellers; a means of filtration may be interposed since the goods tend to filter out any suspended matter in the dye liquor. Steam heating is commonly used either with closed steam coils or with live steam through open pipes. Live steam produces violent agitation, which is sometimes helpful, but also dilutes the dyebath. Steam coils do not cause evolution of steam until the liquor reaches its boiling point, so that delicate goods are not overagitated and the atmosphere is not filled with water vapour. For efficient working, there must be provision for removing the condensate from the steam coils. To even out the cyclical demand on the steam-raising plant, hot water storage tanks are widely used.

Placing the goods in and taking them from the machine is expedited by traveling cranes and other mechanical aids. Since much time can be lost in these operations, methods of continuous dyeing have strong appeal.

Most dyeing machines lend themselves to a measure of automatic control. The speed at which the temperature of the dyebath is raised often affects the levelness of the dyeing; control of the process can be improved by thermostats. The relative motion of liquor to goods can be controlled too. Reversals of operations can be monitored by automatic clocks or relays and the acidity or alkalinity of the dyebath—frequently important factors in dyeing—can also be automatically governed. Radioactive isotopes offer possibilities for control of the dyeing process. Instruments for continuously estimating the amount of water present in a cloth can control the pressure applied by mangles. Optical instruments can be employed for recording the concentration of colouring matter in the bath.

METHODS OF DYEING

Fibres may be dyed (1) in the loose form before spinning; (2) as partly or fully spun yarn in the form of hanks; warps or makeup packages; (3) as woven pieces; or (4) as made-up articles.

Loose Fibres.—If the fibre is dyed in the loose state the dye can easily penetrate a fibrous mass; any unevenness is leveled out during subsequent stages of manufacture, but one drawback is that the coloured waste produced in spinning is worth less than undyed fibre. Considerable weights of loose fibre are dyed by the simplest possible means because complete homogeneity of colour is not essential. A heated container is used, the mass being occasionally stirred by hand, but rinsing is difficult and machines are more economical.

An improved method of dyeing is to use a container with a false bottom and a central vertical pipe into which live steam is injected. This ejects itself against a horizontal plate and distributes the boiling liquor over the fibre, thus slowly circulating the dyebath. Further development led to the loose fibre being held in a perforated container around a central perforated pipe, allowing the mass to be raised easily and transferred from the machine. The perforated container is sometimes slightly narrower at the top than at the bottom and when the flow of liquor is upward the mass tends to be compressed, thereby giving a more even density. Such an apparatus is easily rinsed by pumping out the liquor and replacing it with water. Moreover, it has a low "bath length" (weight ratio of fibre to water).

Alternatively, the goods may be forced through the liquor. One type of machine based on this principle consists of a perforated drum divided into four compartments that carry the fibre. The drum, partly immersed, rotates in the outer dyebath and ensures good and even impregnation. In another type of machine the loose fibre is carried through a heated dyebath while held as a wide web between an upper and lower endless wire mesh belt. A suction device acting on the fibre mass ensures intimate contact of the liquor with the substrate; the composite belt of fibre mass and double mesh passes through several dyeing and rinsing baths with mangles in between each. This process is continuous. Yet another dyeing process for loose fibre causes the substrate to pass continuously through a tube filled with dye liquor circulated by a pump.

The dyeing or redyeing of partially or fully made garments, hose and household linen is somewhat allied to the dyeing of loose fibres. In general, the goods are moved through the liquor and if delicate may be enclosed in bags of netting. In drum dyeing the goods are placed in a horizontal, circular, perforated cage that is fitted with bars on the inside to carry the goods round. The inner cage revolves, first in one direction and then in the other, inside a fixed, outer solid shell, also horizontal and fitted with steam pipes for heating. In the modern type of machine a dye bowl allows additions to be fed to the bottom of the tank and the liquor level can be observed continuously through an external sight glass. In one paddle type of machine, the goods are dyed in a circular or elliptical tank and are circulated horizontally by means of a central island and a roller ("paddle") fitted with peripheral bars parallel to its axle. The paddle operates on the stream between the island and the side of the container. The top is closed with a removable plate. In another paddle type of machine there is no central island; the paddle moves across the full width of the machine and the goods are picked up by the partly immersed paddle on its underside and carried over the top. For delicate articles such as ladies' hose, there are machines in which the dyebath is circulated through the goods. These are, in principle, similar to the Hussong machine used for dyeing yarns (*see* below).

Yarn Dyeing.—Yarns may be dyed as hank or warp or alternatively as made-up packages in the form of cheeses or cones. For small lots of hank the yarn can be dyed in an open vat known as a beck with the yarn suspended from sticks or rods resting across the top of the steam-heated vessel. From time to time the hanks are turned and opened up to attain levelness. For additions the hanks may be lifted out of the beck and then reimmersed. Modern becks are fitted with false bottoms, and specially shaped rods may be used to immerse the hank.

The hanks may be suspended from a revolving reel that turns them continuously and reverses direction from time to time. The revolving reel is used also in machines that are totally enclosed to conserve heat, the heated liquor being pumped from a reservoir in the base and sprayed over the revolving hanks. Another variation is to carry the hanks on wires held at their ends by a pair of concentric wheels. The assembly rotates in an outer circular vessel containing the dyebath and the hanks are rotated by strikers fitted inside the vessel that meet projections at the ends of the rods.

The Hussong machine consists of a vessel fitted with a perforated false bottom, beneath which the heating coils are led. One end of the dyebath container is baffled and an impeller in this smaller compartment gives a circulatory motion under the baffle, through the impeller compartment, over the baffle and through the hanks. The hanks are suspended from sticks held in a carrier fitting into the larger compartment, which constitutes the top of the machine and can be craned up and down. Floating of the hanks out of the liquor is overcome by bolting down the top of the machine and circulating the liquor downward through the hanks, while second sticks are fitted through the lower end of the hanks to keep them under slight tension. Alternatively the hanks may be fixed in a frame under tension and the liquor circulated in one direction only, with automatically controlled pulses. This gives turbulence without unduly disturbing the yarn.

Hanks may be interlaced to give a continuous chain and may be dyed by being passed continuously through a range of open becks fitted with rollers and mangles. Warps are dyed in the same manner. Several chains of hanks or ropes of warp may be dyed in a parallel arrangement. Alternatively, the warp may be dyed at full width from beam onto beam.

Package Dyeing.—The dyeing of yarn wound into packages is based almost entirely on the circulation of the liquor through the goods. Ideally the packages are wound evenly in order to assist penetration and levelness, for the fibrous mass acts as a filter. The liquor must therefore be free from suspended solids and the dyes must be easily soluble. Rinsing is difficult because the goods are relatively impenetrable, which may keep much dye on the surface of the yarn and thus lead to poorer rubbing fastness. The main advantages of dyeing yarn in this form are that there is no rewinding and that a low liquor ratio can be used.

Packages may be enclosed in a bag to provide some protection against infiltration of suspended solids. Penetration can be assisted by the central carrier on which the package is built and which may consist of perforated cones, tubes or springs. The central canals of the packages are then threaded on a longer perforated tube and loaded into the dyeing machine. The packages are compressed down on the carrier, one end of which is connected to a manifold for circulation of the dyebath by an external pump. The flow is reversed several times. After dyeing, the compound carrier can be connected to a vacuum to remove as much water as possible.

The Hussong machine can be modified for the dyeing of cheeses mounted on perforated spigots; in this case the circulation is by impeller and can be reversed as required. Warps on the beam are treated as packages by using a perforated carrier and circulating the liquor in both directions with a pump. The tight packing of warps in this form makes it difficult for dye to penetrate; it is therefore necessary to use powerful pumps, to extract excess water

by vacuum, and then to dry by blowing hot air through the package. The drying of any package must be carried out evenly and slowly to prevent deformation of the unit.

Piece Dyeing.—Most piece goods, because their continuous form is suited to the method, are dyed by being moved through the liquor. If the material can be dyed free from creases or damage to the structure then the pieces may be handled in rope form; otherwise they must be treated in the open width.

The jig machine consists of two large rollers on and off which the fabric is alternately rolled up at open width, dyeing being conducted in a trough narrower at the bottom than at the top and through which the running fabric is conducted by guide rollers from one to the other of the large rollers. Because of the short immersion time, most of the dyeing occurs on the rollers so that the heat loss is high; the top of the jig is therefore often covered by hoods of stainless steel and armour-plated glass. Tension on the fabric is overcome by having the guide rollers freely mounted and by driving each of the main rollers independently. Curved expander bars may be fitted to reduce creases along the warp and a third removable roller known as a batch roll may be fitted for running off the cloth after dyeing. Pressure rollers may also be introduced on top of the driving rollers to give a mangling effect. The jig usually is heated by thermostatically controlled steam coils and can be set to run automatically for a given number of reversals. As the cloth traveling through the liquor carries a slowly moving layer of liquid on its surfaces, turbulence in the dyebath can be produced by agitators. Another main advantage is the liquor-to-goods ratio.

A second machine for dyeing at open width, particularly useful for delicate fabrics, is the "starframe" in which the cloth is held as a spiral; two large sides of the frame are fitted with hooks that engage in the selvages. The assembly, partly immersed, is revolved on its axle in an open, fairly closely fitting trough. The production with this machine is somewhat low because it is common to sew on the cloth false edges that must be mounted by hand on the hooks. The dyebath is heated by coils and the axle, while revolving, is given a slight side-to-side motion to agitate the liquor and promote even dyeing. By varying the time the goods are in the liquor it is possible to produce ornamental shaded effects.

The padding mangle consists of a nip composed of two or more rollers under pressure, and of an impregnating trough fitted with guide rollers. The bowls may be arranged vertically or offset slightly; the liquor is allowed to run back into the impregnating trough. By suitable threading of the machine it is possible to give two immersions and two nips. In some cases a nip is then given below the surface of the liquor to express air, which would otherwise impede penetration through the cloth. It is also possible to arrange the rollers so they form their own trough, thereby giving at the end of the run the minimum amount of liquor to run to waste. Hard coverings on the rollers give low moisture contents in the goods but the effect on the cloth structure frequently precludes this and one hard and one soft roller may be used. The pressure may be applied pneumatically, hydraulically, or by capstans, levers or springs at the end of the mangle roller axle, or by jockey rollers.

The winch, the oldest dyeing machine in use for fabrics, consists of a reel over a heated dyebath. The reel is made up of slats in circular or elliptical form or of fluted rollers. The elliptical form is common with delicate fabrics and gives greater agitation to the cloth, which lies in the dyeing vessel most of the time. Winches are used for either woven or knitted goods.

The goods are run in rope form, several drafts being dyed in a parallel arrangement and kept apart by a peg rail. Because of the large amount of cloth stationary in the vessel, suitable dyes, with the assistance in some cases of leveling agents, must be used; these are added into a compartment that contains no fabric and is formed by a perforated partition. The liquor ratio is very high with this machine, requiring dyes that exhaust from solution, and the large volume of water makes the heating expensive. To reduce cost and even out the heating and cooling of the cloth, the winch is usually enclosed.

Continuous Piece Dyeing.—Continuous piece dyeing reduces cost and makes for even colour but requires large orders to one hue. It has long been practised in the case of sulfur dyes, mineral khaki and aniline black; these were dyed in ranges of open soapers; *i.e.*, vessels fitted with rollers at full width to lead the cloth sinuously through the liquor with a mangle at the end. Many such machines are in use. Later techniques include the use of a mangle, impregnating the cloth with insoluble colouring matter (vat dyes), and developing the colouring matter with an alkaline reducing agent continuously in hot, moist conditions produced by various machines.

The roller ager is a steam chamber containing rollers at full width to lead the cloth through the maximum sinuous course. High-pressure steam coils in the walls give a temperature above 100° C. and live steam is blown in at various points. The preheated cloth enters and leaves by the same slit orifice, which is also heated and is almost completely sealed. In some types of agers the cloth is festooned over poles that rotate slowly, passing the cloth through the machines. Newer types use electric heating instead of closed steam coils and maintain a damp, air-free atmosphere with live steam.

In flash-aging, shorter steaming times are obtained with smaller machines that consist of a heated jacket with heated entry and exit orifices just large enough to take the fabric. Steam is blown in to generate hot, humid conditions.

An alternative is the Pad-Roll, in which the fabric is padded with dye liquor and rolled inside a movable chamber that takes three large rolls of cloth. The rolls are rotated inside the chamber for several hours, thus allowing natural diffusion of the dye into the fibre. The walls of the chamber are heated electrically and small amounts of steam are introduced. If necessary, two different colours can be steamed together if sufficient knitted material is introduced to prevent the two colours from rubbing into each other.

In fluid beds, very small glass spheres floated by an upward current of air give very rapid and efficient heat transfer. But it is difficult to remove the spheres from textiles, and wear on moving parts is considerable.

In the molten metal method a low-melting alloy filled into a U-tube exerts even pressure on cloth passing through it; dyeing occurs without loss of liquor by evaporation. The U-tube is made of heavy steel plates and carries the dyebath at the top of one leg and the washing liquor at the top of the other. Such a machine is very versatile and irregularities in weave or sewing are compensated for by the hydrostatic pressure of the molten metal. But the initial cost is high and the loss of alloy expensive.

The Williams unit, a type of liquid booster, is a tank whose volume is largely taken up by hollow baffles between which the cloth is led in a sinuous course over guide rollers. The liquid is agitated violently by the cloth; either an aqueous solution or white oil is used as the heating medium. Other liquid boosters consist of chambers half filled with heated liquor in which the cloth passes alternately through the heated dyebath, or reaction mixture, and steam.

High-temperature dyeing is used for completely man-made fibres. Package dyeing machines can be built to withstand pressures used with temperatures above 100° C.; they may even be pressurized with compressed air or nitrogen inside the vessel, thus preventing boiling at high temperatures and difficulties in the pump mechanism. On the Barotor batches of cloth are treated in open width and at temperatures above 100° C.; the fabric is wound on a reel and placed in an autoclave. As the reel turns inside the pressure vessel the fabric progresses over the bars, thereby preventing bar marking, and the cloth is alternately dipped and steamed. In the beam dyeing machine the cloth is wound on a perforated roller and the whole assembly is placed in a stout outer shell capable of being pressurized. The liquor is pumped through the perforated roller and circulated continuously through the goods. The ordinary jig can be pressurized by careful sealing or a removable jigger can be wheeled into a shell that may be pressurized.

Other Materials.—Many more types of dyes are used on textiles than on other materials. Textile dyes are often chosen for leather, paper and anodized aluminum and the like, but there are

also some special dyes for these materials. The dyeing of leather is akin to that of wool, though complicated by the presence of the tanning agents and the difficulty of getting the dyes to penetrate into the solid leather since leather cannot be treated in boiling dye liquors. With paper, the dyes are usually added to the pulp from which the paper is formed. With aluminum, the electrically oxidized surface is dyed with substances having affinity for the oxide coating and then is treated to seal the dye into the oxide. Dyes are used extensively in food and drink; this use is subject in most countries to stringent regulations as to type and standard of purity. Furs are usually dyed with oxidation bases but pastel and bright colours are produced on them and on wooled (unshorn) sheepskins by disperse and acid dyes.

See also references under "Dyes and Dyeing" in the Index.

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Literature on the history of dyes and dyeing is voluminous but scattered. *The Colour Index*, 4 vol. (1956–58), supplementary vol. (1962), lists all known current commercial dyes (except those of Russian make and those from some other Communist countries), together with their constitutions where known, as well as those of dyes no longer made commercially and references to history, manufacture and usage. See *Journal of the Society of Dyers and Colourists* (1884 *et seq.*) both for original articles and for abstracts or reviews of publications; and *Ciba Review* (1937 *et seq.*). *See* also E. Bancroft, *Philosophy of Permanent Colours*, new ed. (1813); J. Napier, *A Manual of the Art of Dyeing* (1853); E. Knecht, C. Rawson and R. Loewenthal, *A Manual of Dyeing* (1893); C. M. Whittaker and C. C. Wilcock, *Dyeing with Coal-Tar Dyestuffs*, 5th ed. (1950). (C. O. C.; S. R. C.)

DYKE: *see* DIKE.

DYNAMICS (in music): *see* EXPRESSION, MUSICAL.

DYNAMICS is the branch of science which is concerned with the motions of bodies and the ways in which these motions are influenced by applied forces. Its underlying principles are described in the article MECHANICS, the parent subject of which it forms a part. Dynamics is commonly divided into kinematics, which deals with the purely geometric considerations of motion, and kinetics, which concerns the ways in which motions are produced and modified by forces.

Certain general results of dynamics are arrived at by reasoning from Newton's laws. These relate to any body be it solid or fluid, although the methods of applying them depend largely upon the type of body. It would be difficult in a short article to indicate clearly the general nature and scope of this branch of science since it is a vast subject which has received a great deal of attention from mathematicians, physicists and engineers. In the present article, therefore, an attempt will be made to describe the dynamics of rigid bodies for the sake of definiteness. The motion of fluids is covered in MECHANICS, FLUID.

Particle dynamics is discussed in the article MECHANICS and it sometimes suffices for the discussion of the motions of real bodies, notably in astronomy. But the majority of technical problems of dynamics cannot be solved directly by the methods described. This is because it is comparatively seldom that the size of a body can be neglected in comparison with all the relevant distances involved in its motion. If, as is often the case, distortion is negligible (or, rather, does not matter), then it is necessary to turn to rigid dynamics; if it is not (as in vibration problems) then rigid dynamics must be discarded in favour of the mechanics of deformable solids. The problems which arise are of many types. Some are essentially two-dimensional, like that of a conventional clock escapement, while others (such as problems involving gyroscopes [*q.v.*]) are three-dimensional.

TWO-DIMENSIONAL RIGID DYNAMICS

The relative simplicity and wide application of the two-dimensional (or plane) dynamics of rigid bodies has caused this branch of mechanics to become highly developed. In fact almost every elementary textbook on dynamics begins with the treatment of problems of this sort. Plane rigid dynamics will be used here, however, to provide a simple, and mainly descriptive, introduction to the more complicated three-dimensional theory which covers plane dynamics as a special case. The elements of three-dimensional theory are presented later in more detail.

The tipping mechanism of a truck shown in fig. 1 will be used as the basis of this preliminary discussion. The dynamical problems set by a mechanism of this sort are typical of those met in engineering practice. It is necessary to calculate the forces transmitted by the various parts, and to find suitable sizes, materials and shapes of those parts.

Kinematics of Plane Motion.—A rigid body is said to execute a plane motion when every point within it remains at constant distance from some fixed reference plane. Evidently the members A, B, C, D and E in fig. 1 all perform such motion when the truck is stationary.

Suppose that the truck is standing still and that for some given tipping position the piston attached to D has some prescribed speed of sliding within the hydraulic cylinder. The angle made by a line fixed in the body C and the horizontal will clearly be varying and its rate of change is called the angular velocity of C. The deduction of this angular velocity from the given piston speed is a typical problem in plane kinematics and it can, in fact, be solved in a number of ways; of these, a graphical method involving geometrical constructions is probably the best.

There is no reason why a uniform piston speed should produce a uniform angular velocity of the body. The rate of change of angular velocity is called the angular acceleration, and the value of this quantity can again be found by the methods of plane kinematics. This latter type of calculation is important by reason of its significance in plane kinetics as will be shown.

Kinetics of Plane Motion.—If plane motion of a system occurs parallel to a reference plane OXY, then as a consequence of Newton's laws (*see* MECHANICS)

$$F_x = M\frac{d^2\bar{x}}{dt^2} \qquad F_y = M\frac{d^2\bar{y}}{dt^2}$$

In words, the total applied force F_x which acts in the direction OX is equal to the product of the total mass M and the acceleration of the centre of mass of the system in the direction OX. Similar reasoning holds good for the force-component F_y. The co-ordinates $\bar{x}$, $\bar{y}$ determine the position of the centre of mass and this point will not, in general, be fixed in the system.

A third equation of motion may be found, again from Newton's laws. This states that the total moment, M_z say, of the applied forces about the axis which is perpendicular to the plane OXY and which passes through the centre of mass of the system is equal to the rate of change of the total moment of momentum H_z about that axis. This can be expressed symbolically as

$$M_z = \frac{dH_z}{dt}$$

although this result will be used in another form.

The three equations which have been quoted govern the plane motion of any system and, if the system is a rigid body, then their interpretation is much simplified by the fact that the centre of mass is a point fixed in the body. The first two equations may therefore be written as

$$F_x = M\frac{d^2x_g}{dt^2} \qquad F_y = M\frac{d^2y_g}{dt^2} \qquad (1)$$

where x_g and y_g denote the co-ordinates of the centre of mass G with respect to fixed axes OXY.

Consider now the rotation equation which governs H_z. The moment of momentum is reckoned about the axis through the centre of mass G and perpendicular to the plane OXY. This quantity is not affected by the motion of the centre of mass so that this point of a rigid body can conveniently be imagined fixed; only rotation then will be possible about G as the centre. Fig. 2 shows a body whose centre of mass has been fixed in this way.

The angle made by a line GJ fixed in the body with a line GK which is fixed relative to the reference axes OXY is denoted by θ. Thus the angular velocity of the body is $d\theta/dt$.

The displacement of J during a short interval of time δt is $r\delta\theta$ where r is the distance GJ and $\delta\theta$ is the appropriate small angle of rotation. The velocity of J and hence the momentum of an

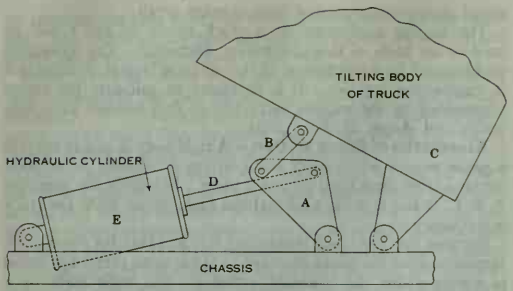

FIG. 1.—HYDRAULIC TIPPING MECHANISM FOR MOTOR TRUCK BODY

element of mass δm at J are therefore

$$r\frac{d\theta}{dt} \text{ and } \delta m.r\frac{d\theta}{dt}$$

respectively. These are directed as shown by the arrow (perpendicular to GJ). Therefore, the moment of momentum of the small mass is

$$\delta m.r^2\frac{d\theta}{dt}$$

Now the derivative $d\theta/dt$ relates to the whole body whereas the quantity $r^2\delta m$ is identified with the particular point J. The total momentum is thus

$$H_z = \frac{d\theta}{dt}\int r^2 dm$$

where the integral is evaluated over the whole body. This integral is a constant which may be identified with the body and it is known as the moment of inertia with respect to the chosen axis through G; let it be represented by I_g. Returning now to the equation of rotational motion it is evident that it may be written as

$$M_z = I_g\frac{d^2\theta}{dt^2} \qquad (2)$$

All the members A, B, C, D and E in fig. 1 move in conformity with equations (1) and (2).

The reason for the relative simplicity of plane rigid kinetics (as opposed to the kinetics of rigid bodies in three dimensions) can now be seen. For equations (1) and (2) are mathematically identical and, moreover, they are obviously mathematically identical with the equations of motion of a particle, *i.e.*, a body of negligible size. This greatly simplifies matters.

D'Alembert's Principle.—Direct application of these equations to a moving mechanism, like that shown in fig. 1, would necessitate separate treatment of each of the individual members A, B, C, D and E and the determination of the forces at the various junctions between them. Unless these are required this procedure is unnecessarily tedious and the analysis may be much simplified by invoking the principle of virtual displacements. This is a theorem of statics which is particularly useful in solving problems of equilibrium so that, for the purpose of analysis, it is necessary to imagine the dynamical problem as if it were a statical one.

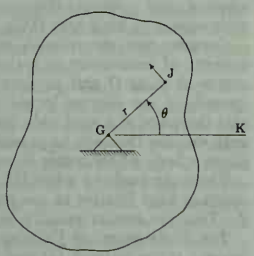

FIG. 2. (SEE TEXT FOR EXPLANATION)

Consider a single link, say C in fig. 1, whose motion is determined by equations (1) and (2). It may be thought of as being composed of a light skeleton, or matrix, in which a large number of small massive particles are embedded. The mass of C is then embodied entirely in the particles. The matrix is acted upon by sets of forces which may be conveniently placed in three categories. First there are the applied forces; these act at the pins and are transmitted from the abutting members (B and the chassis). Secondly, there are the reactions equal to the weights of the attached particles. These two sets of forces account for the left-hand terms in equations (1) and (2). Finally the matrix feels the reactions that are equal and opposite to the forces which impart accelerations to the attached particles. This effect will now be examined separately.

The resultant of the forces acting on the various particles can evidently be thought of as possessing components whose values are given by the terms on the right-hand sides of equations (1) and (2). These components are applied to the particles by the massless matrix and therefore, by Newton's third law of motion, they react on the matrix with equal magnitudes but in opposite directions. The components of reaction on the matrix are called inertia forces.

The matrix is a system to which the forces applied must be in equilibrium if its accelerations are finite, since it possesses no mass. Analytically, this is expressed by the fact that, if equations (1) and (2) were to be applied to the matrix alone their right-hand sides always would be zero since $M = 0$ and $I_g = 0$. It follows that, for the matrix of member C, the three sorts of forces together constitute a system in static equilibrium.

The analytical statement of this is

$$F_x - M\frac{d^2x_g}{dt^2} = 0 \qquad F_y - M\frac{d^2y_g}{dt^2} = 0 \qquad M_z - I_g\frac{d^2\theta}{dt^2} = 0 \qquad (3)$$

and although this appears to be a rather trivial rearrangement of the previous equations, it has a clear physical significance.

The purpose of this rearrangement now can be seen. Suppose that the applied forces (including those of gravity) and the inertia forces are imagined as acting on the massless matrices of all the members of the mechanism shown in fig. 1. The whole may then be regarded as a single system which can be analyzed using any of the techniques of statics and, in particular, that of virtual displacements. Analysis will be greatly simplified by the fact that all the forces at the connections between the various members occur in pairs which cancel out. This type of approach is associated with the name of D'Alembert.

KINEMATICS OF A RIGID BODY

A more detailed discussion of dynamics and the general theory relating to three-dimensional systems will now be given. The reader may well find that a preliminary reading of MECHANICS is desirable.

If a single point of a rigid body is fixed in space, the body is left free to turn about any axis through that point. The freedom is reduced if a second point is fixed so that only rotation is possible about the axis joining the two fixed points. Provided that it does not lie on this axis, the fixing of a third point suffices to fix the body in space. Nine co-ordinates determine the positions of the three points, but there are three relations governing the distances separating them within the body, so that six independent variables serve to specify the position of an unconstrained body in space. It will be seen that the increase in the number of these variables, or degrees of freedom, from three (for a particle) to six may introduce considerable complications.

Quite simple considerations as to the freedom of rigid bodies are of practical importance in the design of structures and of scientific instruments. For instance, consider an instrument which stands on three rounded feet. Let two of these rest in contact with the sides of a V-shaped groove which is machined in a horizontal plane surface while the third foot rests on the plane. The instrument can slide parallel to the groove but no other horizontal motion is permitted. A modified form of this arrangement is used in the construction of a lathe in which the tailstock must be capable of movement along the bed without loss of alignment.

Displacement of a Rigid Body.—A rigid body is capable of two basic types of motion, that is, of translation and rotation. When it undergoes translation, all points within it describe equal

and parallel straight lines. Rotation, on the other hand, occurs about an axis and is such that all points describe circles whose centres lie on this line. The reader can demonstrate for himself by simple reasoning that any displacement of a rigid body can be brought about by a suitable succession of translations and rotations. Now any displacement by which three points of a body take up fresh positions can, in fact, be effected by a translation with a single rotation about a fixed axis. Rather than pursue the problem of general displacements, however, certain particular cases which are of special importance will be considered here.

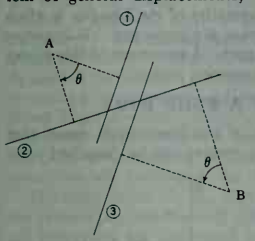

FIG. 3.

Consider the displacement of a body that suffers successively equal and opposite rotations about parallel axes. As there is no motion parallel to these axes, the kinematical problem can be examined by reference to a plane which is perpendicular to the axes. Let the line 1 in fig. 3 be drawn in such a plane. If the body is rotated through an angle θ about the axis which intersects the plane at A, the line is brought to position 2. An equal and opposite rotation θ about the axis B brings the line to position 3. Now the line 3 is parallel to 1 so that the two rotations restore the line's original direction but not its position. The resultant displacement is such that all lines in the plane are unaltered in direction so that the total effect is to translate the body in a direction perpendicular to the axes of rotation.

This result can be expressed symbolically as follows:

[rotation $(+\theta)$ about A]
+ [rotation $(-\theta)$ about B]
= (translation perpendicular to the axes through A and B).

Alternatively,

[rotation $(+\theta)$ about A]
= [rotation $(+\theta)$ about B]
+ (translation perpendicular to the axes through A and B) (4)

The conclusion is therefore that a rotation about any axis produces the same displacement as an equal rotation about a parallel axis together with a translation. The converse is also true.

The significance of equation (4) will become apparent later. Its effect is to simplify greatly the theory of the kinematics and kinetics of rigid bodies since it is only necessary now to discuss the rotations of a body about intersecting axes.

If a body rotates through a finite angle about a fixed axis, this displacement may be represented by a line whose length represents the angle and whose direction and sense are related to the rotation in the same way as the advance to the rotation of a right-handed corkscrew. But if the body rotates about an axis which is fixed relative to a frame of reference and that frame is itself rotated about an intersecting axis fixed with respect to stationary axes, the lines representing these displacements cannot be added to give the correct resultant rotation by the parallelogram rule. Equally, if several such component rotations take place about axes meeting in a point, they cannot be compounded by the polygon law. In other words, a finite rotation is not a vector quantity. This is illustrated in fig. 4. A book is given three rotations each of 180° about perpendicular axes, the resultant rotation being nil since the book ends up in its initial position. Vector addition here would indicate not a zero resultant, but one of $180\sqrt{3}°$.

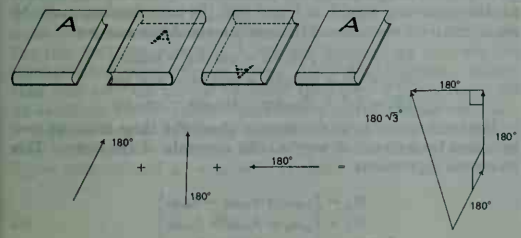

FIG. 4.

Rotations through finite angles about intersecting axes are, in fact, equivalent to a single rotation about a third axis passing through the intersection. But the process of composition of the component rotations is not that of the parallelogram law, and is more complicated.

The position is different, however, if a body performs a very small rotation about an axis which is fixed in a frame of reference and that frame itself rotates through a small angle about an intersecting axis. In contrast with finite rotations, these can be compounded by the vector law to give a resultant rotation about an appropriate axis. Let the body rotate through a small angle $\delta\theta$ about the axis AD (*see* fig. 5 in which A, B, C, D, P lie in a plane). AD is fixed relative to some frame of reference. If PE is perpendicular to AD, then the displacement of P, a point within the body, is PE $\times$ $\delta\theta$.

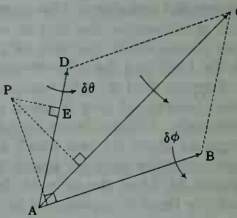

FIG. 5.

If the magnitude $\delta\theta$ of the rotation is represented to some scale by AD, then the displacement of P is AD $\times$ PE; this can be regarded as the "moment of AD about an axis through P which is perpendicular to the plane of the figure" by analogy with the notion of a force which is represented by a vector. Again, if a small rotation $\delta\phi$ of the frame now takes place about the fixed axis AB, the displacement of P is represented by the moment of AB about the same axis through P.

If the parallelogram ABCD is now completed, the sum of the moments of AB and AD about P is equal to the moment of AC about the axis through P, again by analogy with the like result for forces. This is true for all points P in the plane so that all points in the plane move as though a single angular displacement about a fixed axis had taken place which is represented to the chosen scale by AC. Since the body is rigid, only this resultant small rotation could have produced these displacements in the plane and the displacements of all other points must conform with it.

Very small rotations can also be compounded like forces when they occur about parallel axes. Suppose for instance that these rotations are $\delta\theta$ about the axis through A and $\delta\phi$ about that through B, both axes being perpendicular to the plane of the paper (fig. 6). By an extension of the previous argument, it is found that the motion of any point P is the same as if the body undergoes the small rotation $\delta\theta + \delta\phi$ about an axis through C. This axis is parallel to those through A and B and divides the distance AB inversely as the magnitudes of the component rotations about these axes.

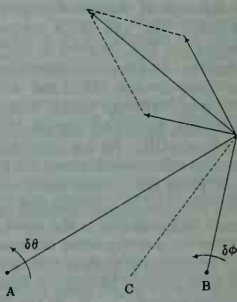

FIG. 6.

These conclusions as to the vectorial nature of small rotations are only valid if the rotations are infinitesimal. Their significance becomes apparent on taking into account the time intervals during which they occur. This leads to the concept of angular velocity.

Angular Velocity and Angular Acceleration.—A body which moves in such a way that some point O within it remains fixed does not in general turn about a fixed axis, so that an instantaneous axis of rotation may be defined. This axis is determined if the directions of motion of any two points A and B in the body are known. During an infinitesimal time, let A move to A′

and B to B′ so that AA′ and BB′ are very small distances. Then AA′ must be perpendicular to OA, and BB′ must be perpendicular to OB. The instantaneous axis of rotation lies in a plane containing OA which is perpendicular to AA′ and also in a plane which contains OB and is perpendicular to BB′. The instantaneous axis of rotation is the line of intersection of these two planes and, although it always passes through O, its position may vary both with respect to the body and in space.

It has been shown that very small angles of rotation of a rigid body about various axes which intersect at a point can be compounded by the vector law into a resultant rotation about a certain axis. The theory can now be extended to introduce the notion of angular velocity. The angular velocity of a body about an axis is defined as the rate at which the angle increases between two planes which intersect on the axis, the one plane being fixed in the body and the other in space.

Suppose that a body performs a small rotation $\delta\theta$ during the short interval of time δt about an axis fixed relative to a frame of reference. Let this frame simultaneously rotate through the small angle $\delta\phi$ about an axis which intersects the first. The resultant small rotation may be found by the parallelogram law. If the lengths $\delta\theta$, $\delta\phi$ of the sides of the parallelogram are divided by δt, and the limit is approached as δt is taken indefinitely small, the parallelogram becomes a representation of angular velocities. Component angular velocities (of a rigid body about an axis fixed in a frame of reference, of rotation of the frame about an intersecting axis fixed relative to another frame, and so on) may be added as vectors to give the resultant angular velocity about the instantaneous axis of rotation.

It follows, by a similar argument, from the result indicated in equation (4) that an angular velocity about an axis involves the same motion of a rigid body as would an equal angular velocity about a parallel axis together with a velocity of translation perpendicular to the axes. Again the converse is also true. From this it can be deduced that the motion of a rigid body can be specified by the velocity of one point together with the angular velocity about an axis through that point. Further, the magnitude of the resultant angular velocity and the direction of its axis do not depend upon the particular reference point.

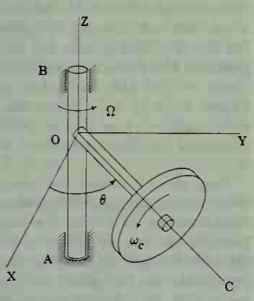

FIG. 7.

Angular acceleration is defined as the rate of change of angular velocity. It, too, is a vector quantity. For consider a body which has an angular acceleration α_a about an axis OA, fixed in a frame of reference which, simultaneously, suffers an angular acceleration α_b about an intersecting fixed axis OB. In the small interval of time δt, α_a produces an angular velocity $\alpha_a\delta t$ about OA and α_b produces an angular velocity $\alpha_b\delta t$ about OB. Since these angular velocities are vector quantities, they can be compounded by the parallelogram rule. But the result of doing this is the same as that obtained by compounding α_a and α_b directly using the parallelogram rule.

The resultant angular velocity ω of a body, which rotates about an axis passing through a fixed point O, can be resolved into components ω_x, ω_y, ω_z in the directions of fixed orthogonal axes OX, OY, OZ. The corresponding components of the angular acceleration are then

$$\alpha_x = \frac{d\omega_x}{dt} \qquad \alpha_y = \frac{d\omega_y}{dt} \qquad \alpha_z = \frac{d\omega_z}{dt} \tag{5}$$

As an illustration, consider the disk shown in fig. 7, which has an angular velocity ω_c relative to an axis fixed in the frame ABC, which frame rotates about the fixed axis AB. Let OC rotate with angular velocity Ω about the spindle AB, with OC perpendicular to AB. If a set of fixed axes OXYZ is used as shown in the figure and θ denotes the angle between the fixed line OX and the moving axis OC, then $\omega_x = \omega_c \cos\theta$; $\omega_y = \omega_c \sin\theta$; $\omega_z = \Omega$. The components of angular acceleration are thus, from equations (5),

$$\left.\begin{aligned}
\alpha_x &= \frac{d\omega_x}{dt} = \frac{d\omega_c}{dt}\cos\theta - \omega_c \sin\theta\frac{d\theta}{dt} = \frac{d\omega_c}{dt}\cos\theta - \Omega\omega_c\sin\theta \\
\alpha_y &= \frac{d\omega_y}{dt} = \frac{d\omega_c}{dt}\sin\theta + \omega_c\cos\theta\frac{d\theta}{dt} = \frac{d\omega_c}{dt}\sin\theta + \Omega\omega_c\cos\theta \\
\alpha_z &= \frac{d\omega_z}{dt} = \frac{d\Omega}{dt}
\end{aligned}\right\}$$

Further development of the kinematics of rigid bodies is often difficult when fixed axes of reference are employed. It becomes simpler to refer motion to moving axes. A treatment of this aspect will be found in A. S. Ramsey, *Dynamics*, part ii.

THE KINETICS OF A RIGID BODY

An explanation has been given of the kinematical result that any motion of a rigid body at any instant can be described completely by the velocity of some point of it combined with an angular velocity about some axis through that point. It has also been shown (in the article MECHANICS) that the forces which act on a rigid body produce a motion of the centre of mass together with an independent motion relative to the centre of mass; this is a rotation about an axis through that point.

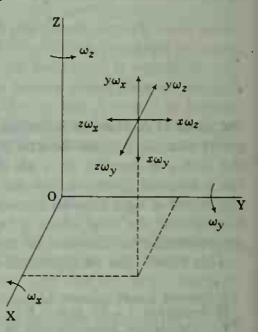

FIG. 8.

When considering the motion of a rigid body, the motion of the centre of mass may first be dealt with as if the body were a single particle with its entire mass concentrated at that point. The rotation about the centre of mass may be treated separately as if this point were fixed in space. The motions of translation and of rotation are independent and the latter may be analyzed by assuming the centre of mass to remain at the origin of fixed axes.

The motion of translation is covered by the discussion of the kinetics of a particle. The problem of rotational motion about an axis through a fixed centre of mass must now be dealt with.

Angular Momentum of a Rigid Body.—Suppose that a rigid body rotates about an axis which passes through its centre of mass and that this point is fixed at the origin of fixed co-ordinate axes OXYZ. Let the angular velocity be ω at some instant with component angular velocities ω_x, ω_y, ω_z in the directions of the axes OX, OY, OZ respectively (fig. 8). The components of velocity of the point (x, y, z) within the body will be

$$\begin{aligned}
v_x &= z\omega_y - y\omega_z \text{ in the direction OX} \\
v_y &= x\omega_z - z\omega_x \text{ in the direction OY} \\
v_z &= y\omega_x - x\omega_y \text{ in the direction OZ}
\end{aligned}$$

Consider the moment of momentum of a small element of the body, mass δm, about the three axes. If this element lies at the point (x, y, z) its moment of momentum about the axis OX is

$$\delta m(yv_z - zv_y) = \delta m[y(y\omega_x - x\omega_y) - z(x\omega_z - z\omega_x)] = \delta H_x$$

If this is rearranged, and the analogous expressions are written for the remaining axes, it is found that the contributions made by δm to the total moments of momentum about the axes are

$$\begin{aligned}
\delta H_x &= (y^2 + z^2)\omega_x\delta m - xy\omega_y\delta m - xz\omega_z\delta m \\
\delta H_y &= (z^2 + x^2)\omega_y\delta m - yz\omega_z\delta m - yx\omega_x\delta m \\
\delta H_z &= (x^2 + y^2)\omega_z\delta m - zx\omega_x\delta m - zy\omega_y\delta m
\end{aligned}$$

The total moments of momentum about the three axes can now be found by integration over all the elements of the body. This yields the expressions

$$\left.\begin{aligned}
H_x &= I_{xx}\omega_x - I_{xy}\omega_y - I_{xz}\omega_z \\
H_y &= I_{yy}\omega_y - I_{yz}\omega_z - I_{xy}\omega_x \\
H_z &= I_{zz}\omega_z - I_{xz}\omega_x - I_{yz}\omega_y
\end{aligned}\right\} \tag{6}$$

where the following abbreviations are used:

$$\left.\begin{array}{llll} I_{xx} = \int(y^2+z^2)dm & I_{yy} = \int(z^2+x^2)dm & I_{zz} = \int(x^2+y^2)dm & \\ I_{xy} = \int xydm & I_{yz} = \int yzdm & I_{zx} = \int zxdm & \end{array}\right\}(7)$$

It will become apparent that these quantities I are of fundamental importance since they determine the dynamical behaviour of the body. The quantities I_{xx}, I_{yy}, I_{zz} are called the moments of inertia of the body about the axes OX, OY, OZ while I_{xy}, I_{yz}, I_{zx} are termed the products of inertia, although they are not usually defined in quite this way. If the axes, by reference to which the integrals (7) are defined, were fixed in the body, the appropriate quantities would be constants whose values characterize the body's dynamical behaviour. It is these constants which are usually referred to as the moments and products of inertia (see *Two-Dimensional Rigid Dynamics* above). They have some interesting and important characteristics, a knowledge of which is essential for complete understanding of the motions of rigid bodies. These quantities will continue to be regarded as being time dependent.

The components H_x, H_y, H_z refer to the axes OXYZ which, for the present purpose, are only *assumed* to be fixed; for the dynamical properties are unaffected by motion of the origin O which is at the centre of mass. It follows that the components are not normally equal to the moments of momentum about parallel axes which really are fixed and which do not have their origin at the centre of mass. A nonrotating body has zero components H_x, H_y, H_z but will not necessarily have zero moments of momentum about the fixed axes. For this reason it is desirable to distinguish between the two sets of components and to this end, H_x, H_y, H_z are referred to as the components of angular momentum in the directions OX, OY, OZ, respectively.

There is a general theorem that can now be restated in a more useful form. It relates to the components of moment of momentum about fixed axes of a system of particles and it is now seen that, for a rigid body, these are equal to the sums of two other convenient sets of components. The first are the components of moment of momentum of a particle placed at the centre of mass and the second are the components of angular momentum.

The angular momentum about an axis is shown in equations (6) to depend not only on the angular velocity about the axis concerned but also on the angular velocities about axes perpendicular to that axis. Again, in general, angular velocity about one axis implies angular momentum about all three axes. Now the quantities H_x, H_y, H_z can be regarded as the components of a vector—that of angular momentum. This may be proved by an extension of the previous argument relating to angular velocity. It follows from equations (6), then, that the vectors of resultant angular velocity and of resultant angular momentum have not, in general, the same direction.

The Equations of Rotation.—Another of the general results (also deduced in MECHANICS: *Systems of More Than One Particle*) for any system can now be restated for a rigid body. This is to the effect that the rate of change of angular momentum of a body about a fixed axis passing through the centre of mass, is equal to the total moment of the external forces about the axis.

In symbols, $$M_x = \frac{dH_x}{dt} \qquad M_y = \frac{dH_y}{dt} \qquad M_z = \frac{dH_z}{dt} \qquad (8)$$

These are the equations of rotation.

If these derivatives are formed, by introducing the expressions (6) for the quantities H_x, H_y, H_z, it is found that the resulting equations are somewhat complex. The complication arises from the fact that the quantities I, defined in equations (7), are not constants but have different values at different instants. Rather than deal with the general problem, therefore, a special case will be examined whose technical importance scarcely needs emphasis.

Suppose that a rigid body rotates about a fixed axis and let this be identified with the axis OX. Under these conditions, I_{xx} = constant and $\omega_y = \omega_z = 0$, so that

$$\left.\begin{array}{l} H_x = I_{xx}\omega_x \\ H_y = -I_{xy}\omega_x \\ H_z = -I_{zx}\omega_x \end{array}\right\}$$

That is to say

$$\left.\begin{array}{l} M_x = I_{xx}\dfrac{d\omega_x}{dt} \\ M_y = -I_{xy}\dfrac{d\omega_x}{dt} - \omega_x\dfrac{dI_{xy}}{dt} \\ M_z = -I_{zx}\dfrac{d\omega_x}{dt} - \omega_x\dfrac{dI_{zx}}{dt} \end{array}\right\}$$

Reference to the definition of I_{xy} in equations (7) reveals that the derivative of I_{xy} with respect to t is given by

$$\frac{dI_{xy}}{dt} = \int(x\frac{dy}{dt} + y\frac{dx}{dt})dm = \int(xv_y + yv_x)dm$$

If the values for v_x and v_y are now substituted into this result, it yields simply

$$\frac{dI_{xy}}{dt} = -I_{zx}\omega_x$$

Similarly,

$$\frac{dI_{zx}}{dt} = I_{xy}\omega_x$$

For the rigid body which rotates about the fixed axis OX, therefore,

$$\left.\begin{array}{l} M_x = I_{xx}\dfrac{d\omega_x}{dt} \\ M_y = -I_{xy}\dfrac{d\omega_x}{dt} + I_{zx}\omega_x^2 \\ M_z = -I_{zx}\dfrac{d\omega_x}{dt} - I_{xy}\omega_x^2 \end{array}\right\}$$

This result shows that the body has an angular acceleration about the fixed axis OX only if the external forces have a net moment about the axis. The angular acceleration is also associated with moments (about OY and OZ) of forces which must be applied at the bearings in order to keep the axis of the body fixed. Moreover, bearing forces must act even if the body runs with constant speed. If the body does not have its centre of mass on the fixed axis of rotation, then the bearing forces will be further augmented on that account.

It is often preferable, in three-dimensional problems of rigid dynamics, to use moving axes rather than fixed ones. Thus it may be possible by this means to ensure that the quantities $I_{xx}, I_{xy}, \ldots$ will not vary with time. One way of achieving this would be to fix the axes relative to the rigid body.

See also references under "Dynamics" in the Index.

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DYNAMISM, from the Greek word meaning "power," is the name coined by the French anthropologist and folklorist Arnold van Gennep for that attitude of the primitive mind towards the sacred or occult which involves a prevailing sense of its peculiar power or mana. Van Gennep is careful not to impute to the savage a theology in which any clear distinction is drawn between the impersonal and the personal aspects of the divine—as contrasted with advanced religion, which, as may be seen in Buddhism and Christianity respectively, may emphasize the one aspect almost

to the exclusion of the other—but suggests dynamism as a term that may be used for classifying any phase of primitive religion in which mana, rather than soul or moral personality, receives emphasis as the leading attribute of that which is worshipped.

See A. van Gennep, *Les Rites de Passage* (1909); E. W. Smith and A. M. Dale, *The Ila-Speaking Peoples of Northern Rhodesia* (1920). (R. R. M.)

DYNAMITE, a high explosive consisting essentially of nitroglycerine absorbed in an inert solid material in order to reduce its sensitivity to shock. *See* EXPLOSIVES.

DYNAMOELECTRIC MACHINES: *see* GENERATOR, ELECTRIC; MOTOR, ELECTRIC.

DYNAMOMETER, a device which permits the measurement of a force exerted by or the power associated with a machine. In general usage, dynamometers are regarded as a means for measuring power. In actuality, dynamometers permit the measurement of a force, and this measurement in combination with a velocity measurement makes it possible to calculate the power.

Theory.—Power is by definition the time rate of doing work, *i.e.*, work per unit time. Work is the equivalent of the product of a force and the distance traveled in the force direction. In other words, power is the product of force and distance divided by time; and the quotient of distance and time is a velocity. For linear movements, power P equals force F times linear velocity V, or $P = FV$. For rotating machines, power P equals force F times lever arm r times angular velocity ω, the product Fr being the torque t. In summary, (1) $P = FV$ for linear motion; and for rotary motion the following equations apply: (2) $P = Fr\omega$; (3) $P = t\omega$; (4) $P = Fr2\pi N$; and (5) $P = t2\pi N$.

Basically power measurement is a combination of the measurements of time, distance and force. Therefore, the force- or torque-indicating element of a dynamometer is used in conjunction with a revolution counter and timer (or speed indicator) for speed measurement and some means for measuring the lever arm length. Thus, for any given device (in which the distance r is fixed), it can be said that $P = FN/K$, where K is the dynamometer constant for the machine and is equal to $33{,}000/2\pi r$, when r is in feet, F in pounds, N in revolutions per minute and P in horsepower. From this equation, it can be seen that for successive power measurements with a given dynamometer it is sufficient to measure F and N at each new condition. It is convenient to classify dynamometers into two types, absorption and transmission.. Absorption dynamometers convert the energy involved into heat and this energy usually serves no useful purpose. Absorption units are used for loading devices whose output is to be measured. Transmission dynamometers transmit the energy and power involved from the dynamometer in a form and to a location where it can be usefully employed. Transmission units may be used for driving machines in order to measure the power output.

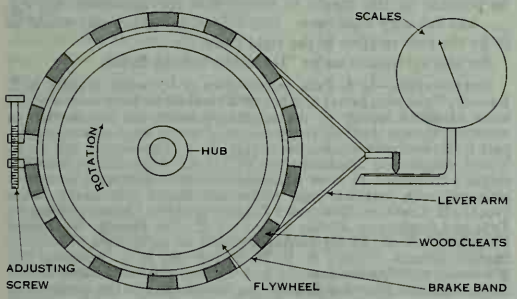

FIG. 1.—PRONY BRAKE

Absorption Dynamometers.—The original dynamometer of Gaspard de Prony (1755–1839) has been modified in many ways. The modern form (fig. 1) consists of a brake band to which are attached wooden cleats. The adjusting screw permits tightening or loosening the band, thus varying the frictional effect between the cleats and the smooth surface of the flywheel. The frictional force is transmitted to the scales through the lever arm which restricts the movement of the brake band. The force indicated on the scales is that exerted by the driving member plus any tare load, or additional force resulting from unbalance caused by the band, the lever arm or the adjusting screw mechanism. For smooth operation, the rubbing surface may have to be slightly lubricated. In addition, the heat evolved may have to be dissipated by circulating cooling water over the inner side of the flywheel. The power absorbed is equal to the force on the scales minus the tare load; this remainder is multiplied by the lever arm length (the perpendicular distance from the line of action of the force on the scales to the axis of rotation) and 2π times the speed, and the result is divided by a suitable constant (equation 4, above). Many modifications of this basic brake have been made using ropes or belts, and ingenious refinements have been used to compensate for load variations. In general, this type of device is applicable to machines of low speed and low, steady power output.

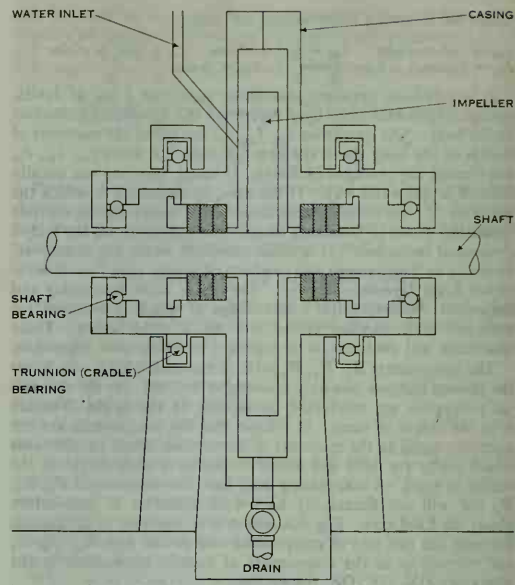

FIG. 2.—CRADLE-MOUNTED, HYDRAULIC DYNAMOMETER (WATER BRAKE)

One type of hydraulic dynamometer is a simple solid disk contained in a closely fitted casing (fig. 2). Water enters the casing and is thrown outward by the rotating disk impeller. The quantity of water admitted and retained within the casing affects the absorption capacity of the brake. Drains allow the water to leave the bottom of the casing and thereby some circulation is possible to dissipate the absorbed energy. By mounting the casing on trunnion bearings, the casing becomes "cradled" and free to rotate within limits. A lever arm extending from the casing to a platform scale permits determination of the torque. The power-absorbing capacity of this type of brake varies almost as the cube of the speed, a desirable feature for nongoverned engines. Sizes as large as 3,000 h.p. have been made. For certain types of work, small diameter, multidisk impeller rotors have been made that will rotate at 25,000 r.p.m.

An electromagnetic brake is another type of absorption dynamometer. There is a small air gap between the toothed rotor of this machine and the direct current energized coils of its stator. Lines of magnetic force produced in the stator pass principally through the teeth of the rotor so that as it turns this magnetic field sweeps through the iron of the stator, thus causing the stator to tend to turn in the direction of the rotor. The stator is restrained and eddy currents are produced which heat the dyna-

mometer; a cooling water jacket in the stator carries the energy away to prevent overheating. The torque produced by this device is transmitted through the cradled casing. Sizes of the order of 2,000 h.p. are not uncommon for this unit and its ease and refinement of control are decided advantages.

An electric generator is yet another type of absorption dynamometer. In this application a separately excited D.C. generator can be connected to the driving machine. The output of the driver is determined by either the power generated by, or the reaction torque on, the generator. In the first case, the generator must be tested so its losses can be accurately determined (*i.e.*, so that its efficiency can be evaluated). From these data the input-output curve can be drawn for the machine. As an absorption device, it would be necessary to note the electrical output of the generator, refer to the input-output curve (giving credence to the proper operating conditions), and thus determine the shaft input to the generator; for a direct-connected machine this latter quantity is the shaft output of the driving engine. Determination of the reaction torque on the generator involves the use of a cradle mounting for the generator stator (similar to the cradle mounting for the hydraulic dynamometer in fig. 2). In this situation, the reaction force, the appropriate lever arm length and the rotational speed are the necessary observations for determining the power input to the generator. Advantages of this dynamometer are the refinement of control of both speed and load which is possible and the ease with which changes in these quantities may be effected.

Transmission Dynamometers.—These machines are a class which can be used to (1) drive the machine whose input is to be measured; (2) indicate the force or torque required to deflect an elastic member such as a spring, or the angle of twist of a shaft; (3) indicate the force or torque necessary to produce a change in electrical resistance of (or voltage on) an electric resistance strain gauge; or (4) indicate the load or force required to produce a pressure in a hydraulic or pneumatic load cell. All such devices do not dissipate the energy but rather they transmit this energy to serve, in general, some useful purpose.

A calibrated electric motor makes an excellent transmission dynamometer. The calibration procedure is performed in order to relate the motor input (measured in volts and amperes, or in watts) to the motor output. The ratio of the output power to the input power is the motor efficiency for that condition of operation (understanding that efficiency may be affected by things other than power alone). The significant losses in a D.C. electric motor are the brush loss, the armature resistance loss and the rotation loss. For A.C. motors, the losses are usually reported in terms of motor efficiency. The calibrated-motor dynamometer has distinct advantages in measuring power in ranges that would be beyond the capacity of conventional dynamometers.

A cradle-mounted electric motor is one of the most easily regulated dynamometers. This device is mounted with the stator supported by ball or roller bearings so that it can rotate within limits. The reaction torque between the stator and the mounting is effectively the driving torque of the motor. Cradle mounting is accomplished in a fashion similar to that used for the hydraulic dynamometer in fig. 2. The torque, or the force and lever arm, and speed must be measured in order to calculate power. One of the most versatile dynamometers is the cradle-mounted D.C. motor-generator type dynamometer. A direct-current motor can operate effectively as a generator. Therefore, the controls of this dynamometer are made so that the unit can be operated as a motor to drive a machine whose input is to be measured, or the controls can be reset so the unit operates as a generator and loads a machine whose output is to be measured. Because of its versatility as well as its ease and refinement of control within the operating limits of the machine, this type of dynamometer is widely used.

Indicating Devices.—A number of contrivances are used for indicating the force exerted by a dynamometer. The spring scale is a common device, but it requires frequent calibration because the physical characteristics of the spring change with service, time and the ambient conditions. The movement of the spring is usually amplified by a suitable mechanism.

A beam balance is perhaps the most widely used force meter because of its stability and ruggedness and the fact that it requires infrequent calibration (although occasional checking is good practice). Platform scales are a form of beam balance. Both of these devices have the advantage that only small displacements are required for sizable forces; therefore, the dynamometer torque arm can remain at essentially the same level throughout its range of operation. A movement of the torque arm of as much as an inch requires a reorientation of the scale in order to measure the total force along its line of action rather than along some other line which would represent a fraction of the total force.

In the proving-ring force gauge the change in inner diameter of a ring because of a force acting on opposite points on the outer diameter is correlated in terms of the force required to produce the change. The proving ring and the spring previously described must not be distorted beyond the point at which their elastic properties will return them to their original dimensions when the force is removed.

Hydraulic and pneumatic force meters are commonly called load cells. These devices are used for transmission dynamometers which measure drawbar pull on a tractor or locomotive. The load cell consists of a chamber completely filled with either a liquid or a gas and enclosed on one side by a flexible diaphragm. A force on the diaphragm increases the fluid pressure, and the increase can be indicated by some type of pressure gauge (either a Bourdon-tube gauge or a manometer, depending upon the range required). One type of pneumatic load cell uses a regulated air supply with a diaphragm-operated pilot valve; an increase in force causes a deflection of the diaphragm, which in turn causes the pilot valve to connect the enclosed space to the air supply (at a higher pressure). Air is bled into the space until the diaphragm is returned to its neutral position. Displacement of the diaphragm in the opposite direction operates the pilot valve to bleed the air out of the cell. The air pressure required to keep the diaphragm in a neutral position is proportional to the load on the cell. Another type of load cell uses an electric resistance strain gauge as the primary element. This gauge is a small pad of fine resistance wire insulated electrically from its surroundings. As a load is increased or decreased on the assembly to which it is attached, deformation of both the assembly and the strain gauge occurs. This change in dimension alters the electrical resistance characteristics of the strain gauge and the change in resistance can be correlated in terms of the force required to produce the change.

Torsion Meters.—Torsion dynamometers are transmission dynamometers of a type; viz., torque meters indicate a force at some lever arm, and torsion meters indicate the force required to change the angle of twist of a member such as a shaft. Many of the devices previously mentioned can be arranged to perform as torque meters. For the torsion meter several techniques have been worked out to translate the angle of twist into the force required to produce the twist. In the Thring-Hopkinson torsion meter, the twist between points on a short length of shaft is observed. A cylindrical sleeve is gripped to the shaft at one end and is free at the other end so that there is relative motion of twist between the free end of the sleeve and the shaft. The relative motion is used to give angular displacement to a mirror which reflects light from a fixed source to a fixed scale. The reflected light impinges on the scale at different points for different angles of twist.

In the Moulin torsion meter the relative twist of a defined length of shaft is made to alter the self-induction of a coil mounted on and rotating with the shaft. An alternating current is supplied to the coil through brushes and slip rings, and the variation in current can be related to the twist of the shaft. An ammeter can be used to indicate the torque directly once the proper calibration has been made.

In the resistance-wire strain gauge torsion meter the unit is mounted between flanges in series with the shaft. Other variations can be made so that a network of strain gauges can be mounted directly upon the shaft whose power is to be measured. In both of these adaptations, the twisting of the shaft causes a deformation of the gauge which in turn changes the resistance of the gauge

and the voltage drop across it. These electrical effects can be calibrated in terms of force required to produce the twist.

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(R. A. O.)

DYNAMOTOR, an electrical machine usually having a single field coil and two windings on its armature such that when one winding is supplied with electrical energy from an external source, the other winding delivers electrical energy at a different voltage. It is thus a combination of motor and generator, or a rotary transformer. *See* GENERATOR, ELECTRIC; MOTOR, ELECTRIC.

(R. M. SN.)

DYNASTY, a family or line of rulers, a succession of sovereigns of a country belonging to a single family or tracing their descent to a common ancestor (Gr. *dynadeia*, "sovereignty"). The term is particularly used in the history of ancient Egypt as a convenient means of arranging the chronology.

DYNE, the unit of force in the centimetre-gram-second system. It is the force which, acting on one gram of mass, produces an acceleration of one centimetre per second per second. *See* GRAM; PHYSICAL UNITS.

DYOTT, THOMAS W. (1771–1861), U.S. glass manufacturer who introduced a number of designs which were later copied extensively and still later became collectors' items, was born in England. Nothing is known of his early life until his arrival in the United States toward the end of the 18th century. He soon established himself in Philadelphia, where he set himself up in what became an immensely successful shoeshining enterprise, the first of its kind in the city. It is not known exactly when he entered the patent medicine business but in that field, too, the enterprising Dyott was soon successful. His medicines, with which he claimed to be able to cure all human ailments, were used throughout the entire United States. About 1812 he took, with no authority but his own, the title of doctor of medicine. Dyott soon began to advertise the sale of bottles, as well as medicines, and about 1818 he became the agent for a number of glass manufacturers. There is some dispute about the year in which he first began to manufacture glass himself, the date sometimes being put as early as 1822, but in any case he probably did not purchase the Philadelphia and Kensington Glass Works until 1833. He enlarged and improved the plant and was soon manufacturing bottles of every description. Dyott's downfall was caused by the failure of the bank he had established as a part of his model community, Dyottville, or, as it was sometimes called, Temperanceville, because Dyott would not hire any worker until he had taken a temperance pledge. When the bank failed in the late 1830s, Dyott was proclaimed a "fraudulent bankrupt" and the Kensington works fell into other hands while Dyott served a prison sentence.

He died Jan. 17, 1861.

DYRRACHIUM CAMPAIGN. Having destroyed Pompey's power in Spain, Julius Caesar returned to Italy and on Nov. 28, 49 B.C., set sail from Brundisium with seven legions for Palaeste on the Epirotic coast. Landing on Nov. 29, on Dec. 2 he headed for Dyrrachium (modern Durres) which, however, he failed to capture. Though numerically weaker than Pompey he succeeded in cutting him off from this city, and then to safeguard his convoys Caesar drew a circle of trenches about 16 mi. in length around Pompey's army. Two deserters from Caesar's camp informed Pompey of the weak position in his defenses and, acting on this information, Pompey determined to attack his enemy's left flank, which rested on the coast. Caesar had built two lines around Pompey's right flank between which were posted the IX legion. Pompey's attack was made at dawn. He landed a number of archers and slingers in the rear of Caesar's men, and while these broke into the unfinished works he attacked them in front with 60 cohorts. The IX legion, taken in front, flank and rear, broke in confusion and spread panic among the reinforcements which had been sent out by Marcellinus, near whose camp Antony checked the Pompeians by a bold counterattack. Caesar, hearing of the disaster, moved rapidly with such cohorts as he could collect toward the scene of action, only to find that Pompey had established a new camp on his own original left flank. Nothing daunted, Caesar entrenched his men opposite to Pompey and attempted to turn Pompey's left flank, but the attack failed. In this battle Caesar suffered a severe defeat: not only were his losses considerable but the blow to his prestige was almost disastrous to his cause. Caesar's operations throughout this campaign, though daring in the extreme, were essentially faulty. By attempting to enclose a numerically superior adversary he was strong nowhere; had Pompey known how to win victory as well as how to fight a battle Caesar would have been decisively defeated. Instead, this turned out to be Pompey's last successful stand against Caesar before Pharsalus.

DYSART: *see* KIRKCALDY.

DYSENTERY. The term dysentery, the "bloody flux" of former times, denotes a symptom complex, the passage of blood and mucus in the stools, together with abdominal pain and straining. This combination of symptoms is common to a number of conditions with ulceration and inflammation of the large intestine and is determined by a variety of different microbial agents.

Types of Dysentery.—Dysentery may be classified as follows:

Bacillary or Epidemic Dysenteries.—The following organisms are responsible: (1) Shiga's bacillus (*Shigella shigae*) causes the most acute and fatal form in most tropical countries. (2) Schmitz's bacillus (*Shigella ambigua*) closely resembles the former in its biochemical reactions and in many other respects. It produces usually a less serious clinical manifestation and accounted for 12% of cases during World War II. (3) Flexner's bacillus (*Shigella flexneri*) is a species divisible into several subtypes. It is common in temperate countries, as well as in the tropics, and produces a clinical disease of average severity. (4) Sonne's bacillus (*Shigella sonnei*) is common all over the world, especially in temperate countries, and spreads with great rapidity, causing epidemics in infants and children; it may produce severe dysentery also in adults. It differs from all other dysentery bacilli in fermenting lactose, but produces its own specific antigens and agglutinins in the body.

Protozoal or Endemic Dysenteries.—(1) Amoebiasis, or infection with the dysentery amoeba (*Endamoeba* [*Entamoeba*] *histolytica*, F. R. Schaudinn, 1903), includes (*a*) primary intestinal amoebiasis or amoebic dysentery and (*b*) secondary amoebiasis—hepatic amoebiasis—or amoebic abscess of the liver, lung, brain or spleen, sometimes also amoebic extraintestinal ulcers (of buttocks or perineum) and amoebic invasion of the skin. (2) Balantidiasis, or infection of the intestinal canal with an infusorian, *Balantidium coli*. The course and pathology of this disease resembles amoebic dysentery. This infection is rare in man, but common in animals, especially pigs and larger apes. (3) Coccidiosis (*q.v.*), an infection with *Isospora hominis*, a rare disease of the intestinal tract of man. (4) Giardiasis (or lambliasis), an infection of the small intestine with *Giardia intestinalis*, a protozoan flagellate, common in children and producing a mucoid diarrhea. (5) Malarial dysentery, the passage of blood and mucus in the course of infection with the malaria parasite (*Plasmodium falciparum*), which congregates in the capillaries of the intestinal walls (*see* MALARIA). (6) Leishmanial dysentery, an infection of the intestinal canal with the parasite of kala-azar (*Leishmania donovani*), when these organisms are found in the pathological exudate in the feces (*see* LEISHMANIASIS).

Helminthic Dysenteries.—A dysenteric syndrome is evoked by ulceration and inflammation, and subsequently by the formation of adenopapillomata in the intestinal tract by deposition of the eggs of certain trematode worms (or flukes) of the *Bilharzia* genus, which are those known as the bilharzial dysenteries (*see* SCHISTOSOMIASIS). Of these the most important is *Bilharzia* (or *Schistosoma*) *mansoni* in Africa and South America. Two other species, *B. haematobia* and *B. japonica*, may occasionally give rise to similar phenomena. Some other trematodes may evoke dysen-

teriform symptoms of a minor degree, such as the small fluke *Heterophyes heterophyes* (in Egypt), and those which inhabit the intestinal tract, and a much larger species, *Fasciolopsis buski* (in China). Of the nematodes the most striking example is *Oesophagostomum apiostomum*, commonly found in monkeys, but rarely in man, in southern Nigeria and central Africa and on the Amazon river. These worms encyst in the mucous membrane of the large intestine, thereby giving rise to dysenteriform symptoms. A small nematode, *Strongyloides stercoralis*, which is found in most tropical countries, has been accredited, on rather slender grounds, with similar properties, although it does not appear to burrow into the mucous membrane.

This formidable list does not exhaust the known causes of dysentery. There are the various forms of colitis, which are found in civilized peoples all over the world, the exact etiology of which remains obscure. These include mucous colitis, a secretory neurosis of the large bowel, which gives rise to diarrhea with the passage of much ropy mucus and, occasionally, of blood. Membranous colitis is an exaggerated form of this disorder in which casts of the mucous membrane appear in the stools, accompanied by blood and mucus. Idiopathic ulcerative colitis (*colitis gravis*) is a very severe, and sometimes fatal, disease of the colon with the passage of blood-stained mucous discharges, eventually producing severe anemia, toxemia and death. It is mainly a disease of early adult life and is liable to remissions and sudden exacerbations. By reasons of its course and manifestations it is liable to be confused with the other forms of bacillary dysentery of which the cause is accurately known. Mercurial colitis is one of the clinical manifestations of mercurial poisoning and closely resembles the above, and a somewhat similar condition is sometimes observed in the uremic state. Other familiar disorders, such as carcinoma of the large intestine, cecum, colon or rectum, occasionally produce dysenteric symptoms long before their serious nature can be recognized. Polyposis, or multiple adenomata of the large intestine, may do the same, and simple polyps in the lower bowel may produce spasmodic contraction and passage of blood-stained mucus. Diverticulitis, a common affection of advancing age, lymphogranuloma of the rectum and Crohn's disease, or chronic cicatrizing enteritis, have also to be reckoned with. Intussusception of the small or large intestine may be associated with amoebic or bacillary dysentery, or, in small children, arise from irritation by a polyp. Submucous lipoma and Meckel's diverticulum may produce a tumour and blood and mucus in the feces. Finally, tubercular ulceration of the large intestine and septic ulceration of the rectum due to internal hemorrhoids must be included.

Bacillary Dysentery.—The bacillary dysenteries are characterized by inflammation of the mucous membrane of the large intestine and occasionally of the terminal portions of the ileum which may lead to superficial necrosis. The symptoms are provoked by efforts of the body to rid itself of the products of this destruction, together with absorption of the exotoxins elaborated by the various dysentery bacilli. Death takes place from dehydration and intoxication. The infection is spread in most tropical countries by contaminated water, food and most probably by the housefly (*Musca domestica*) in those hot countries where this insect abounds. Carriers of dysentery bacilli must also be taken into account. The healthy carrier (that is, one who excretes dysentery bacilli without having suffered from the disease) is rare, but the convalescent carrier is comparatively common. The incubation period varies from three to seven days.

The clinical course of bacillary dysentery is extremely varied and ranges from comparatively mild types to acute fulminating cases with intense toxemia, in which death takes place within two to three days. The latter type has become increasingly uncommon. In most tropical countries an explosive diarrhea attacks most newcomers and is labeled in various places by appropriate synonyms. In Egypt it is familiar as "gippy tummy" and is usually due to *Shigella sonnei*. It is a fleeting but disagreeable disorder not attended by any serious aftereffects. In the acute type of bacillary dysentery the onset is abrupt and within a few hours there is fever with a temperature of 101°–105° F. The patient suffers from severe toxemia, and dehydration soon becomes obvious. Sometimes there is vomiting. Within three or four hours violent diarrhea sets in with severe colic and straining. Blood and mucous discharges are continuous and there is usually incontinence. Abdominal pain and tenderness are severe. The colon is contracted, painful and spastic. In children the onset may be heralded by convulsions. Chronic bacillary dysentery is an extremely exhausting, debilitating disease caused by chronic ulceration of the large intestine and was a common sequel in World War I, but later became rare.

The complications of bacillary dysentery are dysenteric arthritis (which resembles rheumatoid arthritis but is of a more fleeting character), conjunctivitis, iritis, neuritis and sometimes glomerulonephritis. Occasionally there is peritonitis and massive intraperitoneal serous effusions. The disease is diagnosed by the character and appearance of the stools, the serous and blood-stained mucus, by the isolation on culture of the specific organisms in which special selective media are employed (Liefson's desoxycholate-citrate agar). As seen by microscopy the characteristic cellular exudate of the discharges, such as pus cells and large histiocytes derived from the mucosa are important. In doubtful cases sigmoidoscopy may be employed when the typical granular appearance of the mucosa is distinctive.

Treatment.—The treatment of this group was revolutionized by the introduction of special sulfonamide drugs—sulfaguanidine, sulfasuxidine and sulfadiazine. The former practice of drenching the intestinal tract by saline purgatives has been abandoned. For any severe case rest in bed is imperative; in *S. shigae* infections the heart muscle may be damaged by the potent toxins of this organism. All food should be withheld for the first 48 hours, but plentiful amounts of water should be permitted. The usual treatment involves prescribed dosages of sulfaguanidine; if a patient does not respond it is usually advisable to change over to some other sulfonamide, such as sulfasuxidine. It was formerly thought that sulfaguanidine was bacteriostatic because of poor absorption, but it is now known that absorption takes place, though slowly, so that in overdosage toxic symptoms may result. Among these are obstruction of the renal tubules by crystals, leading to suppression; various toxic rashes; and sometimes acute psychoses. If sufficient fluid cannot be absorbed by mouth, parenteral salines should be given intravenously by drip transfusion. This prevents renal blockage which is especially dangerous in hot countries. Total and differential white blood counts should be made at suitable intervals to give warning of granulocytopenia, which may complicate sulfonamide therapy. Of the antibiotics, streptomycin has been found to be the best, especially in the more chronic stages of this infection. Other antibiotics have been used in the treatment of bacillary dysentery; for example, chloromycetin (chloramphenicol) has been used successfully in Hong Kong in association with sulfaguanidine. Aureomycin and terramycin also have been found equally effective.

The patient's pain and sleeplessness should be relieved. Lavage of the lower bowel with hot saline is comforting, and suppositories containing local anesthetics relieve straining. In *S. shigae* infections antidysenteric antitoxin administered intravenously, if given within the first 24 hours, is still employed with good results. It is important that patients with subacute or chronic bacillary dysentery not be kept on semistarvation diet or they will develop evidence of hypoproteinemia. It is therefore necessary after the fifth day to provide a well-balanced, nutritious diet of high vitamin content and with a sufficiency of animal protein.

Amoebic Dysentery.—The *Endamoeba histolytica* is a protozoan which is essentially a tissue parasite and obtains its nourishment from the cells of the intestinal wall. It occurs in the human body in several stages. In the intestine, the trophozoite, or tissue-invading stage, is 20 μ to 30 μ in diameter, though *minuta* stages, 10 μ to 12 μ are often present. There is a characteristic nucleus and a labile protoplasm composed of an inner granular and an outer hyaline zone. By means of pseudopodia the parasite progresses and ingests food, mostly consisting of red blood corpuscles and tissue cells. *E. histolytica* has to be distinguished from *E. coli*, and three other species of nonpathogenic amoebae which

inhabit the intestinal tract of man.

Cyst formation takes place for the purpose of transmission from one host to another. Before this occurs all food contained in the amoeba is thrown out, a thin cyst wall is formed, and there is one large nucleus, constituting the precystic form. The cysts vary in size from 5 μ to 20 μ in diameter. They contain at first a single nucleus, which soon divides into four, the daughter nuclei separating and taking up separate positions at opposite poles. There are also in the cytoplasm chromatoid bodies and sometimes glycogen vacuoles which show up with iodine. The cysts are formed within the amoebic ulcers and are then passed out in the feces. They remain viable for some days in water and apparently in this medium are passed on to another individual. Neither precystic forms nor cysts are produced in the metastatic lesions of amoebiasis.

Amoebic dysentery is usually much more chronic and insidious than is the bacillary disease. It also occurs as an endemic or sporadic infection. The incubation period is variable: it may be 60 days or longer, but in the Chicago outbreak of 1933 it was about a week, in some instances. Apart from individuals who manifest the symptoms of dysentery, there are many others in whom the cysts appear in the feces and these are known as "carriers." In England there are a number of healthy people who harbour the cysts, though indigenous amoebic dysentery is rare. Therefore, some believe that there are two strains of *E. histolytica*. one, the large strain, being high pathogenic, the other, with low invasive powers, not being so.

The pathology of amoebic dysentery consists of ulceration of the large intestine as a result of invasion of the submucosa by *E. histolytica*. Amoebic granulomata are irregular erosions of the mucosa and formations of granulation tissue. The ulcers may be of a large size and solitary, with normal intervening mucosa, or may become confluent. Multiple small ulcers covering the whole surface are known as "sea anemone" ulcers. The ulcerations are apt to congregate at the flexures.

The clinical picture in amoebic dysentery is extremely variable. It may constitute a trivial affection or be very severe; it may be transient, or last for many years. Two chief types may be distinguished: one with insidious onset commencing with diarrhea without much general disturbance; the other more acute with abdominal pain, colic and the passage of blood-stained mucous stools. Very acute fulminating attacks are rare. As a rule three or four stools are passed in the day. Incontinence and tenesmus are uncommon. The chronic type is much commoner, and this manifests itself by frequent remissions and exacerbations with vague abdominal disturbances. There is usually tenderness and induration over the caecum in the right and over the sigmoid in the left iliac fossae. The stools are much more offensive than those passed in the bacillary dysenteries, and contain much altered blood intermingled with the fecal contents, but in the later stages are dark and fluid; solid feces with congealed blood and mucus may be passed when the process is quiescent. As a rule there is no fever, but nausea is often present. Vomiting is uncommon. The disease tends to recovery as a rule and is the outcome of the activities of the parasite and the recuperative powers of the intestine. Rare forms are those with fever and toxemia, which are probably due to secondary bacterial infection of the ulcerations. Death takes place either from perforation of the large intestine and consequent peritonitis, from intestinal hemorrhage or from gangrene of the bowel, especially at the site of the flexures. In the chronic stage, amoebic hepatitis frequently supervenes, there is a gradual loss of weight, the skin becomes dry and sallow and introspective neurasthenic manifestations make their appearance.

In amoebic dysentery there are often long periods of latency which may last a year, or even longer, and it is in these cases that liver abscess may intervene. In others the disease appears to be confined to the caecum (amoebic typhlitis) and may closely simulate appendicitis. Attention has been increasingly drawn to the "amoeboma." This is a tumour composed of hyperplastic granulation tissue occurring at different sites, in the ileocaecal region, the transverse colon, sigmoid flexure or rectum, which closely simulates a malignant growth, and is apt to appear in chronic amoebic dysentery. It may also give rise to a local intussusception which complicates the clinical picture still further. Pericolic amoebic abscesses may also form, but are rare. Complications are amoebic hepatitis (fever, leucocytosis and hepatic pain) and amoebic abscess of the liver and of the lung, rarely of brain or spleen. Amoebic abscess of the epididymis has been reported, while fistulas of the buttocks, perianal amoebic ulcers and abscesses, and similar lesions of the cervix uteri in the female have been described. Amoebic invasion of the skin, producing gangrene, is apt to occur from a pararectal abscess or from a liver-abscess sinus, or to follow on abdominal operation in a subject who is infected with *E. histolytica*. Sometimes these accidents happen in those who have never suffered from clinical amoebic dysentery but who harbour *E. histolytica* cysts in the feces.

Apart from the information to be obtained from the history of the patient and character of the stools, absolute diagnosis is founded upon the detection of *E. histolytica* in the feces. In the acute stage this is comparatively easy when the large active tissue-invading trophozoites can be recognized with ingested red blood corpuscles. They are not always evenly distributed and those portions of the stools containing blood and mucus should be selected. The examination should be conducted while the excreta are warm, since these organisms soon deteriorate and die. It is often more practicable to make scrape preparations by a special instrument (Volkmann's spoon) directly from the rectal mucosa through a proctoscope or sigmoidoscope. In the chronic stages the cysts are found in the diarrheic feces and are often present in enormous numbers, but they tend to vary from day to day and there may often be long periods during which they are absent altogether.

Sigmoidoscopy and proctoscopy are most important. By means of these instruments the characteristic ulcers may be demonstrated. These are often of a small size and superficial character. There may be small submucous hemorrhages and, in the chronic stage, minute pittings with crateriform edges giving rise to what is known as the "pigskin appearance." As a rule, amoebic lesions are visible in the lower rectum in the vicinity of Houston's valves and therefore can easily be seen through a simple proctoscope.

Treatment.—There is one drug, emetine, which is specific for amoebic dysentery. This is the alkaloid of ipecac, which destroys the parasite in very dilute solutions (1:1,000,000). In the acute stages, emetine hydrochloride is injected deeply subcutaneously. Although this method controls the acute manifestations, it does not eradicate the infection and has no effect upon *E. histolytica* cysts. For this purpose emetine bismuthous iodide is given. This compound is decomposed in the intestinal tract into bismuth sulfide and emetine is liberated on the surface of the ulcers. It is best given in enteric or gelatine-coated capsules. A dispersible form has been prepared which is very efficacious. The dose is spread over a period of 10 to 12 days. The patient should be confined to bed on a light diet and the drug should be administered at 10 P.M. No food should be taken after 6 P.M. and a sedative should be taken one-half hour before the specific drug. Another amoebicidal drug is quinoxyl (yatren) given in the form of retention enemata. The bowel should be cleansed with a 2% sodium-bicarbonate solution beforehand. Other drugs are carbarsone, stovarsol and diodoquin. The latter, another quinoxyl compound, is useful in clearing up the carrier state. Other specific drugs in the treatment of the dysenteries are atabrine (mepacrine) and chloroquine in giardiasis, paludrine in malarial dysentery, neostibosan in leishmaniasis and sodium antimony tartrate in bilharziasis. *See* also BACTERIAL AND INFECTIOUS DISEASES; PARASITOLOGY; *see* also references under "Dysentery" in the Index.

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DYSMENORRHEA, or pain on menstruation. *See* GYNECOLOGY.

DYSON, SIR FRANK WATSON (1868–1939), British astronomer and ninth astronomer royal, was in 1921 awarded the royal medal for his important investigations of the distribution and movements of stars and the bearing of these upon the structure of the stellar universe. He was born near Ashby-de-la-Zouch, Leicestershire, on Jan. 8, 1868, and was educated at Trinity college, Cambridge. In 1894 he became chief assistant at the Royal observatory, Greenwich, and in 1905 was appointed astronomer royal for Scotland. He returned to Greenwich as astronomer royal in 1910 and held that post until his retirement in 1933. He was elected fellow of the Royal society in 1901 and was knighted in 1915. His extensive observations of the spectrum of the corona and chromosphere of the sun during an eclipse were published in *Determination of Wave Length From Spectra Obtained at the Total Solar Eclipses of 1900, 1901 and 1905* (1906). His *Eclipses of the Sun and Moon* (1937), written with R. v. d. R. Woolley, who later became the 11th astronomer royal, was a standard textbook in the late 1950s. Dyson died at sea, during a voyage from Australia, on May 25, 1939. (O. J. E.)

DYSPEPSIA: *see* INDIGESTION; GASTROINTESTINAL TRACT, DISEASES OF.

DYSPROSIUM, a chemical element of the rare-earth group, is a hard and very reactive metal. It is oxidized by air and by water; below −123° C. the metal is ferromagnetic and at very low temperatures it is a super-conductor. Because of the presence of unpaired electrons the trivalent ion is strongly paramagnetic; dysprosium oxide and holmium oxide are the most powerful paramagnetic substances known.

Lecoq de Boisbaudran proved the existence of this element in 1886; it was not until 1906, however, that G. Urbain obtained a reasonably pure fraction. The name dysprosium comes from the Greek *dysprositos*, meaning "hard to get at." The element occurs in a number of minerals; those commercially important are monazite, gadolinite, euxenite, xenotime and samarskite. It also occurs in the products of atomic fission. Before the mid-1940s the element was separated by fractional crystallization; since that time commercial processes have used ion-exchange methods.

The symbol for dysprosium is Dy, the atomic number is 66 and the atomic weight is 162.50; the naturally occurring stable isotopes of mass numbers 156, 158, 160, 161, 162, 163 and 164 are known. Dysprosium behaves as a typical trivalent rare earth and forms a series of pale yellow-green compounds. The ionic radius is 0.908 Å. Solutions of Dy^{3+} are also a pale yellow-green and show sharp, discrete absorption bands in the ultraviolet and visible regions of the spectrum that may be used for quantitative analysis.

The metal has been prepared by thermoreduction of the anhydrous halides with alkali or alkaline earth metals. The melting point is in the range 1475° to 1500° C.; its density is 8.565 g. per c.c. for the hexagonal close-packed form.

Because of its high melting point and relatively high neutron cross section (about 1000 barns), dysprosium metal in the early 1960s was being considered as a material for constructing control rods for nuclear reactors. Its compounds have been used as catalysts in the oil refining industry, as components in some electronic equipment and as phosphor activators. *See* RARE EARTHS. (LD. B. A.)

DZERZHINSK, a town of Gorki *oblast* in the Russian Soviet Federated Socialist Republic of the U.S.S.R., stands on the left bank of the Oka, 18 mi. above its confluence with the Volga at Gorki, and on the Moscow-Gorki railway. Pop. (1959) 164,337. Part of the Gorki conurbation, Dzerzhinsk and its satellite townships stretch for 15 mi. along the river, amid pine woods and lakes. It is an important centre of the chemical industry, producing phosphate and nitrate fertilizers, material for artificial textiles and caustic soda. The production of building materials, engineering and flour milling are also carried on. A power station near the town operates on local peat. (R. A. F.)

DZERZHINSKI (Pol. DZIERZYNSKI), **FELIKS EDMUNDOVICH** (1877–1926), Bolshevik revolutionary, a Pole who rose to be head of the political police of the U.S.S.R., was born in Vilna on Sept. 11, 1877, the son of a country squire. He joined the Social Democratic party of Poland and Lithuania in 1895 and two years later was arrested at Kaunas and exiled to Siberia for political agitation. Escaping in 1899, he was rearrested in Warsaw in 1900, but escaped again in 1902 and went to Berlin. After he had taken part in the revolution of 1905–06 in Poland, there followed further years of exile until 1912 when he returned to Warsaw, was arrested again and sentenced to nine years' hard labour. After the Russian Revolution of March 1917 he was released and, as a member of the central committee of the Communist party and of the military revolutionary committee of the Petrograd soviet, played an important part in organizing the Bolshevik Revolution in November. In Dec. 1917 he organized the *Cheka*, the security and terror arm of the Communist party, and became its chairman, winning a reputation for fanaticism in the cause of Communist power. In July 1920, when the Red army was marching on Warsaw, he was a member of a Polish Revolutionary committee in Bialystok, intended to be the government of Poland. After 1921, at his own wish, he devoted himself mainly to economic matters, though retaining general supervision over the security and terror apparatus—renamed O.G.P.U. in 1922—in his capacity of people's commissar for internal affairs, which he had been from 1919. In 1924 he was placed at the head of the supreme economic council. He died suddenly, in Moscow, on July 20, 1926. (L. B. Sc.)

DZHAMBUL (formerly AULIE-ATA), an *oblast* and town lying in the south of the Kazakh Soviet Socialist Republic of the U.S.S.R. The *oblast* (formed 1939) consists of a narrow strip of fertile irrigated land along the foothills of the Karatau and Kirgiz mountains, and a wide strip of desert including the sandy Muyun-Kum south of the Chu river, and the clay desert of Bet-Pak-Dala to the north. The climate is continental with hot, dry summers and cold winters. Sugar beet, cotton, wheat, rice and tobacco are grown along the Chu, Talass and Assa rivers. In the drier areas cattle, sheep, horses and camels are raised. Apart from the large phosphate works built in 1945 at Chulak-Tau in the Karatau mountains, industry consists mainly of processing agricultural products.

The population, 561,546 in 1959 (359,876 rural), consists mainly of Kazakhs and Russians, with some Uzbeks, Ukrainians and Koreans. In the early 1960s there were more than 460 schools and 270 libraries in the *oblast*.

The Turksib railway traverses the *oblast* with a branch line from Dzhambul to Chulak-Tau. Lugovoi is the junction with the Frunze-Rybachye line. A new line joining the Turksib railway at Chu with the Balkhash-Karaganda line at Mointy was built during the fourth Five-Year plan (1946–50).

DZHAMBUL, the capital of the *oblast*, is one of the oldest cities of Kazakhstan. Pop. (1959) 113,346. It stands on the site of Taraz, a 5th-century city, later called Yany (or Yangi) and then Aulie-Ata. In 1933 the city was renamed Mirzoyan, and again in 1937 after the Kazakh poet D. Dzhambul (1846–1945). It has sugar-refining, fruit-canning and wool-washing plants. (G. E. WR.)

DZIERZONIOW (Ger. REICHENBACH) is a town in the Wroclaw (Breslau) *wojewodztwo* (province) of Poland. Pop. (1960) 27,000. It lies on the Pilawa (Peile) river, below the northeastern slope of the Sudetens and 48.3 km. (30 mi.) S.S.W. of Wroclaw, on the main road to Prague. It is the chief town of a district of the same name and a supply centre for an old established textile (flax and cotton) region in Lower Silesia. Heavy industry and the electrotechnical industry have also been developed there.

Tradition places Reichenbach's origin in the mid-12th century and it received town rights in the 13th century. On the division of Wroclaw principality, the town passed to the duke of Ziebice (Münsterberg), who in 1335 became a vassal of the Bohemian

king. After the period of Habsburg domination it passed in 1742, with most of Silesia, to the Prussians. In 1945, with Silesia, it returned to Poland and was renamed Dzierzoniow after the Polish patriot-priest Jan Dzierzon (1811–1906). (K. M. Wi.)

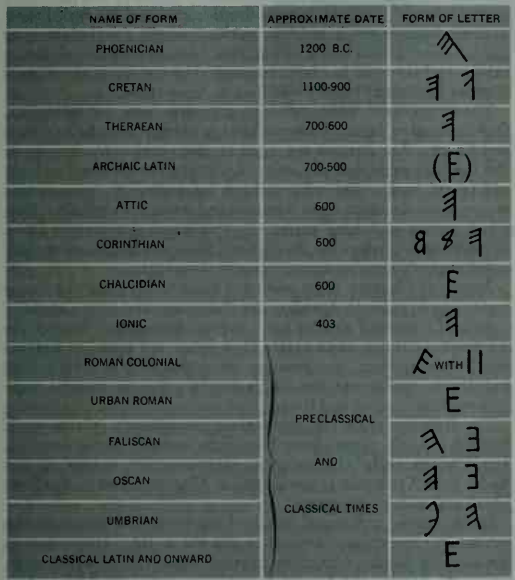
DZUNGARIA, Dsongaria or Jungaria, a former Mongolian kingdom of central Asia, raised to its highest peak by Kaldan or Bushtu Khan in the latter half of the 17th century, but completely destroyed by Chinese invasion about 1757–59. It derived its name from the Dsongars, or Songars, who were so called because they formed the left wing (*dson*, left; *gar*, hand) of the Mongolian army. Its widest limit included Kashgar, Yarkand, Khotan (*qq.v.*), the whole region of the Tien Shan (*q.v.*) and the greater proportion of that part of central Asia which extends from 35° to 50° N. and from 72° to 97° E.

Dzungaria now forms the northern part of the Sinkiang Uigur Autonomous Region (*see* Sinkiang). It is a sparsely settled semiarid area occupied mainly by non-Chinese people, most importantly the Kazakhs, Mongols, and various Muslim groups. It consists largely of a basin north of the Tien Shan, between those mountains and the Altai range, bounded by the Soviet Union on the west and by the Mongolian People's Republic on the north and east. Urumchi (Ti-hua), the chief city, is the capital of Sinkiang, and lies on the route of the railway under construction between Lan-chou and Alma-Ata. (R. M.; X.)

E THE fifth letter of the alphabet, is derived from Semitic 𐤄 (a consonant representing a sound similar to the English "h"), Greek 𐤄, 𐤅 or 𐤆, and Latin **E**. The Semitic character may have derived from an earlier pictograph representing a lattice window or a fence. Forms in use at Corinth were 𐤅 or B. The uncial form was from the 4th century A.D. rounded, Є, and the cursive form was also round, C. From these developed the Carolingian e from which the modern minuscule *e* is derived.

The sound represented by the letter was a mid front vowel corresponding, though inexactly, to the sound of English *a* in *take*. The latter is a diphthong, whereas *e* represented an unmixed vowel sound, such as that heard in French *tête* or *été*. In Greek ε stood

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	1200 B.C.	𐤄
CRETAN	1100-900	𐤄 𐤄
THERAEAN	700-600	𐤄
ARCHAIC LATIN	700-500	(𐤅)
ATTIC	600	𐤄
CORINTHIAN	600	𐤅 𐤅 𐤄
CHALCIDIAN	600	𐤅
IONIC	403	𐤄
ROMAN COLONIAL	PRECLASSICAL AND CLASSICAL TIMES	𐤆 WITH ||
URBAN ROMAN		E
FALISCAN		𐤄 𐤄
OSCAN		𐤄 𐤄
UMBRIAN		𐤄 𐤄
CLASSICAL LATIN AND ONWARD		E



THE DEVELOPMENT OF THE LETTER "E" FROM THE PHOENICIAN THROUGH CLASSICAL LATIN TO THE PRESENT FORM

for a short, close vowel as opposed to η whose sound was long and open, although in all local alphabets, especially in early times, this distinction was not exactly observed. In Attic Greek the long, close sound was expressed by ει. In the Latin alphabet the letter **E** did duty for all shades of the sound, long or short, close or open. (*See* ALPHABET.)

In English an extensive change took place in the sound of the long vowel during and after the later Middle English period (probably between the 15th and 17th centuries). Just as the sound represented by *a* moved forward till it now covers the ground of that formerly represented by *e*, so the latter moved upward, encroaching upon and occupying the territory of the sound of *i*, which became a diphthong. (For a fuller discussion of these sound changes, see the subsections on phonology in ENGLISH LANGUAGE: *Middle English* and *Modern English*.) The sound of English long *e* is now a close high front vowel, as when written double (*e.g.*, in *feed*) or when followed by a single consonant plus silent final *e* (*e.g.*, in *precede*), that of short *e* a more open and less high front vowel, as in *bed*, that has not to any great extent shifted from what may be called its original position (*cf.* the sounds of French *été* and English *bed*). When followed by *r* the sound is modified and is less high, as in *here*. In the word *there* the vowel has the same sound as that of *a* in *hare*. In many English words a mute final *e* is employed as a device to mark the fact that the preceding vowel is long, e.g., *take, wine, stone*. This occurs only when the final *e* is separated from the long vowel by a single consonant. Again, in words such as *added, rotten*, the letter represents little more than a voice glide.

In music, E is the fifth note of the musical alphabet and the third degree of the natural scale of C. Its syllabic name, employed in France and Italy, is *mi*. (J. W. P.)

EA (ENKI), the third member of the primary triad of the Sumerian pantheon, Anu and Bel (*qq.v.*) being the first and second members. His chief city was Eridu, in southern Babylonia. The name Enki means "Lord of the Earth"; *i.e.*, of the earth downward, and so of the deep. The god is mentioned on Sumerian texts of Lagash, *c.* 2400 B.C., as king of the *ab-zu* or *apsu* (fresh-water deeps) and as an oracle god. King Shulgi of Ur built a temple for Enki, and his son Amar-Sin added the *ab-zu* fresh-water basin *c.* 2000 B.C. Hammurabi, in his code, attributes his gift of understanding to Enki, whom he describes as the wisest of the gods, the all-knowing, with power to deprive men of understanding.

On Sumerian literary tablets of the 2nd millennium B.C. (but based on earlier sources) the building of the *ab-zu* temple is attributed to and was initiated by the divine Enmerkar, ruler of Erech (Uruk; modern Warka). The tablets tell how the goddess Inanna (Ishtar) goes to Eridu to ask the wise Enki how to capture one who has wronged her; and how she obtains more than 100 heavenly laws from the near-drunken god, who repents of his generosity, attempts to recover the laws but is outwitted by her messenger. These Sumerian tales present the god, as Enki, in a less pacific character than do the Semitic stories where he is Ea. The organizer of the earth is not always wise: he is on occasion foolish.

As Ea, a name written by means of two signs signifying "house" and "water," this deity was the god of the fresh water below the earth. His temple at Eridu was *é ab-zu*, house of *apsu*, the fresh-water deeps below the earth, from which it is separated by clay. Ea's membership of the divine triad derives from his rank as *shar apsi*, king of the *apsu*. Appropriately he is figured as a man covered with the body of a fish.

His works are works of beneficence to mankind. In the story of the goddess Ishtar's descent into the underworld he is described as creator god. In the deluge story he saves Utnapishtim, the Babylonian Noah. Ea's characteristic is wisdom, but this includes cunning deceit, as shown in his behaviour to Adapa in the myth of mankind's loss of immortality. He is patron of exorcists, the "sons of Eridu." His holy waters are used to purify places, priests and utensils at ceremonies of exorcism, besides houses, temples, cities and persons inhabited by evil spirits. Because sickness was thought to be devils' work, he is the god of physicians, of men who "know water," *i.e.*, the water of Ea. With his wisdom kings and craftsmen are endowed: the arts of civilization are by his grace.

The name Ea first appears in general use in theophoric names after the dynasty of Akkad (late 3rd millennium B.C.) but without the divine determinative. *See* also BABYLONIA AND ASSYRIA: *Religion;* OANNES; and references under "Ea" in the Index volume. (T. FH.)

EADS, JAMES BUCHANAN (1820–1887), U.S. engineer whose reputation rests principally on his work in deepening and fixing the channel at the mouth of the Mississippi river, was born

at Lawrenceburg, Ind., on May 23, 1820. His first engineering work involved the salvage of sunken steamers in the Mississippi, using a diving bell he invented and patented. After a brief, unsuccessful venture in a glassworks at St. Louis, Mo., he returned to salvage work. Upon the outbreak of the American Civil War, he submitted to the U.S. government a bold proposal to construct, within 65 days, seven 600-ton gunboats, steam-powered and armour-plated; the first of these actually was completed in 45 days and the rest soon thereafter. During the war Eads built or converted a total of 25 vessels that saw service on the Mississippi and its tributaries and in the Gulf of Mexico. His next important engineering achievement was the construction of the great steel arch bridge across the Mississippi at St. Louis (1867–74); the specifications—for a 520-ft. clear span and 50-ft. clearance—were pronounced impractical by many of the leading civil engineers of the time.

Among engineers, Eads is best known for opening and maintaining a ship channel at the mouth of the Mississippi. By means of an ingenious system of jetties that redirected and accelerated the current, the river was made to scour its own channel and deposit its load of silt at sea. Shortly before his death, Eads proposed a scheme for a ship railway across the isthmus of Tehuantepec, opposing the proponents of the Panama canal. He died at Nassau, in the Bahamas, on March 8, 1887.

EAGLE, any of several large day-flying birds of prey which along with hawks, harriers and old-world vultures comprise the family Accipitridae. Eagles belong to the subfamily Buteoninae, typified by the European buzzards and large American hawks (*Buteo*); they are distinguished from others of the subfamily by their large, strongly hooked beak, great talons and keen vision. They range throughout the world, and are famous for their powerful, stately flight.

Since ancient times eagles have been used as symbols of empire, of courage, of military prowess. Their likeness is found on Greek and Roman ruins, coins and medals. The bald eagle (*see* below) was adopted as the emblem of the United States, probably because of the ancient usage of the symbol and also because of the bird's magnificent majesty in flight—an almost effortless mastery of the air.

GEORGE M. BRADT FROM NATIONAL AUDUBON SOCIETY

GOLDEN EAGLE (AQUILA CHRYSAËTOS), IN JUVENAL PLUMAGE

The typical eagles (*Aquila*) include species with "booted" legs, feathered to the toes. The best known is the golden eagle (*A. chrysaëtos*), inhabiting mountainous or rocky regions of North America, Europe and Asia. They build a large nest of sticks on cliffs or tall trees, returning year after year to lay one to four large white eggs mottled with brown. The young, clad in white down, assume the dark brown juvenal plumage after ten weeks, and molt annually until the adult golden brown is acquired at four years. Kirghiz Tatars used the golden eagle to capture antelopes; but in Europe, during the height of falconry, it was flown only by kings. (*See* FALCONRY.)

Of eight geographic races, the typical form is found in Europe, another (*A. c. fulva*) breeds in Scotland and the Hebrides, while a third (*A. c. canadensis*) is familiar in North America from Alaska and northeastern Canada south in the Appalachians to North Carolina, Tennessee and central Mexico, especially in the western mountains. Other races are found in Spain, northwest Africa and Asia. Related species include the spotted eagle (*A. clanga*) and the imperial eagle (*A. heliaca*), southern Europe to China; the tawny eagle (*A. rapax*), Africa and India; and several smaller species in Asia, Africa and eastern Europe.

The sea eagles (*Haliaeetus*) range across all continents except South America, and may be distinguished from typical eagles by the naked lower leg. They generally eat fish, and are largely robbers and scavengers. Of the eight species, the noble-looking bald eagle (*H. leucocephalus*), is confined to North America. The bald eagle is not in fact bald; the name derives from the conspicuous appearance of its white-feathered head. The typical race breeds in the southern United States and northern Mexico, while a larger form (*H. l. alascanus*) occurs from Connecticut, the Great Lakes and Washington to northern Canada and Alaska. The nest is a large tangle of sticks atop a large tree or pinnacle of rock, within easy flight of sea, lake or stream; one to three eggs hatch in 35 days, both parents sharing incubation and care of young. The smoky gray down is replaced by dark brown juvenal plumage in about eight weeks, and the pure white head and tail are assumed in the fourth year. Because of its fish-eating habits the bald eagle has been considered an enemy of the salmon fisheries in Alaska; bounty was long in force there.

CY LA TOUR

BALD EAGLE (HALIAEETUS LEUCOCEPHALUS)

The magnificent white-tailed or gray sea eagle (*H. albicilla*), from Iceland to Japan, formerly bred in the northern British Isles and Egypt. The African sea eagle or river eagle (*H. vocifer*) is like the bald eagle, but the white of the head extends over breast and upper back. The white-bellied sea eagle (*H. leucogaster*) occurs in southeastern Asia, Australia and western Polynesia. Two allied species of fishing eagles (*Icthyophaga*) range from India through the Malays to the Philippines, while the large dark wedge-tailed eagle (*Uroaëtus audax*) lives in Australia.

Among the largest, most powerful birds of prey are the harpy eagles (*q.v.*), in South America, the Philippines and New Guinea.

Several species of smaller hawk eagles (*Hieraaetus*) inhabit the old world. Crested hawk eagles (*Spizaëtus*) are found in Central and South America, southeastern Asia, the Malays, Philippines and Japan; and several genera, including the large martial eagle (*Polemaëtus*), occur in Africa.

The Brazilian eagle (*Hypomorphnus urubitinga*), a large black buzzard or hawk, ranges from Mexico to southern South America. The Chilean eagle (*Geranoaetus melanoleucus*) occurs in the Andes from Venezuela to the Straits of Magellan, east to southern Brazil and eastern Argentina.

Quite unusual are several smaller birds of prey belonging to the subfamily Circaetinae, confined to the old world. These include the amazing batlike, bob-tailed bateleur eagle (*Terathopius ecaudatus*) of Africa; the harrier eagles (*Circaëtus*) of Africa, Asia and southern Europe; and the serpent eagles of southeastern Asia and the Malays and Philippines (*Spilornis*), central Africa (*Dryotriorchis*) and Madagascar (*Eutriorchis*).

One old world species of vulturelike bird has been called eagle, its feathered head being quite different from the naked heads of vultures. This is the vulturine fish eagle (*Gypohierax angolensis*), a striking white and black bird of central west Africa. Intermediate between eagles and vultures is the so-called bearded vulture or lammergeier (*q.v.*), now considered to be a giant kite. Any large bird of prey is likely to be called an eagle in a loose way; for example, one large owl of the old world is often called "eagle owl" (*q.v.*).

(G. F. Ss.; Ht. Fn.)

EAGLE OWL (*Bubo bubo*), an owl inhabiting Europe and Asia, though only a straggler in most of Great Britain, and characterized by its large size (often 26–28 in. long), two tufts of feathers on the head and large orange eyes. The over-all coloration is tawny, mottled with brown, lighter below. The eagle owl roosts and breeds within rocky niches and hollow trees. From the vantage of a nearby branch this twilight hunter perches while he surveys his territory in search of prey, mainly

rodents, hares, rabbits and large game birds. It is allied to the great horned owl (*q.v.; B. virginianus*) of North America, but is larger.

JOHN MARINUS FROM NATIONAL AUDUBON SOCIETY

EAGLE OWL (BUBO BUBO), ONE OF THE LARGEST OWLS

EAKER, IRA CLARENCE (1896–), U.S. army officer, strategic air commander in Europe during World War II, was born in Llano county, Tex., on April 13, 1896. He entered the air service during World War I and during the next two decades became one of the U.S. army's outstanding pilots. Eaker led 12 B-17 Flying Fortresses in the first U.S. bombing attack against western Europe on Aug. 17, 1942. As commander of the 8th air force in England, he went to the Casablanca conference in Jan. 1943 and persuaded Winston Churchill and Franklin D. Roosevelt to give daylight bombardment a thorough trial rather than abandon it as had been recommended. Round-the-clock bombing of Germany was developed in concert with the Royal Air Force, which bombed by night. In 1944 Eaker moved to Italy and took command of the Mediterranean Allied air forces, including the U.S. 15th air force, which waged the strategic air offensive against Germany and the Balkans from bases in Italy. He was promoted lieutenant general in 1943 and retired in Aug. 1947. (A. Gc.)

EAKINS, THOMAS (1844–1916), U.S. painter, considered one of the supreme masters of American art, was born at Philadelphia, Pa., on July 25, 1844. At the École des Beaux-Arts in Paris he studied with Léon Bonnat and Augustin Dumont and was the favourite pupil of Jean Gérôme. Later he studied in Spain. Returning to Philadelphia in 1870, he opened his own studio and studied anatomy at the Jefferson Medical college. In 1873 he began to teach at the Pennsylvania Academy of Fine Arts, where he eventually succeeded in transforming the entire course of study, particularly emphasizing the scientific study of anatomy and perspective. He performed many experiments in the photography of motion. In 1886 he was dismissed after he undraped a male model before a mixed class, the culminating incident of a series in which his teaching fervour offended prudish tastes.

A large canvas, "The Gross Clinic," completed in 1875, has sometimes been called Eakins' masterpiece. It contains life-sized figures and portrays the demonstration of a surgical operation to a group of medical students. He did another medical group, "The Agnew Clinic," in 1889.

Eakins executed several pieces of sculpture. With his pupil Samuel Murray (1870–1941) he modeled the heroic "Prophets" for the Witherspoon building, Philadelphia. There is a sculptural quality in his painting and it was not unusual for him to make studies in clay for them. He experimented in many directions. Among his sporting subjects are "Max Schmitt in a Single Scull" (1871) and "Between Rounds" (1899). "The Fairman Rogers Four-in-Hand" (1879) demonstrates the meticulous study that he devoted to a composition. His genius for penetrating, uncompromising character analysis that sometimes offended his sitters can be seen in his many figure studies and portraits.

Eakins died in Philadelphia on June 25, 1916. In his last years he began to receive some recognition, but it was not until after his death that his real stature was appreciated.

See L. Goodrich, *Thomas Eakins, His Life and Work* (1933).

EALING, a municipal borough (1901) of Middlesex, Eng., which under the London Government Act 1963 was to be joined on April 1, 1965, to Acton and Southall to form the new London borough of Ealing (*see* LONDON). Ealing municipal borough had a population (1961) of 183,077 and an area of 13.7 sq.mi. The parliamentary constituencies are Ealing North and South.

Roman remains have been found, and the Saxon Gillingas who were in the area by the 8th century gave Ealing its name. Hanwell and Greenford (including Perivale) urban districts were added in 1926 and Northolt in 1928. The area, though largely residential, has many industries, producing scientific instruments, foodstuffs, pharmaceutical products, plastics, glass, silk thread, wallpaper, vacuum cleaners, engineering appliances, etc. The borough has a technical college and an art school. The open spaces include the ancient common (47 ac.); Walpole park (30 ac.), where Pitshanger manor house contains the central library; and Gunnersbury park (186 ac.), the former estate of the Rothschild family purchased in 1925 and shared by Ealing, Acton, and Brentford and Chiswick councils. Gunnersbury house in the park is a local history museum. Famous names associated with Ealing include John Henry Cardinal Newman and Bishop G. A. Selwyn who were educated at Great Ealing school; William Makepeace Thackeray who went to a private school there; Louis Philippe, later king of France, who taught at Great Ealing school; and Spencer Perceval, the prime minister. At Hanwell is a railway viaduct built by I. K. Brunel, at Perivale a tiny timber-spired church dating to the 12th century, at Greenford a church with a 12th-century structure on the tower and at Northolt an ancient village green and church.

EAR, ANATOMY OF. The ear of vertebrates is the organ in which are centred the senses of hearing and equilibrium. This article is concerned mainly with the structure and functions of the vertebrate organ, especially the human ear; for a discussion of invertebrate "ears" and the physiology and evolution of hearing *see* HEARING. The human ear is divided into three parts—external, middle and internal.

External Ear.—The external ear consists of the fleshy, cartilaginous outer flap (auricle or pinna) and the opening and its inwardly directed tube (external auditory meatus) (fig. 1). The auricle is formed by a yellow fibrocartilage covered by skin. Round the margin in its upper three-quarters is a rim called the helix, in which is often seen a little prominence known as Darwin's tubercle, representing the folded-over apex of the ear of a prick-eared ancestor. Concentric with the helix and nearer to the meatus is the antihelix, which, above, divides into two ridges. Surrounded by the antihelix is a deep pit known as the concha, from whose anterior part the external meatus passes inward into the skull. Overlapping the meatus in front is a flap called the tragus, and below and behind the meatus another small flap, the antitragus. The lower part of the auricle is the lobule, which contains no cartilage. The auricle can be moved slightly (or considerably in some persons) by the anterior, superior and posterior auricular muscles.

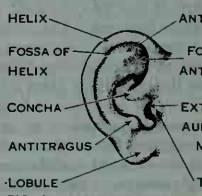
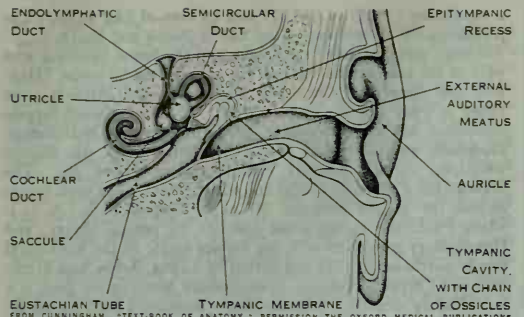


FIG. 1.—STRUCTURE OF THE OUTER EAR

The external auditory meatus is a tube about an inch long, its outer third being cartilaginous and its inner two-thirds bony. It is lined in its whole length by skin, the sweat glands of which are modified to secrete a waxlike substance, cerumen. Internally the meatus is closed by the tympanic membrane or drumskin, the eardrum.

Middle Ear.—The middle ear, or tympanum (fig. 2), is a small cavity in the temporal bone. From it the Eustachian tube runs forward, inward and downward to open into the nasopharynx, thus admitting air into the cavity. From the upper part of the posterior wall of the middle ear an opening leads backward into the air cells of the mastoid process. Lower down is a little pyramid that contains the stapedial muscle, and at the base of this is a small opening that allows passage of the chorda tympani branch of the facial nerve.

The roof of the tympanum is formed by a very thin plate of bone which separates the cavity from the middle depression (fossa) of the skull. Below the roof the upper part of the tym-



FROM CUNNINGHAM, "TEXT-BOOK OF ANATOMY," PERMISSION THE OXFORD MEDICAL PUBLICATIONS

FIG. 2.—DIAGRAMMATIC VIEW OF THE ORGAN OF HEARING, SHOWING THE RELATIONS OF THE EXTERNAL, THE MIDDLE AND THE INTERNAL EAR

panum is somewhat constricted off from the rest, and to this part the term "attic" is often applied. The floor is a mere groove formed by the meeting of the external and internal walls. The outer wall is largely occupied by the tympanic membrane (fig. 2), which entirely separates the middle ear from the external auditory meatus; this membrane is circular and so placed that it slopes downward and inward from above, and forward and inward from behind. Externally the tympanic membrane is lined by skin, internally by mucous membrane; between these two layers is a firm fibrous tissue, convex inward about its centre to form the umbo, or navel.

The inner wall of the middle ear cavity shows a promontory caused by the spiral-shaped cochlea and grooved by the tympanic plexus of nerves. Above and behind the inner wall is the oval window; below and behind is the round window, closed by a membrane. Curving round above and behind the promontory and windows is a ridge caused by the Fallopian aqueduct or canal, which carries the facial nerve.

The whole tympanum is about half an inch long from front to back and half an inch high; it is spanned from side to side by three small bones (ossicles), of which the hammer is external. The hammer is attached by its handle to the navel of the tympanic membrane, whereas its head lies in the attic and articulates posteriorly with the upper part of the next small bone, the anvil. The long projection of the anvil runs downward and ends in a lens-shaped nodule that is jointed to the stapes, or stirrup bone. The two branches of the stirrup are anterior and posterior, whereas its footplate fits into the oval window to which it is bound by the annular ligament. The stirrup thus lies nearly at right angles to the long process of the anvil. Bony processes of the hammer and anvil articulating respectively with the anterior and posterior walls of the tympanum form a fulcrum by which the lever action of the hammer and anvil is brought about. When the handle of the hammer is pushed in by the tympanic membrane, the head moves out; the top of the anvil, attached to it, also moves out; and the lens-shaped nodule moves in, pressing the stirrup into the oval window. Two minute muscles—stapedial and tensor tympani—modify the movements of the ossicles.

The mucous membrane lining the middle ear is continuous through the Eustachian tube with that of the nasopharynx and is reflected onto the ossicles, muscles and chorda tympani nerve. It is covered with minute, hairlike cilia except where it covers the tympanic membrane, ossicles and promontory; here it is stratified.

Internal Ear.—The internal ear, or labyrinth, consists of a bony and a membranous part, the latter contained in the former.

Bony Labyrinth.—The bony labyrinth is composed of the vestibule, the semicircular canals and the cochlea. The vestibule lies just internal to the rear part of the tympanum, and there would be a communication between the two, through the oval window, except that the footplate of the stirrup blocks the way. The inner wall of the vestibule is separated from the bottom of the internal auditory meatus by a plate of bone pierced by many minute passages for branches of the auditory nerve. At the lower part of this wall is the opening of the vestibular aqueduct, by means of which a communication is established with the rear cranial fossa. At the rear the three semicircular canals open into the vestibule; of these canals the external has two independent openings, but the superior and posterior join together at one end and open separately at their other ends. One end of each canal is dilated to form an ampulla. The superior semicircular canal is vertical, and the two pillars of its arch are nearly external and internal. The external canal is horizontal, its two pillars being anterior and posterior. The convexity of the arch of the posterior canal is backward, and its two pillars are superior and inferior. Anteriorly the vestibule leads into the cochlea (fig. 2, 3), which is twisted 2½ times round a central pillar called the modiolus—the whole cochlea forming a rounded cone something like the shell of a snail, though it is only about five millimetres from base to apex. Projecting from the modiolus is a horizontal bony plate, the shelflike osseous, or bony spiral lamina, which runs round the modiolus from base to apex; it stretches nearly halfway across the canal of the cochlea and carries branches of the auditory nerve.

Membranous Labyrinth.—The membranous labyrinth lies in the bony labyrinth but does not fill it; between the two is the fluid called perilymph, whereas inside the membranous labyrinth is the endolymph. In the bony vestibule lie two membranous vesicles, one of which, the saccule (fig. 3), is in front, and the other, the utricle, behind; each has a special patch of sensory epithelium called macula to which twigs of the auditory nerve are supplied, terminating around specialized sensory hair cells.

Attached to the maculae are crystals of carbonate of lime called otoconia. The membranous semicircular canals are very much smaller in section than the bony; in the ampulla of each is a ridge, called crista acustica, made up of modified epithelium containing sensory hair cells resembling those in the maculae. All the canals open into the utricle.

From the lower part of the saccule runs a small canal called the endolymphatic duct. Anteriorly the saccule communicates with the membranous cochlea, or scala media, by a short connecting duct.

A section cut through each turn of the cochlea shows the bony spiral lamina which is continued right across the canal by the basilar membrane, thereby cutting the canal into an upper and lower half, and connected with the outer wall by the strong spiral ligament. Near the free end of the spiral lamina the membrane of Reissner is attached and runs outward and upward to the outer wall, taking a triangular slice out of the upper half.

Three canals may be seen in section: the upper is the scala vestibuli; the middle, or scala media, is the cochlear duct or true membranous cochlea; and the lower, the scala tympani. The scala vestibuli and scala tympani communicate at the apex of the cochlea, so that the perilymph can pass from one canal to the other. At the base of the cochlea the perilymph in the scala vestibuli is continuous with that in the vestibule, but that in the scala tympani bathes the inner surface of the membrane stretched across the round window and also communicates with the subarachnoid space (the space between the inner and middle layers of the meninges, covering the brain) through the cochlear aqueduct, which opens into the posterior cranial fossa. The scala media, containing endolymph, communicates with the saccule through the connecting canal of Hensen, while, at the apex of the cochlea, it ends blindly.

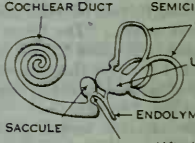


FIG. 3.—DIAGRAM OF THE DIFFERENT PARTS OF THE MEMBRANOUS LABYRINTH

The scala media contains the essential organ of hearing, the organ of Corti, which lies upon the vestibular side of the basilar membrane; it consists of a tunnel bounded on each side by the inner and outer rods of Corti; on each side of these are the inner and outer hair cells, between the latter of which are found the supporting cells of Deiters. Most externally are the large cells of Hensen. A delicate membrane called the reticular lamina covers

the top of all these and is pierced by the hairs of the hair cells, while above this is the loose tectorial membrane attached to the periosteum of the spiral lamina, near its tip, internally, and possibly to some of Deiters' cells externally. The fibres of the cochlear, or auditory, nerve enter the spiral lamina from the spiral ganglion and are distributed to the inner and outer hair cells.

Function of the Ear.—*Equilibrium.*—Originally the function of the ear was to preserve the proper position of the body in space, or balance. (*See* EQUILIBRIUM, ANIMAL.) This is still the principal and, in most species of the low vertebrates such as fishes, the only function. The maintenance of the body balance through the appropriate reflex reactions of the bodily muscles and those of the eyes is, then, the function of the vestibular apparatus, in particular of the utricle and the semicircular ducts.

Part of the labyrinth, the saccule, apparently responds to the sound vibrations, as in certain fishes. In the terrestrial vertebrates the auditory function becomes firmly established and increases in importance, culminating in the birds and mammals. The vestibule, in its own right, undergoes a further parallel development and perfection necessitated by the varied and more specialized use of the limbs in land animals.

Hearing.—The function of the auditory system in the proper sense is to react to the sound vibrations. Ordinarily the bulk of the sound vibrations is caught by the external mobile flaps called auricles, or pinnae, and less so by applying directly to the skull and the body. From the auricle the vibrations enter the external auditory meatus, passing over to the tympanic, or eardrum, membrane and finally to the chain of auditory ossicles. These latter act as an elastic bridge along which the sound is transmitted to the stirrup's footplate elastically fitted into the oval window. The other opening, the round window, is in turn closed off by an elastic secondary tympanic membrane. The perilymphatic fluid filling the rigid bony labyrinth, because of its incompressibility, has only one exit (the round window) by which it may give way whenever the footplate of the stirrup is pushed in, or is sucked in when the footplate is pulled out. The oscillatory movements thus caused pass through the two scalae of the bony cochlea, taking a short cut through one or the other segment of the basilar membrane, closer to the base in the sounds of high pitch and nearer the apex of the cochlea in low-pitched sounds. The remaining sound vibrations pass through the intermediate segments.

Comparative Anatomy.—*Fishes.*—The ectodermal invagination of the internal ear has probably a common origin with the organs of the lateral line of fishes. In the lower fishes the endolymphatic duct retains its communication with the exterior on the dorsum of the head, and in some elasmobranchs the opening is wide enough to allow the passage of particles of sand into the saccule. In certain bony fishes (Teleostei) the swim bladder forms a secondary communication with the internal ear by means of special ossicles. Among the lampreys and hagfishes (Cyclostomata) the external semicircular canals are wanting; *Petromyzon* has the superior and posterior only, whereas in *Myxine* these two appear to be fused.

In higher fishes the three canals are constant. Concretions of carbonate of lime are present in the internal ears of almost all vertebrates; when these are very small they are called otoconia, but when, as in most of the teleostean fishes, they form huge concretions, they are spoken of as otoliths. One shark, *Squatina*, has sand instead of otoconia. The utricle, saccule, semicircular canals, endolymphatic duct and a short lagena are the only parts of the ear present in fishes.

Amphibians.—The Amphibia have an important sensory area at the base of the lagena; it is probably the first rudiment of a true cochlea. The endolymphatic duct has lost its communication with the skin, but it is frequently prolonged into the skull and along the spinal canal, from which it protrudes—through the intevertebral foramina—bulging into the coelom. This is the case in the common frog. In this class the tympanum and Eustachian tube are first developed; the tympanic membrane lies flush with the skin of the side of the head, and the sound waves are transmitted from it to the internal ear by a single bony rod—the columella.

Reptiles.—In the Reptilia the internal ear passes through a great range of development. In the turtles and snakes the cochlea is as rudimentary as in the Amphibia, but in the higher forms (Crocodilia) there is a lengthened and slightly twisted cochlea, at the end of which the lagena forms a minute terminal appendage. At the same time indications of the scala tympani and vestibuli appear. As in the Amphibia the endolymphatic duct sometimes extends into the cranial cavity and on into other parts of the body. Snakes have no tympanic membrane.

Birds.—In the birds the cochlea resembles that of the crocodiles, but the posterior semicircular canal is above the superior where they join. In certain lizards and birds (owls) a small fold of skin represents an external ear.

Mammals.—In monotremes the internal ear is reptilian, but above them the mammals always have a spirally twisted cochlea, the number of turns varying from one and a half in the whales to nearly five in the rodent *Coelogenys*. The lagena is reduced to a mere vestige. The organ of Corti is peculiar to mammals, and the single columella of the middle ear is replaced by the three ossicles already described. In some mammals, especially Carnivora, the middle ear is enlarged to form the tympanic bulla, but the mastoid cells are peculiar to man.

Embryology.—The auricle is formed from six tubercles that appear around the first pharyngeal groove, or gill cleft. Those for the tragus and anterior part of the helix belong to the first, or mandibular, arch, while those for the antitragus, antihelix and lobule come from the second, or hyoid, arch. The tubercle for the helix is dorsal to the end of the cleft where the two arches join. The external auditory meatus, tympanum and Eustachian tube are remains of the hyomandibular cleft, the tympanic membrane being a remnant of the cleft membrane and therefore lined by ectoderm outside and entoderm inside. The auditory ossicles are modified bones of the visceral skeleton of lower vertebrates (*e.g.*, fishes, etc.). The internal ear first appears as a pit from the cephalic ectoderm, the mouth of which in mammals closes up to leave a pear-shaped cavity. The lower part of the vesicle grows forward and becomes the cochlea, while from the upper part three hollow circular plates grow out, the central parts of which disappear, leaving the margin as the semicircular canals. Subsequently, constrictions appear in the vesicle marking off the saccule and utricle. From the surrounding mesoderm the petrous bone is formed by a process of chondrification and ossification.

See also DEAFNESS AND IMPAIRED HEARING; EQUILIBRIUM, ANIMAL; HEARING; SOUND; and references under "Ear, Anatomy of" in the Index volume.

(S. L. PK.; X.)

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EAR, DISEASES OF. The ear is a complex organ of hearing and balance. Any disease that affects the ear may disturb these two vital functions. For a discussion of the structure of the ear, *see* EAR, ANATOMY OF. For a discussion of the hearing process, *see* HEARING.

Diseases of the External Ear.—*Injury (Trauma).*—Injury to the auricle or external ear may cause a blood blister or an infection. Scar tissue may then develop and produce a permanent deformity; a common example of this is the cauliflower ear seen in professional boxers and wrestlers.

Itching Ears (Otitis Externa).—This affliction is very annoying and is usually present in allergic persons who possess a sensitive skin (lining) of the ear canal. The skin may be dry and scaly or it may be moist and weepy in these cases. Scratching the ear and applying soap and water to it should be avoided if relief is to be obtained.

Boils (Furunculosis).—Infection develops occasionally in the skin of the ear canal, resulting in localized swelling and severe pain. These cases respond readily to medical care. Lancing of the localized abscess is sometimes necessary to obtain relief.

Wax (*Ceruminosis*).—Wax is secreted by cerumen glands in the skin of the external canal. An excessive amount of wax may obstruct the ear canal, causing a sensation of fullness and a hearing impairment. These symptoms are relieved by having a physician remove the wax.

Diseases of the Middle Ear.—*Eardrum Injury.*—The delicate eardrum membrane is easily perforated by direct trauma or by concussion such as may be created by a gentle slap of the hand over the ear canal. Sharp pain followed by a sensation of fullness and a hearing impairment characterize this injury. Perforations due to injury usually heal spontaneously with relief of all symptoms unless infection develops. Immediately following injuries of this type, blowing of the nose and introduction of water into the ear should be avoided until healing has occurred.

Middle Ear Infection (*Otitis Media*).—Acute otitis media usually follows a cold. The infection spreads from the nose to the middle ear through the Eustachian tube. Constant and severe pain in the affected ear, a sensation of fullness, fever and a hearing impairment characterize this condition.

Chronic otitis media develops following acute otitis media and occurs when the bone of the middle ear becomes involved in the infection. This disease is characterized by persistent discharge from the ear through an eardrum perforation and is associated with a hearing impairment. The discharge may be intermittent or constant and often has a foul odour. Chronic ear disease may respond to local and general treatment. Surgical removal of the infected bone, however, is often necessary to eradicate the infection.

Rather serious complications occasionally develop from otitis media. Such complications include mastoid disease, extension of the infection into the inner ear with further loss of hearing, and impaired balance. At times even the brain area can be involved.

The danger signs of middle ear disease include persistent pain in the ear region and/or balance difficulties. If either or both of these symptoms develop, a physician should be consulted.

Fluid in the Middle Ear (*Serous Otitis Media*).—This condition usually develops when the Eustachian tube is blocked because of allergic swelling. Fluid accumulates in the middle ear without evidence of infection. This disease is characterized by a feeling of fullness in the ear and a mild hearing impairment. Treatment consists of lancing the eardrum and releasing the fluid. The underlying cause of the allergy must be corrected if relief is to be permanent.

Facial Nerve Paralysis (*Bell's Palsy*).—The seventh cranial (facial) nerve enervates the muscles of facial expression. Any interference with the function of this nerve produces a facial paralysis. The nerve may be injured by trauma but the most common cause of facial paralysis is Bell's palsy. The palsy develops because of swelling of the facial nerve as it passes through its bony canal in the ear. Usually the swelling is temporary, but occasionally it may be permanent. If the function of the face does not return spontaneously within three or four weeks, surgical decompression of the nerve to relieve the swelling may be necessary to prevent permanent paralysis.

Otosclerosis (*Hardening of the Ear Bones*).—Otosclerosis is a hereditary type of hardening of the bone in the stapes (stirrup) area. It is the most common type of conduction hearing impairment in the young adult, is usually bilateral, slowly progressive and occurs more frequently in women than in men. As the bone continues to harden, the condition may involve the hearing portion of the inner ear and result in a nerve type of hearing impairment. No medical treatment will benefit this condition, but surgery will often restore serviceable hearing.

Diseases of the Inner Ear.—*Dizziness* (*Vertigo*).—Although many physiological conditions may produce dizziness, the most common cause is disturbances in the inner ear mechanism.

Ménière's disease (*q.v.*) is due to disturbances in the fluid pressure in the inner ear mechanism. It is characterized by acute attacks of dizziness, often associated with nausea and vomiting, together with hearing impairment and head noise (tinnitus). Treatment is aimed at controlling the fluid pressure changes in the inner ear mechanism.

Labyrinthitis (inflammation of the inner ear) is usually caused by the extension of an infection from the middle ear area. It is characterized by sudden and total loss of hearing, severe balance disturbances associated with nausea and vomiting, and frequently by severe head noise. Treatment is directed toward controlling the infection in the middle ear as well as the inner ear. Such a condition often necessitates surgical drainage of the involved region.

Hemorrhage (*Vascular Disturbances*).—The blood vessels that supply the inner ear mechanism are very tiny and delicate. Any spasm or rupture of these blood vessels interferes with nutrition to the inner ear. As a result, hearing may be lost suddenly, with associated severe head noise and often by loss of balance. Early intensive medical treatment may restore total inner ear function but often there is some permanent loss of hearing in these cases.

Growths (*Tumours*).—Growths may develop in the middle and inner ear regions. The development of such tumours is characterized by gradual loss of hearing, head noise, dizziness, facial weakness and, later head pain. Treatment of this condition usually requires surgical removal of the growth.

Head Injuries With or Without Skull Fracture may cause inner ear damage, which in such cases is characterized by loss of hearing, head noise and balance disturbances. Occasionally the facial nerve may also be injured, resulting in facial weakness.

Head Noise (*Tinnitus*).—Ringing or buzzing in the ear is common and may be due to irritation of the hearing nerve (eighth cranial nerve) as well as to other inner ear trouble as described above. This irritation may be due to infection (neuritis), pressure on the nerve or inadequate circulation.

See also DEAFNESS AND IMPAIRED HEARING; VERTIGO AND DIZZINESS; EQUILIBRIUM, ANIMAL; MASTOIDITIS. (H. P. Ho.)

EAR, NOSE AND THROAT, DISEASES OF. The human ear, nose and throat have such an intimate relationship by virtue of their location and function that they are usually considered together for purposes of medical training and practice. The ear is connected with the nasopharynx by the Eustachian tube (*see* EAR, ANATOMY OF). Consequently, certain diseases of the nose and throat may spread to and affect the ear. The nose and throat are parts of the respiratory and digestive systems. Because of this, the diagnosis and treatment of all types of diseases, including tumours, and the handling of foreign bodies in the lower digestive and respiratory tracts are included in dealing with diseases of the ear, nose and throat. A physician trained in diseases of the ear, nose and throat was once known as an otorhinolaryngologist but the term was later shortened to otolaryngologist.

The ears, nose and throat are of particular interest because they include some of the special senses such as hearing, equilibrium, taste and smell.

See EAR, DISEASES OF; NOSE, DISEASES OF; THROAT, DISEASES OF; EQUILIBRIUM, ANIMAL. (D. M. L.)

EARHART, AMELIA (1898–1937), U.S. aviation pioneer, was born in Atchison, Kan., on July 24, 1898. Her career ended in an unknown spot in the Pacific ocean early in July 1937. Amelia Earhart, after a tour of duty as a military nurse in Canada during World War I and several years of social work in Denison house, Boston, Mass., learned to fly, against the wishes of her family. She achieved fame as the first woman to cross the Atlantic by air when, on June 17–18, 1928, she crossed as a passenger from Newfoundland to Wales in a trimotored Fokker monoplane, with W. Stutz and L. E. Gordon. Four years later (May 20–21, 1932) she made a solo Atlantic crossing and subsequently made a number of solo long-distance flights across the United States both by airplane and by Autogiro. In the early 1930s she took great interest in the development of commercial aviation in the United States. For a time she served as an officer of the Luddington line, which operated one of the first regular passenger services between New York city and Washington, D.C. In Jan. 1935 she made a solo Pacific crossing from Hawaii to California. In 1937, accompanied by Lieut. Comdr. Fred Noonan, she attempted a round-the-world trip in a twin-engined Lockheed. After negotiating over two-thirds of the distance safely, the plane vanished in the vicinity of Howland Island in the South Pacific on July 2. Miss Earhart married the

publisher George Palmer Putnam in 1931, but continued her aviation career under her maiden name. Her biography, *Soaring Wings*, was written by her husband in 1939.

(S. P. J.)

EARL (corresponding to Lat. *comes;* Fr. *comte*), a title and rank of nobility in the British peerage which, while it confers no official power or authority, is inalienable, indivisible and descends in regular succession to all the heirs under the limitation in the grant until, on their failure, it becomes extinct. Earl is the oldest title and rank of English nobles, and was also the highest until 1337 when Edward the Black Prince was created duke of Cornwall by Edward III. It now stands third in precedence, between marquess (1385) and viscount (1440).

The title is of Scandinavian origin and first appeared in England under Canute (1016–35) as jarl, of which the Anglo-Saxon version was eorl. The eorl, as a great royal officer, superseded the ealdorman and was sometimes set over several counties, in the courts of each of which he presided with the bishop of the diocese. After the Norman Conquest his sphere was restricted to a single county and his official duties soon came to be performed by the sheriff, a position he himself might often hold. But the earl was in general still entitled to the "third penny," a third of the profits of justice in the shire court. In the two great palatinate earldoms of Chester and Durham the earl and bishop respectively possessed regalia, special royal privileges; they had their own courts and exercised their own jurisdiction. The earl's hereditary position was strengthened by the system of feudal tenure, under which he was also a tenant in chief, holding estates of the crown. His fief would descend to the heirs of his body, and the earliest charters creating earldoms, such as that (the first known) by which Stephen bestowed on Geoffrey de Mandeville the earldom of Essex (*c.* 1140), were granted with the same limitations. The dignity might thus descend to a woman, and in that case, like the territorial fief, it would be held by her husband in right of a wife. The earldom of Warwick passed in this way through several families till it was finally obtained (1449) by Richard Neville, earl of Salisbury, who had married the heiress of the former earls. If there were coheiresses (more daughters than one), the king determined which, if any, should inherit the dignity.

In the later middle ages letters patent which restricted the succession to the male heirs of the grantee's body gradually superseded other methods of creating earls. From the time of the creation of the earldom of March (1328) their titles no longer always reflected the old county territorial associations and thus the way was paved for the 18th-century practice, which has become even more popular in the 20th, of simply adding the surname to the title —*e.g.*, Earl Poulett, Earl Temple, Earl Lloyd George, Earl Attlee. In Scotland medieval practices lasted longer and it was not till 1600 that letters patent were used to create an earldom (Winton). This helps to explain why so few ancient Scottish earldoms with their almost unlimited right of succession ever became extinct.

The girding with the sword was the only ceremony observed at an earl's investiture until the first years of Edward VI (1547–53), when the imposition of the cap of dignity and a circlet of gold was added. Under James I the patent of creation was declared to be sufficient without any ceremony (1615). An earl's robe of estate has three bars of ermine on the cape.

The earldom of Chester has been held by the princes of Wales since 1301, and the Scottish earldom of Carrick was granted to the eldest son of the sovereign by act of parliament (1469).

The premier earldom is that of Arundel (1139), but it is at present merged with the dukedom of Norfolk. The oldest earldom not merged in a higher title is that of Shrewsbury (1442), the next in seniority being Derby (1485) and Huntingdon (1529). The premier earldom of Scotland, as recognized by the Union Roll (1707), is that of Crawford, held by the Lindsays since its creation (1398), but it is not one of the ancient seven Scottish earldoms and the claim is disputed by the earls of Mar. In the Decreet of Ranking (1606) the earldom of Sutherland, one of the original seven, is regarded as the most ancient in virtue of a charter of 1347, but a house of lords decision (1771) accepted its descent from at least 1275 and it may date back to 1228. It is at present united with the dukedom of Sutherland. The original seven earldoms represented seven provinces, each of which was under a mormaor or steward. This Celtic title was rendered jarl by the Norsemen and under Alexander I (d. 1124) began to be replaced by earl (*comes*) as a result of Anglo-Norman influence. In Ireland the duke of Leinster is, as earl of Kildare, premier earl as well as premier duke.

An earl is "Right Honourable" and is styled "My Lord." His eldest son bears his father's second title, which is in most cases a viscountcy; where, as with Devon and Huntingdon, there is no second title, one using the family name may be assumed for convenience. The eldest son of an earl, whatever his title, always takes precedence immediately after the viscounts. The younger sons of earls are styled "Honourable"; all the daughters are styled "Lady." In formal documents and instruments the sovereign, when addressing or mentioning any earl, usually designates him "trusty and well-beloved cousin," a form first adopted by Henry IV. The wife of an earl is a countess; she is "Right Honourable" and is styled "My Lady."

(S. B.-R. P.)

EARLE (EARLES), **JOHN** (1601–1665), Anglican clergyman, author of an outstanding book of "characters" (*see* ENGLISH LITERATURE: *Early 17th Century: Prose and Poetry*), was born at York in 1601. He went up to Christ Church, Oxford, *c.* 1616 (fellow of Merton College, 1620; D.D., 1642), and *c.* 1631 became tutor to Lucius Cary (later Lord Falkland, *q.v.*), and a member of his circle at Great Tew. Introduced to court by the earl of Pembroke, in 1641 he was appointed tutor and chaplain to Prince Charles (later Charles II). In 1643 he was asked, but refused, to attend the Westminster Assembly (*q.v.*). During 1644–60 he was in exile with the king, and at the Restoration was made dean of Westminster, and, in November 1662, bishop of Worcester, being transferred to Salisbury in September 1663. In 1665 he accompanied the king to Oxford, where he died on Nov. 17.

Earle's learning, wit, and wise tolerance are widely praised. A convinced Royalist and Anglican, he yet tried to conciliate the Nonconformists. The earl of Clarendon describes him as "of greate piety and devotion, a most eloquent and powerfull preacher, and of a conversation so pleasant . . . [and] . . . innocent, that no man's company was more loved . . . . He never had, nor ever could have, an enimy." His occasional verse, written at Oxford, was highly esteemed. During the Civil War, he translated the *Eikon Basilike* (published 1649) and Hooker's *Ecclesiastical Polity* into Latin; the unfinished manuscript of the latter was accidentally destroyed. The *Micro-cosmographie, or, a Peece of the World Discovered; in Essayes and Characters* was published anonymously in 1628, and enlarged in 1629 and 1633. It has a place in the development of the essay (*q.v.*), and lives for its humour, perception, and epigrammatic brilliance. Earle avoids didacticism and forced wit, and portrays genuinely typical personalities: "A Child" ("nature's fresh picture newly drawn"); "A good old Man" ("one whom time hath been long a-working"); "A young raw Preacher" (a splendid piece of ridicule); "A Grave Divine," "whose Death is his last sermon, where in the pulpit of his bed he instructs others to die by his own example."

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(D. M. Pa.)

EARL MARSHAL, in England, ranks as the eighth of the great officers of state, is the head of the College of Arms and appoints the kings of arms, heralds, and pursuivants. He attends the sovereign in opening and closing the session of Parliament, walking at his or her right hand. He arranges state processions and ceremonials, especially coronations, royal marriages, and funerals, and with the lord great chamberlain he assists in introducing newly created peers in the House of Lords.

He exercised joint and coordinate jurisdiction with the constable in the Court of Chivalry, and afterward became the sole judge of that tribunal till its obsolescence in 1737. The marshalship of England was formerly believed to have been inherited

from the Clares by the Marshal family, who had only been marshals of the household. It was held, however, by the latter family as early as the days of Henry I and passed to the Bigods. In 1306 it fell by inheritance to Edward I and in 1316 was granted by Edward II to his own younger brother, Thomas "of Brotherton," earl of Norfolk. As yet the style of the office was only "marshal." The office, having reverted to the crown, was granted out anew by Richard II in 1385 to Thomas Mowbray, earl of Nottingham, the representative of Thomas "of Brotherton." In 1386 the style of "earl marshal" was formally granted to him in addition. After several attainders and partial restorations, the earl marshalship was granted anew to the Howards in 1672 and entailed on their male line, under which settlement it has descended to the present duke of Norfolk. Its holders, however, as Roman Catholics, could not execute the office until a special act of Parliament was passed in 1824. *See* also MARSHAL; PEERAGE.

See "The Marshalship of England" in J. H. Round, *Commune of London and Other Studies* (1899); G. E. C(okayne), *Complete Peerage*. (J. H. R.)

EARLOM, RICHARD (1743–1822), English mezzotint engraver, was born and died (Oct. 9, 1822) in London and was a pupil of G. B. Cipriani. He is remembered principally for the 200 plates which he executed, in a technique combining etching and mezzotint, from the drawings in Claude Lorrain's *Liber Veritatis* in the duke of Devonshire's collection. These were published by John Boydell in 1777. Earlom also did several of the plates for Boydell's Houghton Gallery; a collection of prints of pictures from the collection of Horace Walpole, acquired by Catherine the Great of Russia in 1779; plates from Hogarth and from Dutch and Flemish still-life painters. (R. E. W. J.)

EARLSTON (formerly ERCILDOUNE), a civil parish in Berwickshire, Scot. Pop. (1961) 1,831. The village is on Leader Water in Lauderdale, 34 mi. SE of Edinburgh by road, and on the Roxburghshire border. Originally it was called Arcioldun or "prospect fort," an ancient earthwork on Black Hill. In the 12th and 13th centuries the Lindsays and the earls of March and Dunbar were the chief baronial families. The ivy-clad ruin of the ancient tower, the "Rhymer's castle," was the traditional residence of Thomas Learmont, commonly called Thomas of Erceldoune or Thomas the Rhymer, poet and prophet, who was born there about 1225; the Edinburgh Border Counties Association acquired it in 1895. The leading manufacture is tweeds, and the town is also an agricultural centre. About 4 mi. SSE is Bemersyde, in possession of the Haigs since probably the 12th century, which was presented to Field Marshal Earl Haig by the nation in 1921.

EARLY, JUBAL ANDERSON (1816–1894), U.S. lawyer and Confederate army officer in the American Civil War, was born in Franklin county, Va., on Nov. 3, 1816, and graduated at West Point in 1837. He served in the Seminole War of 1837–38 and then resigned to practise law in Franklin county and take part in Virginia state politics. During the Mexican War he served as a major of Virginia volunteers. He was strongly opposed to secession, but when Virginia withdrew from the Union in 1861 he thought it his duty to conform to the action of his state. As a colonel in the Confederate army, he rendered conspicuous service at the first battle of Bull Run. Promoted brigadier general, later major general, Early served throughout the Virginia campaigns of 1862–63. In the campaign of 1864 Early, who had now reached the rank of lieutenant general, commanded the Confederate forces in the Shenandoah valley. After several successful actions in the Shenandoah and Potomac valleys and a threatened attack on Washington, D.C., he was defeated by Gen. Philip H. Sheridan at Winchester, Fisher's Hill and Cedar Creek. Waynesboro (March 1865) was his last fight, after which he was relieved of his command.

At the end of the war he went to Mexico and then to Canada but in 1867 returned to resume the practice of law. For a time he managed the Louisiana lottery in conjunction with Gen. P. G. T. de Beauregard. He died at Lynchburg, Va., on March 2, 1894. General Early was for a time president of the Southern Historical society, and wrote, besides various essays and historical papers, *A Memoir of the Last Year of the War, etc.* (1866).

See *Lieutenant General Jubal Anderson Early; an Autobiographical Sketch and Narrative of the War Between the States* (1912); D. S. Freeman, *Lee's Lieutenants* (1944).

EARLY CHRISTIAN ARCHITECTURE, in this article, refers to the religious architecture that developed in Europe during the 4th, 5th and 6th centuries of the Christian era. (For the architecture of the Eastern Church during this period *see* BYZANTINE ARCHITECTURE; for European architecture of the preceding era *see* ROMAN ARCHITECTURE; and for that of a later era *see* ROMANESQUE ARCHITECTURE.)

The meeting places of Christians, in the years before the Edict of Milan (313) brought official acceptance of the new religion, were necessarily inconspicuous and tentative. Initial emphasis on the cult of the dead resulted in the need for funerary space, which was provided in rude catacombs, crypts, martyria and chapels. These were fitted with altars and sarcophagi decorated with symbolic paintings of miracles or the agape feast, as in the catacomb of St. Calixtus, or the Virgin Mary, as at St. Priscilla, both at

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CHURCH OF S. VITALE, RAVENNA, ITALY, AN EXAMPLE OF A CENTRAL DOMED BUILDING OF THE EARLY CHRISTIAN PERIOD

Rome, possibly of the late 2nd century; whether from the Old or New Testament, the scenes strongly emphasized salvation. The ecclesia, or congregations, met in the catacombs or in houses. The Jonah sarcophagus at the Lateran museum suggests that Christians could commission sumptuous art, and the restrained character of their early architecture may reflect furtiveness and indecision, more than poverty or austerity.

After 313 the west developed elaborate churches of the basilica (*q.v.*) type in which rows of columns divided a rectangular hall into three or five aisles. The basilica (from a Greek word meaning "kingly") had been a major form in Classic times; suggestions of it appeared in Hellenistic Piraeus and it was brought to noble scale by the Romans in imperial law courts such as the Basilica Ulpia in Trajan's forum at Rome. The royal and juridical implications of the Roman basilica were appropriated by the Christians whose mosaics often depicted Christ as judge, as in the apse over the altar at Sta. Pudenziana, Rome (398), where the enthroned emperor had formerly tried criminals. The imperial symbol, a baldachin or ciborium, rose above the altar, and a domical apse terminated the long vista down the central aisle. Thus Christian architecture retained classical pagan features, much as Christian art did.

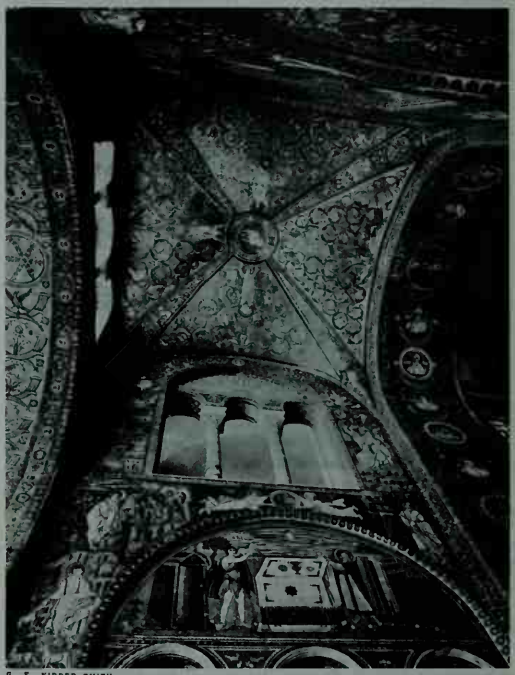
The Junius Bassus sarcophagus (359), though it depicted Christ's passion, was strongly classical in both the style of its figures and its colonnaded format. The principal elements of the typical Christian basilica strongly affected later architecture. First, one encountered a propylea, or gateway, which gave entrance to an atrium or paradisus, which was a colonnaded court, often with a fountain at its centre, where the faithful gathered

before the religious service began. A narthex, or entrance vestibule, located between the atrium and the basilica, provided a space for novices and penitents who were not permitted to enter the basilica itself to hear the service. Inside, the basilica had a broad nave and either two or four side aisles, which were separated by colonnades with arcades or flat entablatures that carried the nave wall to the band of clerestory windows below the gabled roof. In the west men stood in the nave and women in the side aisles, but eastern practice reserved the east end for men, while women stood either at the west or in galleries above the aisles. The end of the sanctuary was enclosed by the apse, usually a vault and half-dome, which had celestial, mortuary and imperial connotations. To mark the sanctified area where only clergy were permitted, a bema or platform, sometimes with a chancel rail, offered a raised base for the cathedra (seat of a bishop), the ciborium (in early times of wood covered with a veil) and the altar (usually a table). Thus the basilica's strong axis thrust attention at the focus for the liturgy, and, in some instances, a transept, which offered more space for clergy near the altar, increased the terminal emphasis and enhanced the sculptural furniture such as the choir for singers and the ambos or pulpits where the Epistles (right side) and Gospels (left side) were read. No fixed orientation aligned the axis until the 5th century when the liturgical practice of having the priest face the altar, with his back to the congregation, was canonized, and thereafter the apse stood at the east end of the basilica, the atrium at the west.

A time-defying reverence has preserved many of Christianity's early edifices. This is the more remarkable in view of their inferior architectural quality. Structurally, their thin brick walls and wooden roofs were unsubstantial and subject to rotting or fires; their alabaster windows, distended plans and primitive provisions for sound and heating offered little convenience; and their plain, even crude, exteriors were ill-composed aesthetically. These shortcomings were nullified as ceremonies were developed that capitalized upon the deficiencies, so that long spaces, resplendent mosaics and sculptured capitals augmented the incense, the mysteriously dim light and the muffled chants. In Rome there is an extant three-aisled basilica, S. Clemente, erected in the 5th century on land that once supported a Roman wall, then a house (about A.D. 100) and later a mithraeum where the Persian cult of Mithras worshiped. Repaired in the 8th century, the basilica was rebuilt in the 11th, revealing the continuity of the tradition. Constantine built three great metropolitan churches at Rome: St. John Lateran (324, but remodeled beyond recall), St. Peter's in the Vatican (with a western apse, dedicated in 326; destroyed in the 15th century) and St. Paul's Outside the Walls (erected in 386 and rebuilt in 1823 after a fire).

In the near east after 330, Constantine erected basilicas at Bethlehem (Church of the Nativity), Jerusalem (Church of Golgotha) and Constantinople (Church of the Holy Apostles), all generally of the Latin type seen at Rome. A new liturgy, however, the Antiochian or Jacobite, from Syria, demanded a tripartite apse, the pastophoria, consisting of the prothesis, where the bread and wine were prepared, the diaconicon, where vestments and utensils were kept, and the apse proper, where the chalice and paten were brought to an altar that was regarded as the tomb of Christ. Christian Syria reveals such basilicas at Ruweha (South church, 4th century), Kalat Siman (St. Simeon Stylites, after 459; with a central octagon and four basilical arms), Kalb Lauzeh (6th century) and Ruweha (6th century). The influence of the eastern basilica, by way of Greece (St. Demetrius, Salonika) and Dalmatia (Cathedral, Parenzo), reached the west, as may be seen at Sta. Maria in Cosmedin at Rome and S. Apollinare in Classe (534–539) at Ravenna. With further modifications the basilica form persisted in the churches of the Carolingian period; it strongly affected the Romanesque and Gothic churches of Germany, France and Spain; and it retained almost classical features in S. Miniato at Florence and the cathedral at Pisa (1063–1118).

Central, domed buildings of the Early Christian period were developed for use as tombs, martyria and baptisteries. The dome (*q.v.*) was often used in primitive architecture, since pliable reeds and branches were easily made to assume hemispherical and conoidal forms. Acquiring symbolic status through use as the ancestral house or tomb, the form was retained in less compatible materials, such as brick, stone and wood. The dome became the symbol of ruling power, whether political or religious. In spite of the obvious difficulties in erecting, maintaining and expanding them, domical structures were valued for their religious symbolism and were erected even in countries where earthquakes frequently demolished them. The tomb chapel of Sta. Costanza at Rome (323 and later), probably built for Constantine's daughter, was of circular plan, as was the tomb of Theodoric at Ravenna (*c.* 520). Baptisteries, which imply the idea of rebirth, shared the symbolism; they followed the centralized plans of classic baths, as did the orthodox baptistery at Ravenna, called S. Giovanni in Fonte (449–452). Some imperial churches were of the central type, notably Justinian's Church of S. Vitale at Ravenna (526–547), which is thought to have suggested to Charlemagne the form for his palace church at Aachen.



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ELABORATE MOSAIC DOME OF S. VITALE, RAVENNA, ITALY

The churches in the west of the central type frequently reflected eastern buildings, such as the rotunda built over the Holy Sepulchre at Jerusalem by Constantine. The east placed liturgical emphasis on the cult of the dead; the ritual emphasized an altar that was regarded as a tomb from which Christ rose at Easter, and the architectural canopy over the tomb had mortuary and celestial symbolism. Central-type churches were built at Antioch, Kalat Siman, Ruweha (where there was a fine cut-stone dome, though the usual practice was probably to make domes of wood), Bozrah and Zorah. The central type grew in importance during the 5th and 6th centuries and prepared the way for the great buildings of the Byzantine period, such as Hagia Sophia. Admired also by non-Christians, the domical sanctuaries eventually provided a basis for Islamic religious architecture.

While the exteriors of Early Christian buildings were plain, their interiors were decorated with fine mosaics, and the splendid panels remaining in Byzantine Ravenna in S. Apollinare Nuovo and

S. Vitale, as well as in 5th century Sta. Maria Maggiore at Rome, suggest the rich effect the early churches made (*see* MOSAIC). Naturalism in figure style was replaced by abstraction, so that the friezes of saints and martyrs at S. Apollinare Nuovo gain their power through rhythmical statement and varied pattern, rather than three-dimensionality. The way in which this planar art perfectly reinforces the architecture deserves close study.

Early Christian architecture reveals an exciting insight into the development of the Christian religious institutions; it suggests how old architectural forms and their symbolism were transformed for new uses; it reveals how firmly ideas and rituals require programmatic expression in the plans of buildings; it cautions against an undue emphasis upon physical efficiency and its functional corollaries lest intellectual and aesthetic performance be curtailed; and it shares with other great architectures the insistence that all the visual arts, including ceremonial ones, support the spaces where sight, hearing and touch are intended to affect reason and emotions.

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TRIPARTITE APSE AND MOSAIC APSE PROPER OF S. APOLLINARE IN CLASSE. RAVENNA, ITALY

See also references under "Early Christian Architecture" in the Index.

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EARLY CHRISTIAN ART, the basis and point of departure of medieval western and Byzantine art, sprang from Greco-Roman art, of which, during the first 150 years of its existence, it merely formed a branch. It was not until Christianity became a permitted religion under Constantine I that it began to develop its own characteristics. From the second half of the 4th century onward the great artistic creations are Christian. The transition from early Christian to Byzantine art (*q.v.*) is taken in this article to date from the first half of the 5th century. The geographical area it covers is that of the Roman empire.

The most important monuments of early Christian art are to be found in Italy. The catacomb paintings, chiefly dating from the period when Christianity was still merely tolerated, or was even persecuted, and the sarcophagi provide the earliest examples. From the mid-4th century wall mosaics become the form of art most representative of the triumphant church.

By far the most important catacombs are those in Rome, though there are others elsewhere in the Mediterranean region. Frescoes cover their walls and ceilings, the earliest dating from the end of the 2nd century. They do not differ in style from contemporary paintings in pagan cemeteries (*e.g.*, at Ostia), but there is some difference in subject. Together with the traditional secular decorative motifs—birds, flowers, emblems of the seasons, rustic scenes—appear subjects from the Old and, more rarely, from the New Testament. By the 3rd century a Christian iconography had been established which depicted the miraculous intervention of God in favour of his chosen people: the sacrifice of Isaac, Susanna and the elders, Daniel in the lions' den, the miracles of Christ, etc. It has therefore with reason been called an iconography of salvation. Similar subjects are depicted in the frescoes of the Christian baptistery at Doura-Europus on the Euphrates (*c.* 230).

The majority of early Christian sculptured sarcophagi have been found equally in Italy, but an important group derives from the south of France (Arles, Marseilles, Toulouse, Aix-en-Provence, Narbonne), others from Spain and north Africa and some from the Rhineland. A separate group, dating from the 3rd to the 5th century, belongs to Asia Minor. As in the catacombs, the subjects are at first chiefly secular, for instance a portrait of the deceased, a philosopher reading or pastoral scenes. But these are increasingly supplanted by cycles of biblical and Gospel scenes such as the passion of Christ, the martyrdom of the apostles Peter and Paul or the Israelites' crossing of the Red sea. Other important works of early Christian sculpture are the wooden reliefs on church doors (Sta. Sabina, in Rome, S. Ambrogio in Milan; first half of the 5th century).

Some of the earliest-known Christian wall mosaics, dating from the mid-4th century, adorn the vaults of Sta. Costanza in Rome. The subjects in these mosaics, except for those in two of the side recesses, are also part religious, part secular. The style is that of contemporary pagan art, which tended toward decorative effects at the expense of elegance of form. The apse mosaic in Sta. Pudenziana in Rome, dating from the close of the 4th century, and those in the two recesses in Sta. Costanza, probably a little earlier, represent new themes inspired by imperial iconography: Christ enthroned in majesty and Christ giving the law and the keys to St. Peter. In the baptistery at Naples (first half of the 5th century) the iconography of the mosaics is dictated by the baptismal liturgy. The mosaics on the walls of the nave in Sta. Maria Maggiore in Rome, executed under Pope Sixtus III (432–440), are the earliest cycle of biblical pictures extant (the stories of Abraham, Jacob, Moses and Joshua); on the triumphal arch appear scenes from the life of Christ.

In Milan a few 5th-century works still exist in S. Aquilino and S. Ambrogio; in Ravenna the baptistery of the orthodox and the mausoleum of Galla Placidia already herald the Byzantine style. Early Christian floor mosaics, found chiefly in northern Italy, on the Dalmatian coast (Salonae), in Greece, Syria, Palestine, Jordan and north Africa, represent either secular subjects or geometric and botanical designs. Religious subjects are found only rarely (Aquileia).

Coptic art, a popular transformation of the Greco-Roman art of Egypt, produced a good deal of sculpture in stone (Ahnas), and some frescoes (Bagawat, Bawit, Saqqarah), whose naïve style, which achieves a powerful decorative effect, survived into the period of Arab occupation.

Early Christian art also produced numerous objects of daily usage, which, being portable, it is not always possible to attach with certainty to any locality. Oil lamps and gilded glass have been found in great numbers in Italy and north Africa; a school of ivory sculptors may have existed at Rome and in northern Italy during the second half of the 4th and the first half of the 5th centuries. Numerous pieces of cloth, both silk and woolen, have been discovered in Egypt (El Faiyûm, Antinoë) but not all are native to that country. The only surviving illuminated manuscript of this period is a few leaves in Berlin of the Itala of Quedlinburg, a fragmentary text of the Old Testament.

The early Christian style can be characterized by a tendency toward spiritualization and by a progressive abandonment of the imitation of nature. Plastic beauty of form is sacrificed to intensity of expression, which is sometimes allied to a certain physical ugliness. Light and shade play over stylized and summarily

ALINARI

CHRISTIAN SARCOPHAGUS WITH RELIEF SCULPTURE OF THE STORY OF JONAH, PROBABLY FROM THE 3RD CENTURY. IN THE LATERAN MUSEUM, ROME

treated forms; the paintings are in bright, contrasted colours.

See also CATACOMBS; MOSAIC.

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EARLY CHRISTIAN CHURCH. This article is intended as a sketch of the development of the church up to the time of Constantine I, the first Christian emperor.

Origin and Growth.—The Christian Church is the Body of Christ, the society of those who accept him as Messiah, Lord, Saviour and Son of God and are incorporated into him through baptism. It is continuous with the Old Testament people of God who looked for a Messiah and his Kingdom, and it inherits the promises made to them. But it took new shape and new life through the teaching and ministry of Jesus, through his training of the apostles and above all through his redeeming death, resurrection and ascension and through the coming of the Holy Spirit at Pentecost.

This new start was at first believed to be nearer the end than the beginning. In daily expectation of the return of Christ as judge, the faithful must prepare themselves for his kingdom and, by urgently preaching his gospel, bring others into the redeemed community. In the event, longer perspectives of a "time of the church" opened up. Christians faced the problems of living among a pagan majority, the missionary challenge proved to be far greater than could have been foreseen, and with it came the task of building a Christian social life. It became necessary to determine a new canon of authoritative scriptures (the writings of the apostles and their circle); on this basis to draw out the theological implications of the gospel; and to adopt such institutional forms as would preserve and propagate the inner life in Christ.

The church spread with astonishing rapidity. Already in the Acts of the Apostles its movement from one headquarters to another can be traced: Jerusalem, Damascus, Antioch; the Pauline missions to Asia Minor (Tarsus, Iconium, Ephesus and Cyprus); the crossing to Macedonia (Philippi, Thessalonica) and Achaea (Athens, Corinth); the beginnings in Rome. Other early evidence tells of more churches in Asia Minor and of Christians in Alexandria. Though Christianity found a springboard in Jewish synagogues, it owed even more to the crucial decision to open the church to gentiles without either circumcision or complete adherence to the Law; and though Roman roads and comparative security facilitated missionary work, much more was due, humanly speaking, to the widespread longing for personal religion and the assurance of salvation.

By the end of the 2nd century there were well-established churches in Gaul (Lyons, Vienne, perhaps Marseilles) and Latin Africa (Carthage), with perhaps a start in Britain, Spain and Roman Germany, though little is known of these areas for another century. To the east, Edessa soon became the centre of Syriac Christianity, which spread to Mesopotamia, the borders of Persia and possibly India. Armenia adopted Christianity at the beginning of the 4th century, by which time there may have been a Christian majority, or near it, in some cities of Asia Minor and Africa *proconsularis,* while progress had been substantial in Gaul and Egypt. The faith had demonstrated its appeal to men of different cultures and environments; the church could be catholic, universal.

This was not done without opposition. First, their stern moral standard (though attractive to some) and their fear of contamination by the idolatry woven into the texture of social life around them compelled Christians to stand aloof from their neighbours and earned them the reputation of being enemies of humanity, or at best useless to society. Second, the Roman state doubted their loyalty and became increasingly convinced that the growth of the church was incompatible with the unity, safety and prosperity of the empire. Serious action against the church corporately was not taken until Septimius Severus forbade conversion under pain of death (202); but long before him a tradition of administrative action against individual Christians and a presumption that they were wicked and dangerous people had been established, ever since Nero had made them scapegoats for the fire of Rome. Although Trajan forbade magistrates to take the initiative against them, Christians denounced by others could be punished simply for persistence in their faith, the proof of which lay often in refusal to participate in the cult of the emperor. Persecution at Lyons in 177, when Marcus Aurelius abandoned Trajan's principle "that they are not to be sought out," pointed to what might come, for apologists (*e.g.,* Justin, Tertullian, Origen) protested in vain that Christians were moral, useful and loyal citizens. In 250, eager to revitalize the empire on conservative lines, Decius ordered all citizens to worship the gods; persecution was extensive and many apostatized, but the church was not destroyed. Valerian tried new methods against the clergy and other leaders (257–258), but the church held firm, and his successor Gallienus granted toleration in practice and perhaps legal recognition. A period of comparative security was ended by the series of persecutions launched in 303 by Diocletian and Galerius. Harsh though they were, they entirely missed their objective. Public opinion, now better aware of the nature of Christianity, was revolted by the bloodshed; first Diocletian and later Galerius (311) acknowledged the failure of this policy, and in 313 Constantine and Licinius agreed upon a policy of toleration (the "edict of Milan") which Constantine soon turned into active patronage. Through nearly three centuries the martyrs had been the seed of the church, and now the accession of a Christian emperor changed the whole situation.

Organization.—By this time the church had considerably developed its organization, partly against these external pressures and partly in order to express its own nature as a historically continuous society with a corporate unity, a ministry and sacraments "given" in Christ. Not later than the first decades of the 2nd century there is evidence in Antioch and several Asian cities of congregations being governed by a single bishop assisted by a group of presbyters and a number of deacons. The bishop was the centre of unity, the chief minister in worship, teaching and pastoral care as well as the supervisor of all administration. The presbyters were collectively his council; individually the bishop might call upon them for help in any of his ministerial duties. The deacons came to be specially associated with the bishop in his liturgical office and in the administration of property, including assistance to the needy.

How far back this threefold ministry can be traced has long been a matter of controversy (*see* MINISTRY, THE CHRISTIAN). It is certain that the normal Christian group, at least in cities, possessed a recognized ministry from its very beginning, and it is almost as certain that the pattern of ministry was not derived from Greek models. The presbyters (elders) were clearly taken over from the Jewish synagogue; the bishop (where this title is not

simply an alternative for presbyter) may be related to the supervisor of the communities known from the Dead sea scrolls. How and when the bishop came to be regarded as having authority over his presbyters and how such a "monarchical" bishop was related to the original apostles—whether by direct succession of appointment, by localization of missionary-founders, by elevation from the presbyterate—remains uncertain. While apostles and other first-generation leaders were alive, there was understandably some fluidity in organization, with apostles, prophets and teachers at work side by side with bishops, presbyters and deacons; moreover, some New Testament terms may indicate at one time an office, at another a function.

Though the first local unit of organization must have been the congregation, the church was soon making use of the administrative divisions of the Roman empire. Normally each bishop became responsible for the church in a recognized *civitas; i.e.*, an urban centre with its surrounding *territorium*. This was his diocese, the fundamental unit of ecclesiastical geography; the subdivision of a diocese into parishes was a much later development. By the late 2nd century, when heresy and other problems compelled the bishops to meet together in councils, they tended to group themselves according to the civil provinces, and by the next century there is clear evidence of the ecclesiastical province, usually coinciding in area with the civil province and accepting the bishop of the civil capital (metropolis) as its primate (metropolitan), a system which received canonical status and further precision at the Council of Nicaea (325). Besides such metropolitans, the bishops of a few outstanding sees acquired a special authority through a combination of the secular importance of the city and its place in missionary history as a mother church. In Egypt, for example, the bishop of Alexandria ruled six provinces, and in Latin Africa the bishop of Carthage was the accepted leader, though without juridical or canonical rights, of the whole area. The Council of Nicaea, while defining the canonical status of the provincial synods and metropolitans, reaffirmed the ancient customary privileges of Rome, Alexandria, Antioch and certain other unnamed sees. Out of this the patriarchates of later times were developed.

Until the destruction of Jerusalem in A.D. 70 the mother church there may have held a certain primacy; but with the shift in emphasis to gentile Christianity Rome quickly became the preeminent see, the church of Peter and Paul, the only apostolic see in the Latin west, the capital of the empire. No one in the west doubted that the bishop of Rome possessed a primacy of some sort; but in the early centuries this was undefined, and attempts to interpret it (whether or not on the basis of Matt. xvi, 18: "And I tell you, you are Peter, and on this rock I will build my church . . .") as containing anything like jurisdictional sovereignty were resisted even in the west (for instance by Cyprian of Carthage) as well as in the east, where the see of Ephesus maintained its own apostolic tradition against Victor of Rome in the Quartodeciman controversy (*c.* 190); and Firmilian of Cappadocian Caesarea supported Cyprian in his dispute with Pope Stephen (*c.* 256; *see* CYPRIAN, SAINT). Here again the accession of Constantine was a turning point, for, with the expansion of the church and its recognition by the state, questions of jurisdiction became more acute (they were exacerbated by the Donatist and Arian controversies; *see* ARIANISM; DONATISTS), while the foundation of Constantinople as the eastern capital, with no ecclesiastical but strong secular claim to pre-eminence, caused Rome to develop and assert the exclusively religious grounds of its own primacy against a possible rival.

Doctrine.—Organization is but means to an end. The church exists to promote the worship of God, the inner life of the spirit, the evangelization of the world and the molding of society according to the will of God. All these things, if they are to be properly Christian, demand constant witness to the saving acts of God in Christ as they were made known to the primitive apostolic community and recorded and reflected upon in the Bible. Hence early Christian doctrine, however much helped to articulation by Greek thought, had to maintain its biblical character, historical, concrete, personal, against other elements, speculative, abstract, rationalist, in its Hellenistic environment. One wing of the church clung so tenaciously to its Jewish heritage that it failed to grasp what was new in Christ; it had no future, especially after the fall of Jerusalem. The mainstream of Christianity worked out a standard of orthodoxy in the course of its struggle with various forms of Gnosticism (*q.v.*), which, though itself soteriological in intention, threatened to spiritualize away the historic acts of divine redemption and to deny a true incarnation of God in Christ, partly on the ground that matter is evil. While apologists of the 2nd century like Justin, Theophilus and Athenagoras went as far as they could to conciliate Greek thought (*see* APOLOGISTS, EARLY CHRISTIAN), the genius of Irenaeus (*see* IRENAEUS, SAINT), who in his book *Against Heresies* comes to grips with the Gnostic challenge, not only emphasized the "threefold cord" of apostolic scripture, apostolic rule of faith and apostolic ministry by which the continuity of the church is preserved, but also grasped the Pauline gospel of redemption (the true understanding of which the half-Gnostic Marcion had arrogated to himself) and stated it afresh with a just appreciation of the coherence of particular doctrines in the Person of Christ. The almost contemporary conflict with Montanism (*q.v.*) and the pungent development of certain aspects of Irenaeus in the early writings of Tertullian (*q.v.*) confirmed the church's awareness of its nature as a continuous society originating in and tied to a divine revelation, identical with the church of the apostles, a true perception which, however, brought with it some danger of traditionalism and institutionalism.

Apart from Origen's *De principiis* (*c.* 225) Christian theology in this period was not systematic, and doctrines were examined rather as circumstances demanded. Gnostic dualism compelled consideration of the creation, the fall and free will, as well as the authority and exegesis of the Old Testament. On the other hand, some matters, precisely because they were not then subjects of serious controversy, were not searchingly studied; thus an aspect of baptism (whether it could be administered outside the church) could receive more attention in the dispute between Cyprian and Stephen than the essential character of the sacrament itself, and eucharistic theology was not yet elaborated. Even the doctrine of redemption was less fully pondered than might have been expected, though the concepts of ransom and deification were brought forward for future development.

But a Christian society was bound to reflect upon the Person of Christ. The material reality of his human body had soon to be affirmed against those who thought it derogatory to a divine Saviour. It took longer to perceive that his complete humanity must be as firmly proclaimed. And although Tertullian taught expressly that Christ combined perfect divinity and perfect humanity in one Person, the theoretical problems of this dogma awaited exploration and clarification in the 4th and 5th centuries. In the intellectual formulation of their belief in the deity of Christ simultaneously with the unity of God, many were helped by the concept of the Logos ("word" and "reason") of God, which had roots both in the Bible and in Greek philosophy and so had at once an apologetic and a constructive value. It proved almost as dangerous as it was fruitful, since it was difficult to understand what kind of subordination is involved in the fact that the Logos is generated by the Father. Some points in Origen's thinking led toward the Nicene orthodoxy of the future, others toward Arianism.

Some theologians held that Jesus was a man raised to divine honours through his moral and spiritual perfection (adoptionism; *q.v.*); others allowed no permanent reality to Son and Spirit, treating them as aspects of the one God, modes of his dealings with mankind (modalism, Sabellianism, *q.v.*). Such problems were argued principally in terms of the relation between Father and Son, with comparatively little attention to the Person of the Holy Spirit.

Again, the doctrine of the Trinity was firmly stated, almost in the later terminology, by Tertullian, followed by Novatian—three co-equal and co-eternal *personae* in one *substantia*—but new problems emerged and deeper thought was required in the following century (*see* also JESUS CHRIST: *The Dogma of Christ in the Ancient Councils;* TRINITY).

During this gradual clarification of the essentials of Christian

orthodoxy there was also scope for free discussion and speculation within the limits of the rule of faith and the baptismal creeds, a freedom of which the adventurous mind of Origen took full advantage. Heresy meant denial of the basic tenets of faith rather than departure from a complete and formally accepted scheme of doctrine. Whether these tenets suffered from the slackening of eschatological expectation and the introduction of Greek forms of thought is open to debate. But it was not only, or even primarily, the theologian who was responsible for the preservation of authentic Christianity; it was maintained in the worship and discipline and common life of the churches. Once more, the conversion of Constantine exposed this continuity of tradition to fresh dangers while opening up fresh opportunities for the intellectual conquest of the empire.

The Life of the Church.—Candidates for admission to the church were instructed during a lengthy catechumenate, after which they were baptized, generally at Easter, by their bishop. As the sacrament of baptism included what was later separated off in the west as confirmation, the newly baptized faithful (*fideles*) were at once admitted to the full privileges and obligations of the Christian life. Though adult baptism was perhaps the norm, especially for baptismal theology, infant baptism was also practised from an early date (*see* BAPTISM, CHRISTIAN: *Early Church*). The Holy Communion (Eucharist) was the principal Sunday service, the regular gathering (*synaxis*) of the faithful for worship, the preaching of the Word, instruction, discipline and fellowship. While it was never shapeless and always included certain actions taken over from the Last Supper, it was only gradually, and perhaps not within this period, that the liturgies of the leading churches took a fixed verbal form (*see* EUCHARIST). Easter, Pentecost and, in the east, Epiphany were annually commemorated, before long anniversaries of martyrs were being observed, a system of feasts, fasts and vigils was worked out, and so a Christian year was established (*see* CHURCH YEAR). At first worship must have taken place in private houses. Sometimes houses were handed over to the community and transformed into churches (*e.g.*, Doura-Europus on the Euphrates, *c.* 232, and several at Rome), but numerous churches were constructed as such in the peaceful intervals of the 3rd century, and they were plentiful by the time of Constantine, who added some notable ones (*e.g.*, the Anastasis or Holy Sepulchre at Jerusalem, St. Peter's at Rome). Where catacombs (*q.v.*) existed, as at Rome and Naples, they were burial places, not, by intention, places of refuge or ordinary worship; but they and the open-air cemeteries (*areae*) contained chapels commemorating martyrs which frequently grew into great churches or monasteries.

Christians thought of themselves as a redeemed community, promised eternal life in Christ and meanwhile charged to live a holy life in expectation of the end of this world, which might come at any moment with the advent of Christ as judge; yet charged also to preach the gospel to the world. This created a tension not easy to resolve. On the one hand it seemed necessary to separate themselves from a society that was not only, by Christian standards, immoral but also riddled with pagan practices; this conviction is fully displayed in Tertullian's *De idololatria*, in a rigorist sect like Montanism and eventually in monasticism. Public life and much social intercourse were precluded. On the other hand, Jesus had mixed with publicans and sinners, and evangelization was a plain duty. Before Constantine, however, this meant bringing individuals out of the world into the church rather than making society Christian; a high moral standard, refusal to compromise, steadfastness before persecution, proved to be powerful missionary weapons. Evidence of direct missionary campaigns such as Gregory the Illuminator's in Armenia (3rd century) is scanty (*see* MISSIONS: *Early History*).

Since Christians were not automatically made perfect by baptism, and periods of peace removed the selective test of persecution, the moral life of the church was protected by a disciplinary system. Grave offenders publicly acknowledged their sin before the bishop and the congregation, were excommunicated for a greater or lesser period, during which they performed works of satisfaction, and finally (in parts of the church penitents passed first through several grades) were publicly restored to communion by the bishop. Private penance was a later development. Public penance for grave sin was only available once, and, although practice was not everywhere uniform, it was widely held that apostasy, adultery and murder involved final excommunication. Relaxation of this early severity caused much unrest among the rigorists and sometimes led to schism. Montanism, Novatianism and Donatism were all, in part, movements of protest against what was felt to be an abandonment of the standard of individual holiness required if the church was itself to remain holy. This disciplinary system carried with it a threat to the central doctrine of justification by faith, since the conditions of forgiveness tended to be assessed quantitatively; and works similar to those performed by penitents (*e.g.*, almsgiving) were believed to merit heavenly rewards. Ascetic practices were also encouraged, partly as a means toward the purification of the soul for the contemplation of God, but in part as works to be rewarded. Thus a double standard of morality was countenanced, one level of life sufficient to ensure salvation, another aspiring after perfection and proportionately higher rewards; a distinction was made between the precepts (commandments) of the Lord and the counsels.

Nevertheless, the penitential system and the ascetic movement, together with the eremitical monasticism which was firmly established in Egypt under the leadership of Anthony in the opening years of the 4th century, played an important part in maintaining the high, sacrificial demands of the Christian faith, keying the church up to face the final persecution under Diocletian and his colleagues, from which it emerged victorious to meet the new difficulties and new opportunities afforded by the conversion of Constantine.

See also references under "Early Christian Church" in the Index.

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(S. L. G.)

EARLY ENGLISH PERIOD, in architecture, the first of the three divisions into which the English Gothic style is usually divided. Although originally the term was applied to English Gothic up to the beginning of the 14th century (as by Rickman and R. P. Spiers), it is more customarily limited to the first half of the 13th century. In the last quarter of the 12th century, partly through the influence of the Cistercian order and partly through that of the French design of the early Gothic parts of Canterbury cathedral (choir, *c.* 1175–78), pointed arches and other Gothic ideas became more and more common, so that by the end of the century the transitional period was over and the architecture of England completely Gothic. It is this earliest developed Gothic which is known as Early English. The chief characteristics of the style are: frequent use of high, slim openings, capped with steeply pointed arches, known as lancets, often grouped in threes, fives (the "five sisters" in the transept of York cathedral) or even in sevens; simple four-part church vaulting (*see* ARCH AND VAULT), often with a ridge rib in addition to groin, cross and wall ribs; arch moldings, consisting of complex combinations of convex projections with deep, rounded hollows; nave and chapter-house piers of a central core of stone surrounded by a number of black Purbeck marble shafts, tied together by occasional molded bands; capitals, almost always consisting of a circular abacus with rich moldings below, or sometimes with conventionalized foliage with many rounded lobes; frequent use of ball-flower and dogtooth ornament.

Toward the end of the period the use of tracery became general, lavishness of ornament increased, as in the diaper patterns in the arch spandrils of Westminster abbey, and naturalism in the carving grew. Outstanding examples of the style are Salisbury cathedral, begun 1220; the nave and transept of Wells cathedral, end of the 12th century to 1242; parts of York cathedral transepts, 1230–60. *See* GOTHIC ARCHITECTURE; DECORATED PERIOD.

(T. F. H.)

EARN, a loch and river of Perthshire, Scot. The loch is 6½ mi. long from east to west and ½ mi. in maximum breadth. It discharges by the Earn river. On its shores are Lochearnhead (at

the west end of the lake and at the southern extremity of Glen Ogle), which has a station on the railway from Perth to Stirling, and where are the ruins of St. Blane's chapel; Edinample castle, an old turreted mansion situated in well-wooded grounds near the falls of the Ample; Ardvorlich house, the original of Darlinvarach in Sir Walter Scott's *Legend of Montrose;* and the village of St. Fillans at the foot of the loch. The river, a notable fishing stream, flows out of Loch Earn eastward for 46 mi. with a gentle inclination toward the south, and reaches the Firth of Tay, 6½ mi. below Perth.

The principal places of interest on the banks of the Earn are Dunira house; the village of Comrie; the town of Crieff; Forgandenny; Bridge of Earn, a pleasant health resort; and several mansions and ruined castles. Strathearn, as the valley of the Earn is called, extending from the loch to the Firth of Tay, is a scenic and, on the whole, fertile tract, though liable at times to heavy floods in low-lying areas.

EARRING, an ornament worn pendent from the ear, sometimes suspended by means of a ring or hook passing through the lobe of the ear. The impulse to decorate or at any rate to modify the appearance of the ear seems to be almost universal. The Berawan people of Borneo used plugs through the lobe of the ear 3¾ in. in diameter. A Masai stone earplug is known that is 4½ in. in diameter and weighs 2 lb. 14 oz. Among Europeans, though ear ornaments of extravagant size and elaboration are not unknown, such ornaments tend to be smaller in size and to emphasize workmanship and fineness of material.

The general usage appears to have been to have earrings worn in pairs, the two ornaments in all respects resembling each other; but a single earring has sometimes been worn. It appears probable that the earrings of Jacob's family, which he buried with their foreign gods (Gen. xxxv, 4), were regarded as amulets or talismans, such unquestionably being the estimation in which some ornaments of this class were held from a very early period. Thus in New Zealand earrings were decorated with the teeth of enemies and with talismanic sharks' teeth.

In the orient earrings were worn by both sexes; in the west (including the ancient Hebrews and Egyptians) as a general rule they have been considered exclusively female ornaments. Among the Greeks and Romans earrings were worn only by women, and the wearing of them by a man is often spoken of in classical literature as a distinctly oriental trait.

Earrings are frequently represented in archaic Greek art, or their traces are left in the perforated ear lobes of statues. After the 4th century such perforations occur seldom. In one instance, a Greek inscription records the weight of the detachable gold ornaments on a statue, among which a pair of earrings is included.

Earrings are frequently discovered by archaeological excavation. In Egypt, a system of pendent chains is found hanging from a disk. In Assyria the decoration consists of pendants or knobs attached to a rigid ring. Earrings of the Mycenaean period are uncommon on the mainland but are abundant among Mycenaean finds of Cyprus, in the form of pendent bulls' heads or of decorative forms based on the bull's head.

In the tombs of the Greek settlers in the Crimea (4th century B.C.), earrings of marvelous complexity and beauty were found. The lexicographer Pollux, speaking of the names given to earrings, derived from their forms, mentions caryatids, hippocamps and centauresses.

Jewels of the same class, of exquisite beauty and workmanship were found in the sepulchres of ancient Etruria. Earrings of comparatively simple forms, but set with pearls and other stones, were the mode in Rome. Archaeological excavations of burial places of Anglo-Saxon Britain revealed jewels in considerable numbers, including earrings.

These ornaments showed a considerable decline in Europe and America during the 19th century but were revived again in the 20th. The modern tendency away from piercing of the ears and toward the use of somewhat insecure clamping devices probably was influenced by the widespread utilization of "costume" jewels, whose loss is a matter of no great monetary importance. The more common types of holding clamps include the spring-loaded hinged clip and the screw clamp, both of which hold the ornament to the ear by friction against both sides of the lobe.

See also JEWELRY.

EAR SHELL: *see* ABALONE.

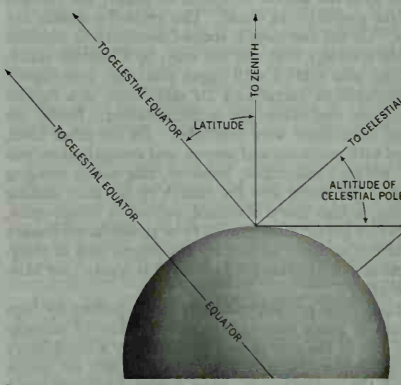
EARTH. In this article the earth will be considered as a whole, ignoring the details of its surface features, the oceans and the atmosphere. The subject will be treated under the following headings: (1) the earth as a planet; (2) structure of the interior; (3) origin, composition and age; (4) magnetism and temperature; and (5) origin of the surface features.

THE EARTH AS A PLANET

Figure of the Earth, Gravity.—The view that the earth is a sphere goes back to classical antiquity. It was held by Pythagoras as early as the 6th century B.C. Aristotle, in the 4th century B.C., supported it by such arguments from observation as the circular form of the earth's shadow seen on the moon during an eclipse. Similarly, he noted the changes in the position of the sun and stars observed by one who travels north–south. Eratosthenes (about 250 B.C.) used the latter argument for the first quantitative determination of the size of the earth. He found that when, at Syene in southern Egypt, the sun was vertically overhead at noon during the summer solstice, it deviated from the zenith by about 7° at Alexandria in northern Egypt. Eratosthenes' result for the size of the earth agrees remarkably well with modern data. The spherical form, however, did not become generally accepted until, in the 16th century, explorers actually sailed around the earth. The distance a traveler has to proceed northward in order to make the height of the pole star increase by 1° is "the length of one degree of latitude" (fig. 1). The first reliable modern determinations date from the 17th century.

Actually, the length of a degree of latitude depends in turn slightly on the latitude itself at which it is measured. This indicates that there is a deviation of the earth from spherical shape. Newton was the first to demonstrate that the centrifugal force of the earth's rotation would tend to make the earth bulge out at the equator, giving it the shape of an oblate spheroid (the surface swept out by an ellipse when it is rotated about its short axis). Such a surface is flatter near the pole than near the equator and 1° of latitude is therefore longer in high latitudes than it is in low ones. Whereas the length of a degree is determined by geodetic (surveying) methods, flattening is most accurately found from certain astronomical observations. If a is the major (equatorial) half-axis of the earth and b the minor (polar) half-axis, the flattening is defined as $\alpha = (a - b)/a$. Determinations of this quantity yield: $\alpha = 0.003367$.

Geodetic determinations of the size of the earth achieve a high degree of accuracy. Values for the axes are: $a = 6{,}378{,}388$ metres and $b = 6{,}356{,}912$ metres. The distance from pole to equator



FROM R. H. BAKER, "ASTRONOMY," D. VAN NOSTRAND COMPANY, INC., 1938

FIG. 1.—THE LATITUDE OF A PLACE ON EARTH EQUALS THE ALTITUDE OF THE NORTH CELESTIAL POLE AT THAT PLACE

measured along the earth's surface, it may be noted, is nearly 10,000 km. or 10,000,000 m., this being the original definition of the metre at the introduction of the metric system. For practical purposes it is necessary to have a standard of length independent of the geodetic determinations of the size of the earth, but the above relationship holds true to a high degree of approximation (the error being about 2 parts in 10,000). It follows that the mean length of a degree is about (10,000/90) km. = 111 km., or 69 mi.

Since the earth is not a perfect sphere, the strength of gravity depends on latitude. In 1671 a French astronomical expedition to Cayenne, in Guiana, found that its pendulum clock ran more slowly there than at Paris. The following is an abbreviated form of the accurate formula for gravity: $g = 978.05\ (1 + 0.00529 \times \sin^2 \varphi)$, where g is the acceleration of gravity in cm./sec.^{2} and φ the latitude.

Clearly, if extreme precision is sought, the irregularities of the earth's surface constitute deviations from the spheroidal shape. Gravity measurements offer a convenient means of defining an idealized, smoothed earth's surface which deviates somewhat from the spheroidal shape. This surface, serving as reference to the geodesist, is known as the "geoid."

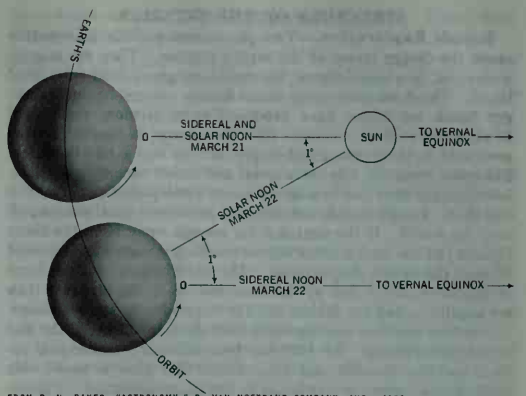
The total mass of the earth is found from absolute gravity measurements in conjunction with measurements of its size. This also determines the mean density (the density is, however, not constant throughout the earth, as will be shown). The precise measurements of Charles Boys (1895) and of Karl Braun (1896) gave 5.527 whereas Paul Heyl found 5.517 (in 1930) and 5.514 (in 1942). It seems certain that the mean density is very near 5.52. This corresponds to a total mass of the earth of 6×10^{27} grams.

Earth Dimensions

Circumference, equatorial	24,902.45 mi.*
Diameter	
Polar	7,899.98875 mi. (12,713,824 m.)*
Equatorial	7,926.6779 mi. (12,756,776 m.)*
Flattening	0.003367*
Volume	1.083×10^{27} cu.cm. (1,083,319,780,000 cu.km.)
Mass (weight)	5.98×10^{27} g. (6,586,242,500,000,000,000,000 tons, est.)
Mean density	5.52 g. per cu.cm.
Ratio of mass	
Sun to earth	333,432:1
Earth to moon	81.45:1
Revolution	365.25 days
Rotation	23 hr. 56 min. 4.09 sec.
Orbital velocity	18.5 mi. per sec.
Distance from sun	
Aphelion (max.)	1.520×10^{13} cm. (94,448,000 mi.)
Perihelion (min.)	1.470×10^{13} cm. (91,341,000 mi.)
Mean	1.495×10^{13} cm. (92,894,000 mi.)
Area	
Total	510.1×10^{6} sq.km. (196,949,971 sq.mi.)
Land	58,552,330 sq.mi. (52,559,999 sq.mi. excluding Antarctica)
Altitudes	
Highest	29,028 ft. (Mt. Everest)
Lowest	−35,800 ft. (Challenger deep, Mariana trench)
Lowest on land	−1,286 ft. (Dead sea)

*Based on International Ellipsoid of Reference.

Rotation and Precession.—The time in which the earth revolves once around its axis is known as the sidereal day. Since the earth at the same time revolves around the sun in 365 days, the sidereal day is shorter than the conventional mean solar day by about 1 part in 365 (fig. 2). The exact length of the sidereal day is 23 hr. 56 min. 4.09 sec. of mean solar time. Astronomical observations show that the earth is not an ideal timekeeper. The length of the day is subject to certain minute changes. These might be classed under three headings: (1) a gradual slowing down of the earth's rotation—*i.e.*, lengthening of the day; (2) small annual or seasonal variations; (3) small irregular variations in the length of the day. The magnitude of the gradual slowing down is found from ancient astronomical observations, especially from ancient eclipses and from the more accurate astronomical data available since about 1600. This effect amounts to a change in average time of about 30 sec. per century. However, if this phenomenon is assumed to have existed throughout the earth's lifetime, the earth must once have rotated much more rapidly than it does now. The cause of the slowing down has not been established with complete certainty, but most probably it is due to the effect of tidal friction in the oceans. The loss of angular momentum by the earth is compensated by the moon, whose orbit moves farther away from the earth in this process. The theory has been developed in detail by Sir Harold Jeffreys. The seasonal fluctuations in the length of the day are minute, of the order of some thousandths of a second per year; they can be explained by changes in the size of the polar icecaps, changes in atmospheric circulation, etc. The irregular changes are equally minute and can apparently be traced to motions in the earth's core (*see* below).



FROM R. N. BAKER, "ASTRONOMY," D. VAN NOSTRAND COMPANY, INC., 1959

FIG. 2.—THE SIDEREAL DAY IS SHORTER THAN THE SOLAR DAY BECAUSE THE EARTH, ALSO REVOLVING AROUND THE SUN, MUST ROTATE FARTHER AFTER COMPLETING THE SIDEREAL DAY BEFORE THE SOLAR DAY IS ENDED. (ANGLES ARE EXAGGERATED)

In the absence of any external influences upon the earth, the direction of its axis of rotation in space would remain the same for all time. There are, however, other members of the solar system, in particular the moon (and also the sun), whose gravitational forces influence the earth. Since the earth is flattened, the moon's gravity tends to tilt the earth's axis so that it becomes perpendicular to the moon's orbit (and to a lesser extent the same is true for the sun). A spinning body (gyroscope) subject to such a force will not, however, yield to it, but the axis of rotation will precess—*i.e.*, sweep out a cone in space. This motion of the earth's axis is known as the precession of the equinoxes. It was discovered by the astronomer Hipparchus (120 B.C.) and first theoretically explained by Sir Isaac Newton. Precession implies that the pole of the heavens is not always in the same place among the constellations but moves about: for instance, 12,000 years hence it will coincide with the star Vega. The length of one period of the precession is 25,800 years. The precession makes the sun's orbit in the heavens (the ecliptic) and its intersection with the celestial equator (the equinoxial points) move in such a direction as always to meet the sun, at a rate of 50″.26 per year. This amounts to about 29° since Hipparchus' time; hence the ancient Greeks' description of the sun's yearly path across the constellations no longer fits. (*See* also PRECESSION OF THE EQUINOXES.)

The force tending to alter the tilt of the axis is not constant; when the sun or moon is crossing the equator, for instance, it has no effect. The path of the pole is therefore not exactly a circle but contains a superimposed smaller oscillation, the nutation, with a period of 18.6 years and an amplitude of 9″.2. The "Chandler wobble" is another gyroscopic effect of extremely minute amplitude and a period of 440 days; it is accompanied by a slight deformation of the earth's body. The solid body of the earth undergoes a slight daily tidal deformation due to the gravitational action of the moon and sun. The amplitude is small, about 25 cm. at most; it must be taken into account, however, in extremely accurate gravity measurements.

STRUCTURE OF THE INTERIOR

Seismic Exploration.—Two phenomena provide information about the deeper layers of the earth's interior. They are seismic waves and, to a lesser degree, the earth's magnetic field (discussed later). These are completely out of human control. Some hydrogen bomb explosions have produced earth tremors that could be observed at great distances from the source, so that the shocks generated by them penetrated deeply on their way across the earth. But apart from this relatively novel and rather expensive method, investigators have had to wait for major earthquakes to occur now and then. Larger quakes are recorded at seismological stations all over the world. If the station is far enough away from the focus (source) of the quake, disturbances reaching it must have traveled through the earth's deep interior. The disturbances have the form of shocks or pulses, but by the time they reach the observer they are usually spread out in time and are referred to as seismic waves.

The first effective seismographs were developed toward the end of the 19th century. By 1903 the International Seismological association was founded and from about that time a world-wide quantitative survey of earthquakes has been conducted. The information bearing on the earth's interior has been carefully analyzed by Jeffreys, Beno Gutenberg and K. E. Bullen. There are two main types of seismic waves, the P waves (primary, because they travel fastest) and the S waves (secondary, because they travel more slowly and hence arrive later at the station than the P waves). The P waves are compressional (longitudinal) in nature, whereas the S waves are shear (transverse) waves. For purposes of this article, this fact is not of major importance; it should be noted, however, that the existence of two types of waves greatly increases the amount of information to be had about the earth's interior. If the material of the earth's interior were uniform, all seismic disturbances would propagate along straight lines. But the mechanical properties of the material change with depth, and this leads to a phenomenon akin to refraction: the paths of the seismic disturbances are curved. They are convex toward the inside of the earth. Frequently, a seismic wave, on emerging to the surface of the earth, is reflected there and then progresses through the interior along another curved path. This may be repeated several times. The paths are determined by means of a step-by-step mathematical process, starting with short paths and then going to longer ones that reach progressively greater depth. The primary data are the travel times, the times elapsed from the moment of the earthquake to the arrival at the observing station. They depend in a rather complicated way on the distance between focus and observer. The derived data are the elastic properties of the interior as functions of the depth. (*See* also EARTHQUAKE.)

The most conspicuous feature of the earth's interior is the existence of a sharp boundary at which reflection and refraction occurs and which encloses the part known as the core; it represents an extremely well-defined discontinuity. The mean radius of the core (ignoring flattening) is 3,470 km. or nearly 55% of the earth's radius. The most outstanding feature of the core is that it never transmits S waves. Because this is a distinctive characteristic of liquids, it is generally accepted that the material of the core is in a liquid state, probably consisting in the main of molten iron. The existence of the core was first quantitatively established by Gutenberg in 1913. Later studies have shown that there exists a further boundary, somewhat diffuse, which encloses the so-called inner core. Its radius, not precisely known, is about 1,300 km. There is some evidence that the inner core is solid again, and a number of investigators believe it consists of solid iron (solidified again under the extreme pressures prevailing), but the question is not definitely settled.

The following terminology for the main layers of the earth is generally accepted (*see* fig. 3). Outermost is the crust; it is about 30 km. deep below the continents but extremely thin, if not completely absent, below the oceans; its lower boundary is called the Mohorovičić discontinuity, after its discoverer. This is not everywhere a sharp discontinuity. The region below this and above the core is designated as the mantle, extending to the boundary of the core at a depth of about 2,900 km. The mantle has some internal structure, but this structure is not too pronounced

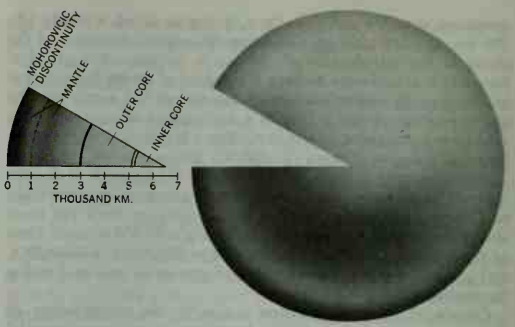


FIG. 3.—MAIN LAYERS OF THE EARTH

considering the mantle's enormous depth. The lower part of the mantle, below a depth of about 900 km., seems to be completely homogenous. The core (outer core) is fluid and appears quite homogenous; little is known about the inner core.

Seismic Velocities, Density, Pressure.—From the primary data of seismology, namely, the travel times as function of distance, the variation of seismic velocities with depth can be computed. In the mantle as well as in the core there is a progressive stiffening of the material with increasing pressure; this makes the waves run faster at greater depths. The density distribution in the earth's interior cannot be uniquely determined from such data, but certain rather restrictive conditions are imposed on it thereby. A further condition results from a knowledge of the "moment of inertia" of the earth about its axis. This latter quantity is known with great accuracy from a combination of astronomical and geodetic observations. For a homogeneous sphere the moment of inertia about an axis through the centre is 0.4 ma^2 where m is the total mass, a the radius of the earth. The observations show that the moment of inertia of the earth is 0.334 ma^2, which can only be interpreted as indicating a rather pronounced increase of density toward the central parts of the earth. Combining the last figure with the seismic data and arguments regarding homogeneity of certain layers, Bullen determined a number of possible density distributions of which a plausible one is shown in fig. 4. The graph does not include the inner core, since little can be said about its density.

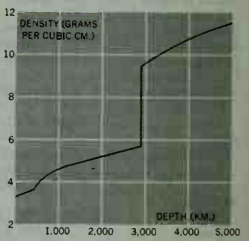


FIG. 4.—PROBABLE DENSITY DISTRIBUTION IN THE EARTH DOWN TO THE LIMIT OF THE INNER CORE

The pressure inside the earth rises rather regularly with increasing depth. In the mantle the rise is at a rate of about 470 atm./km. (1 atmosphere of pressure = 14.7 lb. per square inch). The pressure at the boundary of the core is 1,370,000 atm., at the centre of the earth it is 3,700,000 atm. The strength of gravity is also a function of the depth; it clearly must vanish at the centre of the earth. Calculations based on the density distribution of fig. 4 show, however, that gravity is remarkably constant throughout the mantle, to within 1% or 2%; but beginning at about the boundary of the core it decreases steadily to zero.

ORIGIN, COMPOSITION AND AGE

Formation of the Earth.—The physics and chemistry of the earth are extraordinarily complex and have many interrelated facets. This makes it difficult to present the subject in a straightforward logical order. Some physical properties, such as density and gravity, which can be deduced, in part at least, from direct seismic observations, have been referred to. Other physical properties, such as the temperature, are best deferred until after the chemical composition of the earth has been discussed.

Astronomers have speculated about the origin of the solar system ever since Kant and Laplace suggested in the 18th century that the stars and planets arose from the condensation of vast gaseous masses filling cosmic space. It is possible that the formation of the sun occurred much earlier than that of the planets. Many theories about the origin of the planets have been propounded and rejected. In more recent times some progress has been made. It is generally accepted that the planetary system developed out of a disk-shaped mass of gas surrounding the sun. It is beyond doubt that the overwhelming part of original cosmic matter consisted of hydrogen (and some helium) and that these gaseous components must have been lost to space from the disk at an early stage. The less volatile matter condensed, mainly in the form of silicates and of metallic iron, these being the prime constituents of present-day meteorites as well as of the interior of the earth (*see* below). At the time the gas escaped, the solid matter probably consisted of bodies much smaller than the present planets, since the latter would hold on to a gaseous envelope by gravitation, at least to some of the gases heavier than hydrogen. The smaller lumps of silicates and iron eventually collected by gravity and, colliding with each other, formed the present planets.

While this picture is crude and speculative in its details, it brings out one crucial point common to all modern theories as distinct from the views held in the 19th century. The original matter from which the planets condensed must have been relatively cold. It could have been warmed only by the slight absorption of sunlight possible in the planetary disk. The corresponding temperatures were probably lower than those prevailing now at the surface of the earth. This is a fact of importance for an understanding of the history and even of the constitution of the earth. It follows that the original earth was not a molten mass. It might have come near to melting at a later stage as a result of the heat developed by radioactive substances, which heat remains largely trapped inside the earth. But this is a secondary process, and the picture is different from that of an original ball of molten lava cherished by earlier speculations. At some time the earth must have been soft enough to permit separation into the present layers, and at this time the radioactive substances, which tend to associate chemically with the relatively lightweight compounds, would have become concentrated in the outermost layers, thus preventing further heating of the deep interior. H. C. Urey worked out many details of this scheme of the formation of the earth.

Chemical Composition.—The composition of the earth's crust can be investigated directly by quantitative chemical analysis of samplings from many rocks. The pioneer in this field was V. M. Goldschmidt, who in the early decades of the 20th century undertook the painstaking task of determining the average proportions of the chemical elements in the earth's crust. To appreciate the significance of the results it is necessary to compare them with what is known about the chemical composition of cosmic objects other than the earth. Such objects are, in the first place, meteorites, messengers from outer space falling upon the earth. It is generally conceded that meteorites are fragments of a larger body pertaining to the solar system which was shattered by a collision with some other planetary object. A great number of chemical analyses of meteorites have been made. Next, quantitative determinations of the relative proportions of the chemical elements can be made for the sun by spectroscopic methods. Finally, the same can be done for other stars, although there the accuracy is limited.

One conclusion that long has been drawn from the vast mass of observations is that the gross chemical composition of matter in the universe is relatively uniform. There might be small variations from one star to the next, but on the whole the impression of over-all uniformity is strong. Scientists are thus led to think of a definite gross composition of primordial matter from which the earth and the other planets were formed. The figures given below for the relative proportions (known as "cosmic abundances") of the most important elements are from a compilation by H. Suess and Urey (1956). Since the abundances are only relative, they are expressed as the numbers of atoms existing per one atom of a reference substance. The latter is taken to be the element silicon, since rocks consist largely of compounds of silicon. These abundances are as follows:

Hydrogen ...40,000.0	Sodium 0.04	Sulfur 0.37
Helium 3,100.0	Magnesium 0.91	Argon 0.15
Carbon 3.5	Aluminum 0.09	Calcium 0.05
Nitrogen 6.6	Silicon 1.0	Iron 0.6
Oxygen 21.5	Phosphorus 0.01	Nickel 0.03
Neon 8.6		

Remarkably enough, only six of the remaining elements have abundances that lie between 0.001 and 0.0001; all other elements are so rare that they exist only in minutest traces on the cosmic scale.

At the formation of the earth most of the volatile gases must have escaped to space. Some of them remain on the planet Jupiter, which has a density much lower than that of the earth. These volatiles must have included most of the carbon, nitrogen and oxygen, except for a fraction that may have been able to form nonvolatile compounds. The most important nonvolatile elements in the above table are magnesium, silicon, sulfur and iron; on the earth they are to be found mostly in the form of compounds rather than of the elements themselves. Some fraction of the oxygen is retained by forming compounds with the nonvolatile elements, especially silicon; a relatively small amount of hydrogen is retained in the form of water, although even all the water of the oceans and such water as is contained in rocks constitutes only a minute fraction of the total mass of the earth.

On the whole, the lighter compounds are more concentrated in the crust; they include oxides and more complex compounds of sodium, magnesium, aluminum and calcium that form many important constituents of common rocks. Geologists are able to discriminate between rocks pertaining to the surface layers and others that have been pushed up from lower layers and should therefore resemble more closely the chemical composition of the earth's mantle. On the basis of such data it is commonly believed that the earth's mantle consists primarily of certain compounds (silicates) containing oxygen combined with silicon, magnesium and iron. This takes care of three of the commonest nonvolatile elements, leaving sulfur to be accounted for. So far as sulfur exists in the interior of the earth, it is most probably in the form of iron sulfide. Geochemical evidence, however, indicates that the element is far less abundant on earth than the over-all cosmic abundance figure given above; much of it must have escaped and the remainder is not likely to be a major constituent of the earth.

Many students of the problem of the earth's constitution have proposed that the main constituent of the mantle is a mineral called olivine, since the oldest known rocks are largely composed of this substance. Olivine is a composite of magnesium orthosilicate, Mg_2SiO_4, and iron orthosilicate, Fe_2SiO_4. The two can crystallize together with any proportion of magnesium to iron. The common variety of olivine contains about one part of iron to nine parts of magnesium, but it is quite possible that farther down in the mantle the relative proportion of iron increases. Another group of minerals that might be important in the constitution of the mantle are the metasilicates of magnesium, $MgSiO_3$, and of iron, $FeSiO_3$, known as pyroxene. Olivine and pyroxene make up most of the silicate component of meteorites. Since there is good evidence that meteorites are fragments of a planetary body that has been shattered, their chemical composition is likely to be representative of the interior of a planet. Furthermore, seismic data as shown in fig. 1 agree well with the assumption that the earth's mantle consists mainly of minerals of the olivine type. There is some evidence indicating that at greater depth minerals of this kind might change their crystal structure to a more compact form.

The core is most probably composed of molten iron. This view has been held for many years and is generally accepted, although a few isolated dissenters look for a more complicated constitution. There is undoubtedly also a small amount of nickel, and some other impurities might be dissolved in the fluid mass. The view that the core consists of iron fits all the known physical and chemical facts. It is in agreement with the seismic data and, since the melting point of iron at high pressures is much lower than

that of the compact silicates, it explains the appearance of a sharp discontinuity at the core's boundary. Iron is by far the heaviest of the common nonvolatile elements, hence it will try to find its way toward the more central parts of the earth. Meteorites are composed mostly of the silicates mentioned above and of metallic iron (or an iron–nickel alloy). Some meteorites consist almost entirely of silicates, others entirely of iron and some contain lumps of metallic iron embedded in the silicates. This is commonly interpreted by saying that meteorites are fragments of a cosmic body smaller than the earth in which the temperature, pressure and force of gravity were smaller, so that the rather complete separation of metallic iron and silicates by gravity which exists in the earth did not take place.

The composition of the inner core is doubtful. The cosmic abundance tables show, however, that the sum total of all the elements heavier than iron (relative to the main constituents of the earth) is not remotely enough to fill a volume the size of the inner core; hence it is usually assumed that the inner core consists of iron, solidified under the extreme pressures prevailing near the centre of the earth.

Radioactive Age Determinations.—For many years geologists have estimated the length of periods in the earth's history on the basis of the rate of deposition of sediments, the thickness of observed layers and so on. They early arrived at minimum figures of well over 100,000,000 years for the main part of geological history. The discovery of radioactive decay around 1900 provided an entirely new and much more reliable method for dating events in the earth's history. Radioactivity consists in the transformation of one species of atomic nucleus into another. In the case of naturally radioactive substances this transformation occurs spontaneously, and no chemical or physical condition of the environment has any effect on the rate of radioactive decay. In any given interval of time a fixed fraction of the atoms of the mother substance decay into atoms of the daughter substance. Radioactive decay, therefore, furnishes a natural and trustworthy type of clock wherewith to probe the distant past. Only the most long-lived of radioactive substances can be used for the dating of earlier periods in the history of the earth.

Sometimes several radioactive transformations occur in succession. The first radioactive substances that were discovered form a "family" of this type. Its parent substance is uranium, which through a series of decay processes goes over into radium and thence through a series of further decay processes into lead. The decay of uranium is by far the slowest process, so that by measuring the rate at which lead is formed in a substance containing uranium, the rate at which uranium decays is measured directly, inasmuch as the subsequent processes require only a short time compared with the decay of uranium itself. Each chemical element consists of a mixture of several types of nuclei (isotopes), and only one isotope of each element participates in a given radioactive transformation. Thus if a substance contains both uranium and lead it is possible to separate the particular isotope of lead produced by radioactivity, and by comparing this with the amount of uranium present, the time during which the radioactive decay has been going on can be ascertained.

The radioactive processes given below are used in the dating of rocks. The first two are complex families terminating in two different isotopes of lead, the other two are one-stage transformations. The numbers indicated are half lives—*i.e.*, they give the time in which exactly half the nuclei of the mother substance present to begin with have been transformed into nuclei of the daughter substance.

Uranium-lead	4,500,000,000 years
Thorium-lead	14,000,000,000 years
Potassium-argon	1,500,000,000 years
Rubidium-strontium (est.)	50,000,000,000 years

The techniques of finding minute quantities of certain chemical elements and in particular their isotopes are extremely delicate, and it has taken many years to develop them. They are now sufficiently advanced so that if the age of certain rocks is determined by means of two or three of the radioactive schemes, the results agree closely.

In making these determinations it is assumed that at the time of the formation of the rock (for instance, by solidification from a volcanic magma) the isotopic constitution of the daughter substance is that normally found in the absence of radioactivity. As time goes on the isotope newly formed becomes enriched, and it is this enrichment that is measured. The oldest rocks thus dated are nearly 3,000,000,000 years old. None older than these have been found near the surface of the earth, but a series of dates extends from there with almost no gaps down to the present. It is interesting to see how these dates are tied in with the series of events determined by geologists. As is well known, the order of geological strata is fixed entirely by means of fossils; thus the geological method presumes the existence in these periods of living beings of gradually increasing complexity. By means of radioactive dating methods it is possible to ascertain definite lengths for the periods of geological history, especially more recent ones. The earliest period distinguished by geologists is the Cambrian, which occurred about 400,000,000–500,000,000 years ago. All older rocks are somewhat loosely lumped together as Pre-Cambrian. This is not to say that life did not exist in the Pre-Cambrian but merely that fossils have not been distinguished in these old rocks, and hence their position in a geological sequence cannot be ascertained as simply as that of more recent rocks.

Attempts have been made to estimate the total age of the earth. This is done under certain plausible assumptions, using data on the relative proportions of lead isotopes in very old rocks and in meteorites. In this way an age of the earth is arrived at of about 4,500,000,000 years. The figure is not too accurate, and it might be better to say that the earth is probably between 4,000,000,000 and 5,000,000,000 years old. The term "age of the earth" is not well defined here, since it is not quite clear through what processes the solid substances passed before forming a body approximately the present size of the earth.

MAGNETISM AND TEMPERATURE

Earth's Magnetic Field.—Seismic waves that have traversed the deeper layers, it has been noted, give us information about the earth's structure. An entirely different type of messenger from the interior is provided by the earth's magnetic field. The magnetic compass has been used by mariners for navigation from about the end of the middle ages. The earliest compasses consisted of lodestone (a magnetic mineral) fastened to a piece of wood which floated on water. Later, this was replaced by a magnetized steel needle resting on a sharp point and free to swing about it. The magnetic needle points approximately to the north, but usually its direction differs from true geographical north by several degrees of angle, depending on position on the earth. This deviation is known as magnetic declination. If the magnetic needle is made to move freely in a vertical plane rather than a horizontal one and if this plane is oriented in the direction of magnetic north, the needle will come to rest in a position that makes an angle with the horizontal, the north pole of the needle pointing downward in the northern hemisphere and upward in the southern hemisphere. The angle with the horizontal is known as magnetic inclination. By combining the measurements of declination and inclination a direction in space is obtained along which a needle would point if suspended so that it could rotate freely in any direction. It is possible to measure the strength of this pull, the "intensity" of the magnetic force. If the spatial direction and the intensity of the magnetic force are measured at all places of the earth's surface, the results constitute what is known as the earth's magnetic field. Knowledge of this field has been gradually accumulated by magnetic surveys extending all over the earth.

In 1600 William Gilbert enunciated the proposition that "the whole earth is a big magnet," based upon the knowledge of that time and borne out by all later observations. All magnetic fields have sources, either in the form of magnetic substances such as magnetized steel, or in the form of electrical currents which are surrounded invariably by fields of magnetic force. The question arose whether the sources of the earth's magnetic field are inside or outside the earth. About 1830 the mathematician C. F. Gauss proved that if the magnetic field is known at all points of the

earth's surface, the field can be separated into two parts: one whose sources are entirely inside and another whose sources are entirely outside the earth's surface. Subsequently it was shown that only a small fraction of the earth's magnetic field comes from outside sources; the overwhelming part originates inside the earth. For a long time physicists thought that the magnetic field was due to magnetic materials embedded inside the earth, but as knowledge of the interior grew this possibility was gradually eliminated, since at the high temperatures prevailing in the earth all substances lose their magnetization. Thus it became necessary to look for another source.

The earth's magnetic field has two outstanding characteristics. The first is its irregularity, as seen for instance in the variation of the magnetic declination from place to place, the over-all pattern of which is quite complicated. The second is its gradual change in time. This is a phenomenon well known to all navigators: since the declination of the needle changes continuously, magnetic maps that indicate the declination are seriously in error after a few years and must be redrawn periodically from new observations. This change is known as the "secular variation" of the earth's magnetic field. If a variation of 10′ per year continues over, say, 60 years, it corresponds to the considerable change of 10° in declination. The pattern of change is, however, itself variable.

These rapid changes make it clear that the field does not originate in the solid mantle of the earth. W. Elsasser demonstrated that the magnetic field is caused by electric currents that flow in the fluid, metallic core. The secular variation indicates that the fluid of the core is in motion. This motion carries the electric currents about and thus produces the variation of the field observed at the surface. The details of this variation, rather irregular, may be interpreted as representing so many large-scale eddies in the fluid. From the secular magnetic variation may be obtained a value for the average speed of the fluid iron; this is 0.03 cm./sec. or about 10 km. (6 mi.) per year. Further development of these ideas leads to the conclusion that the fluid motion not only modifies the electric currents but also can produce and maintain them. This process resembles closely the one that takes place in a rotating generator of electric current as found in power stations, where current is produced by the motion of metallic wires past each other. In the core, streams of molten metal are the equivalent of the moving wires. This explanation of the earth's magnetic field, known as the dynamo theory (Elsasser, 1947), has become accepted generally. The question as to what keeps the core in motion is taken up below.

Rock Magnetism.—When a lava melt is solidified in a magnetic field and the field is removed later, it is found that the solid rock formed retains a slight amount of so-called remanent magnetization along the direction in which the original magnetic force pointed. The remanent magnetism is due to small grains of magnetic material (iron oxide) embedded in the rock. On the basis of this it becomes possible to infer the direction of the earth's magnetic field at the time an ancient lava flow occurred. Similarly, sandstones have been shown to retain a small remanent magnetization along the direction of the field in which the material was deposited. The study of rock magnetism has been developed to the level of a systematic approach, giving information about the character of the magnetic field at earlier times in the earth's history. There seems to be little doubt that during the last 500,000,000 years or so that are accessible to detailed geological study the earth has had a magnetic field similar to its present one.

Work on rock magnetism has shown, surprisingly, that apparently the magnetic field has reversed its polarity many times, perhaps hundreds of times during the past history of the earth—that is, the magnetic south pole became the north pole, and conversely. A detailed explanation of this remarkable phenomenon is lacking; it can be said merely that its occurrence is conceivable in terms of the dynamo theory, since a self-excited generator can produce electric current in one direction as well as in the other, depending on its starting conditions.

One school of geologists maintains, largely on the basis of evidence provided by ancient climates, that the earth's geographic poles have shifted their position relative to the crust. According to this view the north pole was somewhere in the Pacific in early geological ages. Rock magnetic studies may permit verification of this hypothesis. No final conclusion had been reached by the 1960s, but there is much evidence that such pole migration indeed occurred in the past.

Temperature and Heat Transport.—There is no direct way of determining the temperature distribution inside the earth, but an instructed guess may be ventured. Something can be said about the surface layers, and it is a well-known fact that the temperature rises in the lower levels of deep mines. The rate at which heat is delivered to the surface is given by the rate at which the temperature rises (the thermal gradient), multiplied into the thermal conductivity which is a characteristic constant of the material. Thus by measuring the two last-named quantities the heat flowing out of the earth can be determined. The results of heat-flow measurements on the ocean bottom indicate that even where the oceans are very deep the heat flowing out of the earth is comparable to that flowing out on the continents. The average thermal gradient in the outermost layers of the earth is about 12°–15° C. per kilometre of depth. The average heat flow near the surface of the earth is about 1.2×10^{-6} cal. per square centimetre per second.

Assuming that, say, a thermal gradient of 14°/km. continued to greater depth, the temperature at a depth of 300 km. would be about 4,200° C. This is certainly far above the melting point of any silicate, even at the pressures prevailing at such depth. Hence the temperature must level off; that is, the thermal gradient must radically diminish even at moderate depths inside the earth. It long has been concluded that most of the heat flowing out of the earth is produced by radioactivity (the most important contributions coming from the decay of the uranium and thorium families) and that the radioactive material must be strongly concentrated in the top layers of the earth. If the material were distributed at greater depth, the earth would have been completely melted long ago. On the assumption that the earth was formed in a cold condition and that radioactivity was evenly distributed in the beginning, then the earth would gradually heat up by radioactivity during its early history. This follows from the fact that heat conductivity of rocks is poor: in a crude way of speaking, heat cannot penetrate a layer of silicates more than 200 km. thick even in the course of several billion years. Eventually, then, the iron will melt and thereafter the melting point of silicates will be approached. After the silicates have become soft enough (they perhaps need not melt completely) a separation of the material into layers will take place. It may be shown that radioactive substances form compounds that are relatively light and tend to float toward the surface.

For a long time it was believed that most of the radioactive material is in the crust, and since the crust is thick under the continents but thin or almost absent under the oceans, this would mean that most of the heat flow would occur in continental areas. Heat-flow measurements on the ocean bottom have shown that this view is wrong; the radioactive material is there, though under the oceans it is apparently in the mantle (below the Mohorovičić discontinuity) and not in the crust.

Next consider the temperature distribution in the deeper layers of the earth. In this it is necessary to rely largely on guesswork, but any assumed distribution is subject to certain conditions. It must remain below the melting point of the simple silicates throughout the mantle, it must be above the melting point of iron in the outer core, and if the inner core consists again of iron the temperature must rise to the melting point of iron at the boundary of the inner core and exceed it inside the latter. The best way to obtain the temperature inside the earth is therefore to estimate the increase of melting point with increasing pressure. This can be done only roughly since the pressure at the boundary of the core is about ten times that of pressures obtainable in the laboratory.

Estimates of the temperature in the earth's interior tend toward relatively low values, perhaps in the neighbourhood of 3,000° C. at the boundary of the core and near 4,000° at the centre

of the earth. These estimates, however, may be in error by many hundreds of degrees.

Silicates, as has been said, conduct heat only very slowly, and on this basis any heat contained in the deeper layers of the mantle would, as it were, remain nearly sealed in during the lifetime of the earth. In 1956, however, E. Clark and Francis Birch brought to light another mechanism of heat transport in the mantle, namely, by radiation. All substances radiate when raised to sufficiently high temperatures. At moderate temperatures this radiation consists of infrared rays: the heat radiated by a hot stove can be felt but not seen. As the temperature increases, more and more of the radiation becomes visible, first as red, then as yellow and finally as white glow. Stefan's law says that the total amount of energy radiated is proportional to the fourth power of the absolute temperature, hence it rises extremely steeply with increasing temperature. There is no doubt that such radiation is present inside the earth; the main question is whether it can travel fast enough from place to place to transport an appreciable amount of heat. The rate of heat transport by means of radiation depends essentially on the transparency of the materials involved; the more transparent they are, the more rapidly heat can flow by radiation. Such minerals as olivine are rather transparent even to the naked eye, as may be seen by holding a thin plate against the light. At an early stage of the investigation of this effect, it appears that at temperatures somewhat above 1,500° C. radiative heat transport begins to approach the magnitude of ordinary heat conduction, and at somewhat higher temperatures radiative transport becomes much more efficient than ordinary conduction. The result of all this is that in the deep interior of the earth the temperature can be equalized much more readily than had been assumed; hence only a moderate thermal gradient should be present in the lower parts of the mantle.

In regard to the core, there is one piece of fairly direct evidence, namely, the relatively rapid fluid motions that are mirrored, as it were, in the variation of the earth's magnetic field. By far the most plausible explanation of these motions is that they represent a form of thermal convection, entirely akin to the upwelling that is observed when a pot of water is heated from below, making the warm water from the bottom rise to the surface. This view is held by most students of the problem. For a long time it was difficult to understand how such convection can occur in a notoriously good conductor of heat such as a metal which is surrounded and thus shielded by a poor conductor such as the rocky mantle. The obstacle disappears when radiative heat transport is taken into account. Radiative transport is quite small in the core since metals have a very low transparency; on the other hand, the radiative transport in the lower mantle appears to be more effective than the transport by conduction in the core, and this difference keeps the convective process in the core going. Whether the core cools down gradually as a result of the heat carried away through the mantle, or to what degree this loss is compensated by heat produced by radioactive materials in the core or in the inner core, had not been decided in the early 1960s.

ORIGIN OF THE SURFACE FEATURES

The surface of the earth shows a remarkable degree of irregular structure. In spite of the assiduous work of generations of geologists very few generalizations have emerged. One of them is that the levels of the earth's surface cluster around two preferred heights: (1) sea level—most of the areas of the continents and of the offshore continental shelves do not differ much from sea level—and (2) ocean bottoms, with an average depth of about 5 km. (3.1 mi.). Levels between these are rare. Another remarkable regularity has to do with the asymmetrical distribution of land and water masses. If a diameter is drawn arbitrarily across the earth's centre in more than 90% of all cases one end of the diameter is on land, the other on the sea. The fact that conclusive explanations, going beyond mere speculation, of such simple regularities cannot be given is indicative of lack of understanding of most of the basic physical and chemical processes that have shaped the surface of the earth in its present form.

Isostasy.—There is, however, a hypothesis, founded on physical law and accepted on observational evidence, according to which the surface features of the earth are subject to the principle of isostasy, first developed by J. H. Pratt and G. B. Airy around 1850. Clearly, if the continents were fluid they would flow out laterally and eventually disappear in the ocean deeps, covering the earth uniformly. The fact that this is not observed indicates that the material of the continents has a finite strength. On the other hand, rocks can be deformed, and this type of deformation is known as plastic flow. The deformation of the earth's crust may be visualized by means of the flow of pitch (although pitch, technically speaking, is not plastic but viscous). If a load is put on the pitch—for instance, a piece of rock—the load will gradually sink down. The crust considered as a load on the mantle differs from this example in an important respect: the load is less dense, it is specifically lighter than the substratum. Such a load will sink only to a depth where it is floating freely with respect to vertical displacements; it resembles an iceberg floating in the water with the larger part submerged beneath the surface. According to the principle of isostasy there is a tendency toward vertical equilibrium of the crust, which is much easier to achieve than horizontal spreading. Quantitatively speaking, the total mass encountered on going from the surface down toward the earth's centre tends to be the same for any point of the surface. Where there is a mountain there seems to be more mass, but isostasy indicates that there must be a deficiency of mass farther down: the mountain has a root consisting of matter less dense than the material farther down and than the material under the oceans. The root is bigger than the mountain itself; the lighter material extends down to about six times the mean elevation of the mountain.

This idea of isostatic (vertical) compensation was first developed on the basis of gravity observations. If ideal isostatic balance prevailed, gravity would be the same over the oceans and continents (apart from variation with geographical latitude). Actually most mountainous elevations and most oceanic deeps are fairly well compensated isostatically. Deviations, known as gravity anomalies, occur in the regions where active mountain building goes on. The Pacific island areas (*e.g.*, the Japanese islands) are an example. Volcanic activity is concentrated in these same regions, as are earthquakes. Many earthquakes originate fairly near the earth's surface, but in these active regions earthquakes are observed to originate at depths down to 700 km.; these are known as deep-focus earthquakes. Thus the upper mantle seems to participate to at least this depth in the mountain-building processes. Whether the lower mantle also plays a role, more or less indirect, in influencing the geological activity near the surface is unknown. (*See* also ISOSTASY; GEODESY: *Isostasy.*)

Theories of Mountain Building.—The problem of the formation of the continents and mountains is one of the few great unsolved questions of physical science. A series of four agencies has been held responsible for mountain building, either individually or jointly, though it is probable that several (especially the last three) have been acting together. The actual mechanisms as related to geological observation cannot be discussed here; the principles will merely be enumerated.

1. Contraction.—The meaning is best represented by the popular simile that the earth resembles a shrunken apple, the mountains and valleys being the wrinkles of its skin. This is the oldest hypothesis, but ever since the discovery of radioactive heating of the earth it has been difficult to believe that the earth has shrunk appreciably in geological times.

2. Convection.—If the mantle were a viscous fluid heated from below, convective upwelling would occur at a slow rate. Speeds have been estimated as of the order of one millimetre per year. If the thermal conditions are right there must certainly be a tendency toward convection, though the mantle is a plastic solid and not a viscous fluid, and this might make actual patterns look quite different from those of a fluid. With the leveling off of the temperature curve down in the mantle, moreover, it is doubtful whether convective motions can extend deeper than the upper mantle. It has been impossible to identify any specific geological phenomenon as caused by convection, but the general idea is strongly in the mind of geologists and geophysicists.

3. Phase Change.—By this is meant a change in crystalline structure of minerals, which may occur as a result of either temperature or pressure changes. In particular, there is much evidence that at high pressures certain more compact forms of minerals are stable that do not exist at the surface of the earth. It has been claimed that the Mohorovičić discontinuity at the bottom of the crust represents such a phase change. Temperature might rise by radioactive heating and this could shift the discontinuity downward. Temperature falls again and the discontinuity rises if the heat is carried off by volcanism and other agencies. The tendency toward isostatic equilibrium might then produce fairly large vertical displacements. Such ideas are comparatively new, and while they may not be enough to explain mountain building alone, the process can play an important subsidiary role in a complete theory.

4. Accretion.—Since, on going down into the earth, the temperature first rises very rapidly and then more slowly, the silicates of the mantle might be closer to melting at a few hundred kilometres depth than elsewhere. If melting occurs locally, the material will separate into its lighter components on top, the heavier below. Lighter material might gradually make its way through the overlying layers to the top, and in this manner the amount of crustal material can grow. Volcanism appears to be a process of this kind. It is thus possible that the continental blocks of the crust have only gradually accumulated through geological ages. There is also strong evidence to the effect that the ocean and the atmosphere are secondary products of accretion—that is, have been slowly formed in the course of the earth's history from material coming out of the rocks. The accretion theory has become popular, and there is little doubt that some of the insights it provides are highly significant. A definitive theory of mountain building, which remains to be propounded, is likely to be very complex and to contain a combination of several of the aforementioned mechanisms.

Encyclopædia Britannica contains a vast number of articles relating to the earth. For the main article on the science of the earth, *see* GEOLOGY; for composition and chemistry of the earth, *see* GEOCHEMISTRY; for earth physics, *see* GEOPHYSICS and the numerous related articles on various branches of geophysics cited there; geodesy, the science of earth measurements and internal structure, is discussed at length in GEODESY. *See* also references under "Earth" in the Index.

BIBLIOGRAPHY.—There is a lack of general nontechnical presentations dealing with the physics of the earth's body. The pages of the *Scientific American* may be consulted as a substitute. *See* G. P. Kuiper (ed.), *The Earth as a Planet* (1954); *Handbuch der Physik* (*Encyclopedia of Physics*), vol. 47, *Geophysik I* (articles in English); for smaller reviews *see* W. M. Elsasser, "The Earth's Interior and Geomagnetism," *Reviews of Modern Physics*, vol. 22 (1950); J. A. Jacobs, *Advances in Physics*, vol. iii of *The Interior of the Earth* (1956); T. P. Kohman and N. Saito, "Radioactivity in Geology and Cosmology," *Annual Reviews of Nuclear Science*, vol. 4 (1954). More specialized books are K. E. Bullen, *An Introduction to the Theory of Seismology* (1953); H. C. Urey, *The Planets* (1952); V. M. Goldschmidt, *Geochemistry* (1954); W. A. Heiskanen and F. A. Vening Meinesz, *The Earth and Its Gravity Field* (1958). (W. M. E.)

EARTHENWARE, opaque ceramic bodies that are permeable under the glaze. They are composed of varying mixtures of three basic ingredients: (1) plastic clays, to give workability; (2) flint, to prevent deforming during firing; and (3) feldspar, to act as a flux and give hardness to the fired body. Small amounts of other ceramic ingredients are also added, depending on production needs.

Earthenwares are bisque fired from about 650° to 1,000° C. and then are covered with a glaze coating to make them nonabsorbent; the glaze coating is fired at temperatures ranging from 1,000° to 1,100° C. Decorating processes are similar to those for chinaware. (*See* CHINAWARE: *Decorating the Ware.*)

Principal earthenware types include faïence, majolica, delftware, terra cotta and queen's ware. *See* POTTERY AND PORCELAIN: *European Pottery to the End of the 18th Century.* (P. V. G.)

EARTH INDUCTOR COMPASS: *see* COMPASS.

EARTHNUT, a European plant, *Conopodium majus* (Umbelliferae, or parsley family), so-called because of its edible tubers. It grows in woods and fields in the British Isles, and from Norway, France, Spain and Portugal to Italy and Corsica. It is a slender, smooth perennial two to three feet high, with much-divided leaves and small white flowers in compound umbels. The basal leaves wither at flowering time, and the stem leaves wither as the fruits mature. The tubers, reaching one inch in diameter, are more commonly used as food on the continent than in Britain. The plant is also called pignut or hognut. The peanut (*q.v.*) or groundnut (*Arachis hypogaea*) is sometimes called earthnut.

(J. W. Tr.)

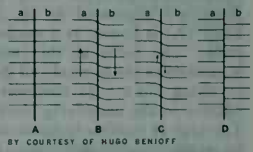
EARTH PILLAR, a column of soft rock, or earth, which has not a homogeneous structure throughout but contains large blocks embedded in much finer material. By exposure to conditions of denudation, especially rain action, the large blocks protect the material beneath and so, by differential action, the earth pillars are produced. Glacial drift and morainic deposits are ideal substances in which earth pillars can be formed and these structures are therefore found in regions of recent glaciation. Earth pillars are most likely to be found where the climate is semiarid with precipitation concentrated. The "bad lands" of western North America furnish excellent examples, and there are specimens in Tirol and other parts of the Alps, in Scotland and in the Dead sea region.

EARTHQUAKE. Whenever the state of elastic strain or distortion of a limited portion of the earth is suddenly changed, either increased or decreased, elastic waves are set up which travel outward in all directions. The shaking of the ground produced by the waves is known as an earthquake. The limited region in which the strain increment occurs is called the earthquake source. Earthquakes are classified according to the nature of their sources. Those originating in a strain increase are termed explosion earthquakes. They are produced by man-made dynamite or nuclear-energy blasts and by volcanic-steam explosions and sudden movements of molten lava within the earth in association with the activity of volcanoes. The latter, called volcanic earthquakes, are generally small in size in comparison with other natural earthquakes, although a few are large enough to be severely destructive over small areas.

All great earthquakes and the great majority of small ones are generated by the sudden decrease or release, in a volume of rock, of elastic strain previously accumulated over an interval of time varying from a minimum of about a year in regions of great activity to many centuries in others. Earthquakes of this type are designated tectonic earthquakes. The volume of rock involved is related to the energy of the earthquake and is roughly 2,000,000 cu.mi. for the largest shocks. The strain accumulation is produced by differential movements of portions of the earth's outer layers. In the majority of shocks the movements are horizontal. The processes of orogeny—the growth and wearing down of mountains —result in vertical differential movements and these are also responsible for a substantial number of earthquakes.

MECHANISM OF GENERATION

In the case of explosion shocks, the sudden expansion of the charge produces an outward movement of the surrounding rock and this movement is propagated to great distances in the form of to-and-fro wave motion owing to the elastic nature of the rock (*see* GEOPHYSICAL PROSPECTING). In tectonic earthquakes, the sources are associated with great fractures in the crust of the earth known as faults. The behaviour of a fault (*q.v.*) in the generation of an earthquake is illustrated in fig. 1. In drawing (A), on the left, the fault is represented by the heavy line. Suppose that after the occurrence of an earthquake, parallel lines are drawn on the ground perpendicular to the fault as shown. At some later time it will be found that the blocks (a) and (b) have moved relative to each other as shown at (B). The high pressure existing within the earth produced by the weight of the overlying material presses the blocks together with great force and the resulting friction between the two surfaces of the fault



BY COURTESY OF HUGO BENIOFF

FIG. 1.—DIAGRAMS ILLUSTRATING MECHANISM OF EARTHQUAKE GENERATION ON A FAULT (*see* TEXT)

prevents them from slipping past each other. Consequently, the adjacent regions are distorted (strained) and the original parallel lines become curved in the vicinity of the fault as indicated. The strain involves a storage of elastic energy in the same way that a bent bow contains stored elastic energy available for driving an arrow. As the strain gradually increases there comes a time when at some point along the fault the elastic stress becomes sufficiently large to break the restraining frictional bond and at that point, called the focus or hypocentre, the fault surfaces suddenly slip as represented in (C). The slip at this point increases the stress at neighbouring points caused by crowding and these then slip also. In this way slip is propagated rapidly along the fault for a greater or less distance depending upon the size of the original strained volume and the strength of the frictional bond. After the slip has occurred the configuration appears as in (D) with the fault surface of block (a) permanently displaced relative to block (b). The release of frictional restraint and the sudden consequent fling of the two fault surfaces converts the stored elastic strain energy into kinetic energy in the form of elastic waves in the rock that travel in all directions from the region of strain relief.

In any single earthquake the amount of slip—that is, the relative displacement of the two fault surfaces—may be a few inches in a very small earthquake or up to 50 ft. or more in a large earthquake. The largest measured slip was in the Yakutat, Alaska, earthquakes of 1899 where a vertical slip of 47 ft. was measured.

After the earthquake has taken place the fault surfaces again become locked by friction and cementation. The blocks then continue their relative movement as before and in time another earthquake is produced. The rate of the steady relative block motion has been measured on only one fault, the San Andreas of California, where it was found to be approximately two inches per year. During the 1906 San Francisco earthquake, the slip occurred on a northern 270-mi. segment of the fault from San Juan to Upper Mattole. The slip was horizontal with a maximum displacement of 21 ft. In 1857 a similar slip occurred on the southern segment from San Bernardino northward. The total accumulated slip on this fault since movement began has been estimated by California geologist Mason Hill to be not less than 350 mi. It may be very much greater.

The extent of faulting, defined as the length of the fault segment over which slip takes place, varies from a few hundred yards in a small shock to a maximum of several hundred miles in the greatest earthquake. The great Kamchatka earthquake of Nov. 4, 1952, and the Aleutian earthquake of March 9, 1957, each exhibited active segments of approximately 600 mi. as indicated by the distribution of aftershocks (*see* fig. 6).

The direction of slip may be horizontal, vertical or a combination of the two depending on the nature of the fault. The volume of strained rock which constitutes the source of earthquake energy is roughly a rectangular prism with approximate dimensions that may extend up to 600 mi. in length, as at Kamchatka, by 150 mi. in width and 20 mi. in depth. When a seismologist announces the position of an earthquake he usually refers to the position of its epicentre, the point on the surface vertically above the hypocentre, rather than the centre of the source.

The three principal kinds of faults are illustrated in fig. 2. Fault (A) is known as a normal fault. The plane of the fault is inclined to the vertical and the overlying block slips downward relative to the underlying block. This type of fracture is generated by tensional forces directed horizontally at right angles to the fault acting together with the downward force of gravity. In (B) the character of the fault is the same as the one in (A) except that the direction of motion is reversed. This type is termed a reverse fault and originates from compressive forces acting horizontally at right angles to the fracture. In (C) the slip is strictly horizontal and the fault is known as a strike-slip or lateral fault. Faults are fairly common in which the slip direction is a combination of that of (C) with either (A) or (B). The San Andreas fault is a good example of a fault with horizontal slip only, as in (C) in the figure. It is branched in the southern portion and fig. 3 shows an air photograph of a segment of one of the branches, looking northward. The town of Indio is below to the left just off the picture. Because of the desert climate of this region, weathering is slow and the fault stands out as a clean cut. Although the two truncated mountain areas at the lower left and at the centre of the photograph appear to be the two parts of a single mass displaced by the fault, they are in fact entirely unrelated structures. The relative block motion as shown by the arrows is such that the one on the left has moved up from the south relative to the other, and the total motion has been so great that the mating portions of both blocks are not identifiable because of differences in the geologic processes to which they have been subjected.

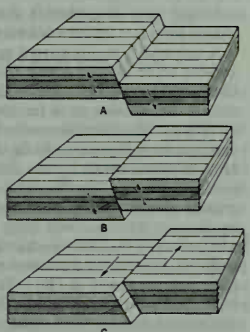


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FIG. 2.—FAULT TYPES: (A) NORMAL FAULT; (B) REVERSE FAULT; (C) STRIKE-SLIP OR LATERAL FAULT

SPENCE AIR PHOTOS

FIG. 3.—BRANCH FAULT OF SAN ANDREAS SYSTEM, LOOKING NORTHWARD

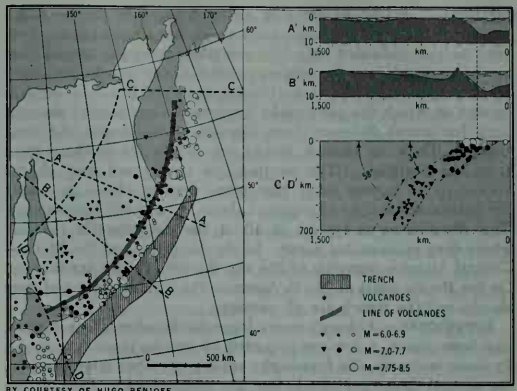
OCCURRENCE

Depth Distribution.—Earthquakes are conveniently classified in three depth ranges—shallow, intermediate and deep. The shallow shocks have hypocentres extending from the surface to a depth of 30 mi. This classification includes most of the great earthquakes and those of greatest destructiveness. The intermediate group has hypocentres ranging from 30 to 185 mi. below the surface of the earth. These are fewer in number than the shallow type and, except for those occurring near the upper boundary, are smaller and less destructive. The deep earthquakes have hypocentres extending in depth from 185 to 450 mi., approximately one-tenth of the earth's radius. No shocks have occurred at greater depths since seismographs have been available for observing them. It is assumed that they do not occur deeper, since at the high temperatures which prevail there the rock flows or creeps under stress and consequently is unable to accumulate sufficient strain to generate earthquakes. However, it is possible that under the conditions existing within the earth, processes may occur at rare

intervals involving sudden changes of state with consequent sudden changes in volume of a mass of rock and so produce earthquakes deeper than those observed in the short time since the seismograph (*q.v.*) was invented.

Geographic Distribution.—Although probably no area of the earth is entirely free of earthquakes if a sufficiently long time interval is considered, in recent times the great majority have occurred in well-defined regions. The epicentres of large shallow earthquakes, magnitude 7.9 and greater (see *Magnitude*, below), that occurred in the 20th century are plotted in fig. 4 together with a few dating back to 1896. From this map it can be seen that there are two principal active regions, a rather narrow belt extending around the margins of the Pacific ocean and a wedge-shaped area lying across southern Asia, Asia Minor and the Mediterranean region, with its broad base in China and the point off the coast of Portugal. The circumpacific belt thus includes the western coasts of North and South America, the Aleutians, Kamchatka, the Kuriles, Japan, the Philippines and a strip through the East Indies to New Zealand. The wedge-shaped area includes, among others, portions of Mongolia, southern and western China, Tibet, Baluchistan, northern India, Assam, Turkistan, Iran, Turkey, Bulgaria, Greece, Italy, Algeria and Portugal. Fairly large earthquakes occur in the antarctic region to complete the Pacific circle, although no great shocks have been recorded from that region since instrumental data have been available. Other regions of minor activity with smaller earthquakes include a narrow band along the mid-Atlantic ridge from Spitsbergen and Iceland south to about latitude 60° S. This joins another narrow belt from the southern tip of South America running east to a point south of Malagasy (Madagascar) where it bends to the north and extends into the Indian ocean to the coast off Arabia and then turns west to join another narrow belt running north to south down the eastern part of Africa through the Great Rift valley of that continent.

The geographic distribution of intermediate-depth earthquakes (fig. 4) is very similar to that of the great shallow earthquakes except that their epicentres generally lie farther inland along the Pacific margins and they are entirely absent along the Pacific coast of North America from Lower California to Alaska. Moreover, they are almost entirely absent from the regions of minor shallow activity.

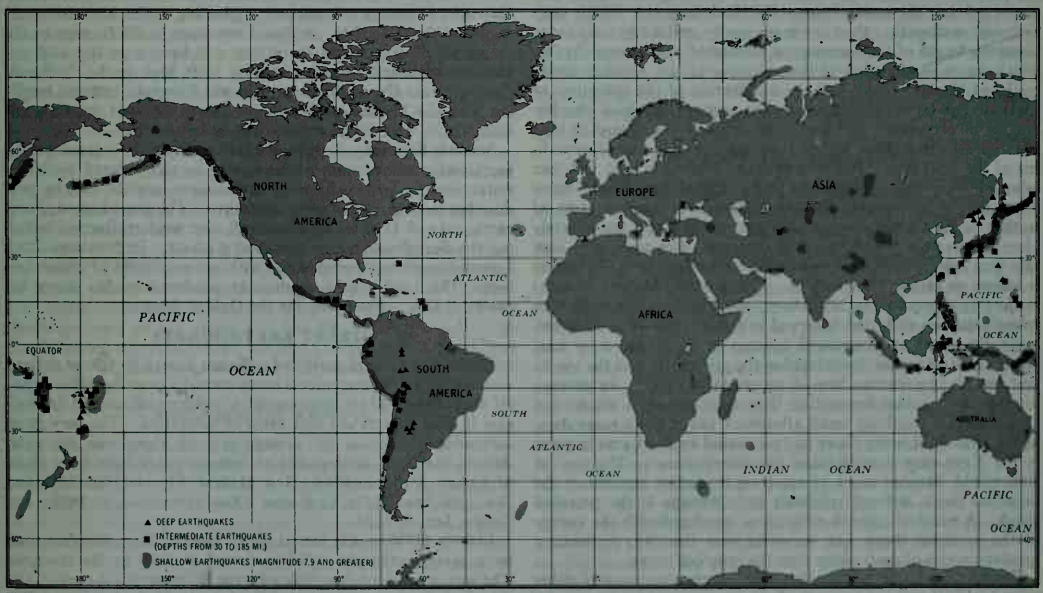


BY COURTESY OF HUGO BENIOFF

FIG. 5.—MAP OF THE KAMCHATKA-KURILE REGION WITH PROFILES AND A SECTION SHOWING DISTRIBUTION IN DEPTH OF EARTHQUAKE HYPOCENTRES (M = MAGNITUDE; 1 KM. = 0.621 MI.)

The deep earthquakes are still more restricted in their distribution (fig. 4). They follow the western rim of the Pacific from Kamchatka to the Tonga-Kermadec islands and the eastern arc from Chile to Peru only. Moreover, their epicentres generally lie still farther inland as compared with the intermediate-depth shocks. In the Asiatic-Mediterranean wedge they are represented by only two shocks. One appeared under southern Spain on March 29, 1954, at a depth of 400 mi., and the other under Sicily on Feb. 19, 1955, at a depth of 290 mi.

Along the circumpacific margins the spatial distribution of the three depth classes of earthquakes follows a unique pattern illustrated on the map and vertical section of the Kamchatka-Kurile region (fig. 5). The geographic distribution of epicentres of larger earthquakes from 1904 to 1945 is shown on the map, the open circles referring to shallow shocks and the filled circles and triangles to intermediate and deep shocks respectively. The



BY COURTESY OF HUGO BENIOFF

FIG. 4.—WORLD DISTRIBUTION OF EPICENTRES OF EARTHQUAKES

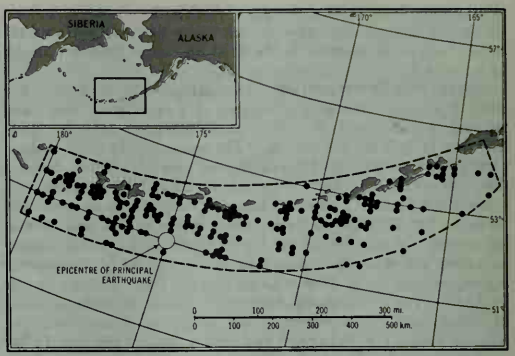
locations of volcanoes are also included together with a rough outline of the great oceanic trench which lies off the coast. Vertical sections indicated (A′) (B′) are taken along the dashed lines on the map and show the relative position of the trench, the neighbouring uplift and the line of volcanoes. (C′D′) is a vertical section on which the earthquake hypocentres are plotted showing their horizontal distances from the line of volcanoes and their depths. Thus the shallow shocks are distributed farthest away from the continent. The intermediate shocks and deep shocks appear to lie in two fairly thin plane regions which dip under the continental margin at angles of about 35° and 60° respectively. This distribution is typical of all of the circumpacific margins where deep earthquakes occur. In the Aleutians and the Mexico-Central America segments of the arc, the deep shocks are missing. On the Pacific coast of North America, the intermediate and deep shocks and the trench are all missing.

Foreshocks.—Although many large earthquakes occur without any forerunners, a few are preceded by one or more foreshocks. In some instances, the foreshocks appear in rather large numbers for several days or hours before the main shock. Thus in the Pleasant Valley, Nev., earthquake of 1915, people living near the fault felt almost continuous shaking accompanied by rumbling noises beginning at 5:49 P.M. and continuing until 10:53 P.M. when the principal shock occurred. In about 1 case in 20 a large earthquake is followed by another of equal or greater energy.

Aftershocks.—Every large earthquake is followed by a number of smaller earthquakes known as aftershocks. They appear immediately after the principal shock and may continue to occur for a period extending from a day or two, in exceptionally short sequences, to a maximum of about 15 years. The majority of sequences continue for about two years. Following the Kern county, Calif., earthquake of 1952, a seismograph of high sensitivity located at Palomar observatory, 172 mi. from the epicentre, exhibited continuous ground vibration for more than 24 hours due to the large number of aftershocks. The aftershock epicentres are usually distributed over a roughly rectangular area having a long dimension corresponding with the active fault segment of the principal shock and a transverse dimension extending up to 150 mi., depending upon the region and the size of the earthquake. When the principal earthquake is small the aftershocks tend to be concentrated near the ends of the active fault segment. With large principal earthquakes they are more nearly uniformly distributed along the length of the segments as illustrated on the map (fig. 6), which shows the location of the epicentre of the Aleutian earthquake of March 9, 1957, and the distribution of the epicentres of some of the larger aftershocks. The manner in which the frequency of occurrence and size of aftershocks are related in time has indicated that about half of them are due to elastic afterworking of the fault rock. If a thin flat strip of steel is bent and then released, it returns immediately to its original flat shape. Some other materials, however, behave differently. Thus a strip of leather or plastic will recover only part of its strain immediately after release; the final portion of recovery takes place at a slow rate that may require days or months for completion. This effect is known as elastic afterworking. It has been observed in rocks subject to stress in the laboratory, and the law of recovery so found coincides with that observed in a large class of aftershocks.

Another class of aftershocks appears to be produced by final release of strain redistributed during the original fling of the blocks and retarded by viscous flow of subcrustal material. In general, aftershocks are less destructive than their principal shocks but occasionally a relatively small aftershock can produce more damage as a result of being closer to a populated area. A case in point is the Kern county earthquake mentioned above. The city of Bakersfield, situated about 15 mi. from the active segment of the principal shock, suffered relatively little damage in the principal shock. A small aftershock with about one-hundredth the energy of the principal shock, but occurring near the city, produced a greater amount of destruction than the principal shock.

Tsunami.—Large earthquakes with sources near coasts either inland or offshore, and particularly those occurring in the vicinity of great oceanic trenches, occasionally produce great ocean waves



BY COURTESY OF HUGO BENIOFF

FIG. 6.—EPICENTRES OF THE ALEUTIAN EARTHQUAKE OF MARCH 9, 1957, AND A NUMBER OF ITS LARGER AFTERSHOCKS

known as tsunamis (sometimes erroneously called tidal waves). Some are believed to be caused by vertical fault movements and others by submarine landslides initiated by earthquakes. In the open ocean the wave amplitudes are small, two or three feet at the most, but their wave lengths—distance from crest to crest—may be more than 100 mi. The wave periods—the time from crest to crest—usually range from 15 to 30 min. The waves travel at speeds ranging from about 150 m.p.h. in water 1,600 ft. deep to about 670 m.p.h. in water 30,000 ft. in depth. Although the amplitudes are small in the open ocean, they increase greatly upon approaching shore, especially in V-shaped bays where they may rise to 90 ft. or more and thus produce very great destruction and loss of life. The initial wave usually, but not always, begins with a recession which appears as an abnormally low tide occurring in a matter of minutes and exposing the ocean floor far beyond the limits of normal low tides. Residents of coastal regions subject to these waves recognize these abnormal recessions as the first movements of a tsunami and flee immediately to high ground. Tsunamis travel great distances across the ocean with relatively little loss of energy. A tsunami originating in the Aleutian earthquake of April 1, 1946, produced waves up to 55 ft. high in the Hawaiian Islands, where more than 150 lives were lost and 488 homes demolished. The waves were 12 ft. high on the California coast at Santa Cruz, where one man was drowned; tsunami resulting from the Alaskan earthquake of March 27, 1964, hit Crescent City, Calif., with 10-ft. waves, causing ten deaths.

Seismic Seiches.—Seismic seiches are oscillations generated by earthquake surface waves in closed or partially closed bodies of water (*see* SEICHE). In great earthquakes, seiches may be produced at large distances from the source. The great Lisbon, Port., earthquake of 1755 set up seiches all over western Europe including the Scandinavian countries and Finland. In Scotland, Loch Lomond oscillated for an hour with an amplitude of about two feet. The 1964 Alaska earthquake produced seiches along the coasts of U.S. states bordering the Gulf of Mexico.

GREAT EARTHQUAKES

About 50,000 earthquakes of sufficient size to be felt or noticed without the aid of instruments occur annually over the whole earth. Of these about 100 are large enough to produce substantial destruction if their centres are near areas of habitation. The very great earthquakes occur at an average rate of about one per year. Among the great earthquakes of historic times have been those of Lisbon, Port., in 1755; New Madrid, Mo., in Dec. 1811 and Jan. and Feb. 1812; California (San Francisco) in 1906; and Tokyo, Jap., in 1923.

Lisbon (1755).—On Nov. 1, 1755, Lisbon, Port., was destroyed by a great earthquake which occurred at 9:40 in the morning. The source was probably situated some distance off the coast. The principal shock was felt strongly for about six minutes. The violent shaking demolished all large public buildings and about

12,000 dwellings. Nov. 1 being All Saints' day, a large portion of the population was in the churches, most of which were destroyed with great loss of life. The total number of persons killed in Lisbon alone was estimated to be at least 60,000, including those who perished by drowning and in the fire that burned for six days following the shock. Damage was severe in Fès, Mor., and some damage was reported in Algiers, 700 mi. to the east. The earthquake generated a tsunami which produced waves 60 ft. high at Cadiz, Spain, and 40 ft. high at Lisbon. They traveled on to Martinique, a distance of 3,740 mi., in ten hours and there rose to a height of 12 ft.

New Madrid (1811–12).—One of the greatest earthquakes occurred near New Madrid in southern Missouri. Actually, there were three large shocks, on Dec. 16, 1811, Jan. 23, 1812, and Feb. 7, 1812. Very likely one was the principal shock and the others were foreshocks or aftershocks, but the available information is inadequate to settle this point. There were numerous other aftershocks of which 1,874 were large enough to be felt in Louisville, Ky., 200 mi. distant. The principal shock produced waves of sufficient amplitude to shake down chimneys in Cincinnati, O., 400 mi. away. They were felt as far away as Canada in the north and the Gulf coast in the south. The area of greatest shaking was about 40,000 sq.mi., considerably greater than that which accompanied the California earthquake of 1906, and largely on this basis it has been assumed by many seismologists that this earthquake was the largest United States earthquake since white men arrived. However, continental channel waves travel great distances with little loss of energy. Consequently, in continental earthquakes such as the Missouri shock, the area of strong shaking can be abnormally large as compared with coastal shocks. In coastal regions the channel is distorted or absent and hence the waves are attenuated faster with distance as compared with the mid-continental areas. If judged on the basis of the size of the shaken area, an earthquake of a given energy situated well inland will thus appear to be greater than one of the same size occurring in the more active Pacific coast areas. There is no question, however, that the New Madrid shock was a great one. In one region 150 mi. long by 40 mi. wide, the ground sank from 3 to 9 ft. and was covered by river water which rushed in. In places, forests were overthrown or ruined by loss of soil shaken from the roots of the trees.

California (1906).—On April 18, 1906, at about 5:12 A.M., the San Andreas fault slipped over a segment about 270 mi. in length extending from San Juan in Benito county to Upper Mattole in Humbolt county, and from there out under the sea an unknown distance. The slip was felt from Los Angeles in the south to Coos Bay, Ore., in the north. Damage was severe in San Francisco and in other towns situated near the fault such as San Jose, Salinas and Santa Rosa (20 mi. from the fault). Approximately 700 people were killed. The earthquake started a fire which did about $400,000,000 damage. Several European companies in which the burned property was insured went bankrupt in their attempts to cover the losses; others defaulted.

Tokyo (1923).—An earthquake struck Tokyo, Jap., near noon on Sept. 1, 1923. The death toll from this shock was estimated at 74,000. Fifty-four per cent of the brick buildings and 10% of the reinforced-concrete structures collapsed. One per cent of the dwellings were shaken down and 700,000 houses burned. The shock started a tsunami which reached a height of 36 ft. at Atami on Sagami bay, where it destroyed 155 houses and killed 60 persons.

ENGINEERING ASPECTS

In the early engineering applications of seismology, it was assumed that the destructiveness was directly related to the maximum horizontal ground acceleration taking place during passage of the seismic waves. A structure was thus considered immune to earthquake damage if it was designed to withstand a constant horizontal acceleration of some standard force usually taken as one-tenth to one-quarter of gravity. Although this approach results in a substantial reduction in earthquake damage as compared with designs that do not take horizontal forces into consideration, it fails in many cases to offer effective protection, first because earthquake accelerations are not constant but oscillate to and fro, and second because acceleration is not the characteristic of motion responsible for destruction. During an earthquake a structure or member of a structure is bent or distorted back and forth and when the bending exceeds a certain critical value the structure fails. The maximum flexure or amplitude is determined by the value of the earthquake spectrum at the frequency of vibration of the structure and by the damping or friction of the structure. In other words, although the earthquake is made up of vibrations of many frequencies occurring together, a structure responds only to those frequencies which lie in a narrow range near its own free vibration frequency, and the response is reduced by friction. In designing an earthquake-resistant structure, the engineer requires knowledge as to the maximum values of the earthquake spectrum likely to occur at a given site, and the vibration characteristics of the structure he designs. He then makes certain that walls, joints, ties and other members are designed so as to permit the structure to undergo those maximum strains or flexures without failure. Steel reinforcing is introduced into brick and masonry structures, since without it a small amount of flexure usually produces failure. The engineer may also introduce frictional members to reduce the anticipated response generally. Moreover, stone and other ornamentation on the exteriors of buildings is either entirely eliminated or greatly reduced, and that which is retained is anchored firmly to the building to prevent its being shaken loose to fall to the streets below.

An example of some of the unexpected effects that may arise from failure to take into account the spectrum aspects of seismic destruction may be cited. In the Kern county earthquake of 1952, the destructiveness was quite low in Los Angeles because of the moderate intensity of the shock there. However, one of the newly constructed office buildings, which went through the earthquake without even a crack in its principal components, suffered extensive damage to its lighting system. The lights in the offices were of the fluorescent type and were mounted in long, flat rectangular metal boxes. The boxes were suspended from the ceiling by aluminum tubes 30 in. in length, rigidly fastened to the ceiling and to the boxes. The fixtures thus formed pendulums with low damping and with periods that happened to resonate with a frequency range in the earthquake spectrum that was strong. The fixtures were set into violent oscillations and in a matter of seconds the supporting tubes sheared off at the junctions with the boxes and $60,000 worth of light fixtures were draped over the desks below. Had the designers introduced a small amount of friction in the mountings such as wrapping the tubes with plastic ribbon, or if the joints had been stronger, the fixtures would have withstood the shaking without damage.

THEORY AND RESEARCH

Origin of Earthquakes.—Earlier it was stated that the source of seismic energy is elastic strain set up by differential movements in the earth's outer layers (see *Mechanism of Generation*, above). Attempts to explain the origin of these movements—the ultimate causes of earthquakes—are very nearly in the realm of pure speculation. In the early days of seismology it was confidently believed that these differential movements were produced by buckling of the surface layers of the earth as a result of cooling of the interior from a warmer state. Later, geophysicists learned that the radioactive constituents of rocks are such that, instead of cooling, the earth is more likely warming up from a colder state. Hence, the hypothesis of the cooling origin has been abandoned by most research men.

Another hypothesis assumes that as a result of the interior of the earth being warmer than the outer portion, convection of the viscous molten material takes place between the two. It has been shown by geophysicist Chaim Perkeris that convection currents, if they exist, should occur in large convection cells of particular dimensions and form so that under large parts of the crust the moving material rises and at other parts it descends. Between the two there is a horizontal flow and it is argued that friction between this flow and the under side of the solid crust above results in the forces responsible for the fault strain accumulation.

One of the difficulties with this hypothesis is that the predicted shapes of the convection cells do not correspond with the shapes of the corresponding earthquake belts. Another objection is associated with questions of symmetry. In the regions of convection rise and descent, material should flow in or out equally from opposite directions forming symmetrical stresses above, whereas in the Pacific arc, such as shown in the Kurile-Kamchatka region and in the Asiatic-Mediterranean wedge, the sections are highly unsymmetrical.

Another hypothesis which attempts to explain the origin of the vertical differential movements assumes that in the vicinity of the circumpacific marginal belts the continents are growing by accretion of material acquired from below by chemical or physical differentiation and that growth is greatest at the margins. Being of lower density than the surrounding medium, the continents float in it and thus, as material is added to their undersides, they rise and spread proportionately. Being in contact with the lower oceanic block of higher density, the upper continental material flows out over the oceanic block which pushes under the lighter continent to form a slanting fault plane on which the earthquakes occur, as shown in fig. 6. Bulging and overriding of the continental margin produces the mountain chain, and the downward movement of the adjacent oceanic block forms the trench. A difficulty with this hypothesis is that during formation of this marginal structure the earthquakes should exhibit fault slips upward on the continental side and downward on the ocean side. In many earthquakes occurring in or near these marginal contacts with vertical fault slip components, the directions are reversed, indicating that the continent is descending at the margin rather than growing.

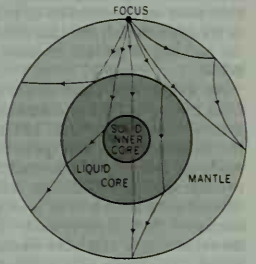


FIG. 7.—SECTION OF THE EARTH SHOWING A FEW OF THE PATHS TRAVERSED BY LONGITUDINAL WAVES FROM AN EARTHQUAKE FOCUS OR HYPOCENTRE

The origin of block movements responsible for horizontal slip earthquakes is even more obscure. In studying the directions of horizontal slip around the Pacific arc, it is found that in nearly all of the great faults lying parallel to the rim, such as the San Andreas fault, the sense of slip is right hand when viewed from above. It appears, therefore, that around the whole Pacific arc the continents are rotating clockwise relative to the bottom of the ocean. The earthquakes are thus generated at the contact between these two great structures moving relatively to each other. (One cannot say as yet which is rotating and which is stationary or whether they are both rotating.) What agent is responsible for this rotation? Wandering of the pole of rotation of the earth has been suggested, here again as pure speculation. There is evidence that long ago the north pole of the earth lay in what is now the Pacific ocean. In moving from that point to its present position, rotational forces of the right direction would tend to make the oceanic area rotate relative to the continent. The fact that motion continues now as a result of stresses acting in the past is explained on the basis of viscous effects delaying the strain release. This speculation also is not without serious difficulties.

Earthquake Waves.—Earthquakes generate four principal types of waves. Two of them are propagated within the earth and are known as body waves. The other two are propagated along the surface and are called surface waves. The body wave with the higher speed is known as a longitudinal, compressional or primary or P wave. In this wave the motion of the rock particles is to and fro in a straight line, parallel to the direction of propagation. Thus, as the wave passes a given point, the rock is alternately compressed and stretched. The speed of this wave varies from about 3.7 mi. per second in surface rock to 6.45 mi. per second in the earth's mantle near the boundary of the earth's core, which is 1,800 mi. below the surface. The increase of speed with depth is a result of the increase of hydrostatic pressure with depth. The speed drops to five miles per second when it enters the core and increases again to seven miles per second at the center of the earth. It takes slightly more than 20 min. for a P wave to travel from a shallow hypocentre through the centre of the earth to the antipodal point. In general, the increase in speed with depth makes the longitudinal waves travel in curved paths, concave upward. A few of the many paths which these waves take are shown in fig. 7. It will be noticed that some are direct from focus to observing site. Others involve one or more reflections at the surface, or reflections from the discontinuity at the surface of the earth's liquid core. Many other paths occur so that the whole pattern of them is very complex.

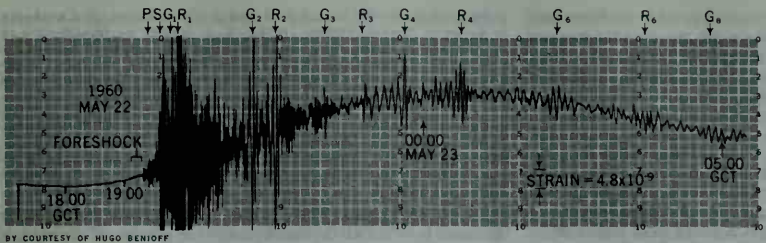
S Waves.—The other body wave is called a transverse, shear or secondary or S wave. The particle motion in this wave is in a plane at right angles to the direction of propagation. During passage of this wave, a small volume of rock is distorted in shape, first in one direction and then in the reverse. In P waves, the volume changes while the shape remains fixed; in S waves, the volume remains constant but the shape varies. The speed of the shear wave increases from about 2.1 mi. per second at the surface to 4.5 mi. per second near the boundary of the core. Shear waves cannot be propagated in a liquid, and the observed absence of such waves passing through the core is one of the compelling arguments for the hypothesis of the liquid nature of the outer portion of the earth's core. However, the seismic evidence indicates the existence of a small solid inner core. The paths of S waves within the earth are very nearly identical with those of P waves except for the absence of paths passing through the core. Transverse waves vibrate at a slower rate than longitudinal waves from the same source, or in more precise terms it is said their periods are longer. The vibratory excursions of the ground which they produce—their amplitudes—are also larger.

Surface Waves.—Of the two surface waves, the Love wave, named after A. E. Love who first predicted its existence, travels faster. It is a transverse wave in which the particle motion is horizontal only. Love waves exhibit dispersion; *i.e.*, up to a certain limit those of longer period (or slower vibration rates) travel faster than the shorter period waves owing to the deeper penetration of the former into the higher velocity regions of the earth. One Love wave that travels at high speed is known as a G wave after Beno Gutenberg who first observed it. This wave travels at a speed of 2.7 mi. per second. It requires 152.2 min. to make a complete circuit around the earth.

The other surface wave is called a Rayleigh wave after Lord Rayleigh who first theoretically predicted its existence. In these waves, the ground particles vibrate in vertical ellipses in such a direction that when at the top of the ellipse they are moving opposite to the direction of travel of the wave. Like the Love waves, Rayleigh waves are dispersed, the longer periods traveling faster and for the same reason. Their maximum speed has been figured at about 2.55 mi. per second, although higher speeds have been recorded, and their circuit of the earth at about 163 min. As they move away from the source, body waves spread out in the two dimensions perpendicular to the direction of travel; thus their vibration amplitude decreases rapidly with distance. Surface waves are confined to a thin surface layer and thus spread in one dimension only. Consequently, their amplitudes decrease more slowly with distance. Hence, in seismograms (recordings made with seismographs) of distant earthquakes, the surface waves generally appear with larger amplitudes than the body waves. In very large earthquakes, surface waves have been recorded after six complete passages around the earth requiring about 12 hours.

Another wave, discovered by Maurice Ewing and Frank Press and called Lg by them, is related to the surface waves. It is a form of guided wave which travels in the continental crust only. As a result of this characteristic, the wave has served effectively to outline continental boundaries in regions where they lie under shallow ocean areas.

Fig. 8 is a recording of the great Chilean earthquake of May 21–22, 1960, made at Isabella, Calif., with the fused quartz strain seismograph of the California Institute of Technology. The large scale sinuous displacement of the trace is the response to the tidal



BY COURTESY OF HUGO BENIOFF

FIG. 8.—SEISMOGRAM OF THE GREAT CHILEAN EARTHQUAKE OF MAY 21–22, 1960, RECORDING CIRCUITS OF G WAVES AND RAYLEIGH WAVES AROUND THE EARTH (*see* TEXT)

strain of the solid earth produced by the gravitational attraction of the sun and moon. The different seismic waves are identified as follows: P, the direct compressional body wave; S, the direct shear body wave; G_1, the direct surface shear or G wave; G_2, the surface shear wave which left the source in a direction opposite Isabella and traveled around the earth along a major arc; G_3 is G_1 after making an additional circuit around the earth; G_4, G_6 and G_8 are G_2 after one, two and three additional circuits around the earth respectively; R_1, the direct Rayleigh wave; R_2, the Rayleigh wave around the major arc; R_4 and R_6 are R_2 after one and two additional circuits around the earth respectively. (The time scale of the seismogram is expressed in Greenwich civil time [GCT].)

Seismic Intensity.—Seismic intensity is a term intended to refer to the level of violence of shaking at any given place and, as such, it can have a precise scientific meaning. Unfortunately, when the term first began to be used, instrumental techniques capable of accurate measurement were not yet developed. The early seismologists, consequently, established a substitute in the form of a scale based on a set of arbitrarily chosen effects resulting from the shaking. The first such attempt was known as the Rossi-Forel scale after its authors, M. D. DeRossi and F. A. Forel. This was later modified by G. Mercalli and finally by H. O. Wood and Frank Neumann, and in this form is known as the Modified Mercalli scale. It has 12 grades or steps, given below in abridged form.

Modified Mercalli Scale of Felt Intensity (1931; Abridged)

1. Not felt. Marginal and long-period effects of large earthquakes.
2. Felt by persons at rest, on upper floors or otherwise favourably placed to sense tremors.
3. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration can be estimated.
4. Vibration like passing of heavy trucks (or sensation of a jolt like a heavy ball striking the walls). Standing motorcars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of 4, wooden walls and frames creak.
5. Felt outdoors; direction may be estimated. Sleepers wakened. Liquids disturbed, some spilled. Small objects displaced or upset. Doors swing, open, close. Pendulum clocks stop, start, change rate.
6. Felt by all; many frightened and run outdoors. Persons walk unsteadily. Pictures fall off walls. Furniture moved or overturned. Weak plaster and masonry cracked. Small bells ring (church, school). Trees, bushes shaken.
7. Difficult to stand. Noticed by drivers of motorcars. Hanging objects quiver. Furniture broken. Damage to weak masonry. Weak chimneys broken at rooi line. Fall of plaster, loose bricks, stones, tiles, cornices. Waves on ponds; water turbid with mud. Small slides and caving along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
8. Steering of motorcars affected. Damage to masonry; partial collapse. Some damage to reinforced masonry; none to reinforced masonry designed to resist lateral forces. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
9. General panic. Weak masonry destroyed; ordinary masonry heavily damaged, sometimes with complete collapse; reinforced masonry seriously damaged. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud ejected, earthquake fountains, sand craters.
10. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Railway rails bent slightly.
11. Rails bent greatly. Underground pipelines completely out of service.
12. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.

It is clear that the Mercalli scale lacks scientific precision and is, in effect, only a rough, arbitrary classification of earthquake effects depending upon such observations as whether or not the shaking is felt by persons at rest or in motion, the stopping of clocks, damage to buildings and so on. Since all of these effects depend upon sensitivity of particular individuals, vulnerability of types of architecture, construction practice and such, the value of the scale is clearly in its descriptive qualities only. Moreover, it must be emphasized that intensity as indicated by any method and particularly by the Modified Mercalli scale, does not refer to the size of the earthquake. Thus, the intensity at a point close to a small earthquake may be the same as that distant from a large earthquake.

Destructiveness.—A more nearly precise approach to the specification of the intensity or damaging effects of an earthquake at any point has been made on an instrumental basis and, to eliminate confusion with the old intensity scales, the term destructiveness is substituted for intensity. Destructiveness at any point depends upon the size of an earthquake, that is, the energy liberated in seismic waves; the distance of the point from the source; the number and amplitude distribution of vibration periods at the earthquake source (called the spectrum of the source); the modifying effects on the spectrum by the intervening paths of the waves; and the nature of the ground at the observing site. To measure the destructiveness, a large number (theoretically an infinite number) of free-swinging pendulums might be set up, each with a different period covering a range from about $\frac{1}{20}$ sec. to about 10 min. After the occurrence of an earthquake, a curve could be drawn, plotting the maximum excursion of each pendulum against its frequency. This curve is the spectrum of the earthquake vibratory motion at the given site, and destructiveness is defined as the area under this curve. If the effects of the earthquake on a particular structure situated at the site where the spectrum was measured are now considered, it will be found that the maximum vibratory excursion to which any particular structure such as a flagpole, a building or the water in a reservoir will be subject is the amplitude of the spectrum for the frequency of vibration of the structure, provided that the damping (a factor which indicates how quickly its vibratory motion dies down when the excitation is removed) of the structure is small. When the excursion reaches a certain value for any structure, the structure is permanently damaged or destroyed. The reason, then, that destructiveness is defined as the area under the curve is that it involves not only the height of the curve at any point but also the number of periods at a given height. Thus, a narrow, higher spectrum would produce much damage in a few structures while a broad lower spectrum having the same area would produce a little damage in many different structures. The total destruction would then be the same in the two cases. Although a multipendular array as described above can be used to record the seismic spectrum, in practice it is obtained from records of a single pendulum by means of a rather complex mathematical operation.

The destructiveness at a given site is determined by the size and character of the earthquake at the source, by the distance from the source and by the character of the ground at the site. In soft ground such as alluvium, the amplitude of ground motion for higher frequencies is much greater than it is in hard rock—as much as eight times greater in extreme cases. For this reason, in estimating earthquake risk or probable destructiveness in a region such as California where faults are fairly uniformly distributed, the principal criterion is the density and rigidity of the ground or in phys-

ical terms the ground impedance. Each type of ground can thus be specified crudely by a ground factor which expresses the increase of vibratory motion compared with the motion in firm rock. Maps showing roughly the distribution of probable maximum destructiveness of a region can thus be drawn by assigning ground factors to the various geologic formations included within the area, and combining these with information of past earthquake activity. Such maps were constructed by C. F. Richter in detail for California and in less detail for the whole United States. Since the ground factor is not a constant but in fact varies from an average maximum of about three at high frequencies to unity at frequencies less than about $\frac{1}{8}$ cycle per second, it must be used with caution in estimating probable damage to structures that have long periods, such as reservoirs, dams, large bridges and towers.

Magnitude.—The only precise way in which the size of an earthquake can be accurately specified is by the energy released as seismic waves. Before the days when electronic computers became available, the calculation of the energy of an earthquake from the data given by seismographs was very laborious and, consequently, was carried out for only a few earthquakes. In order to provide a quick and easy means of classifying nearby earthquakes as to relative size, Richter devised a magnitude scale based on the maximum trace amplitude of a seismogram written by a horizontal pendulum seismograph of 0.8 sec. period and magnification of 2,800. He chose as a standard earthquake one providing a maximum trace amplitude of one micron (one-thousandth of a millimetre) on this instrument at a distance of 100 km. (62 mi.). He then defined magnitude as the logarithm to the base ten of the ratio of the amplitude of any earthquake at the standard distance to that of the standard earthquake. Since earthquakes occur at varying distances, it was necessary also to devise an empirical rule showing how the amplitude varies with distance. In this form the scale was useful only for earthquakes of small size at distances less than about 600 km. (370 mi.). The scale was later extended by Gutenberg and Richter to apply to distant shallow earthquakes recorded on other types of instruments and still later, by Gutenberg, to deep earthquakes. In applying the scale to nearly all earthquakes for which instrumental data were available over the interval from 1900 to 1950, Gutenberg and Richter found that the largest magnitude on the list was 8.6 and the smallest recorded earthquake on high sensitivity instruments had a magnitude of about 0. Thus, the theoretical ratio of trace amplitudes on the standard instrument of the largest magnitude earthquake to smallest is about 400,000,000 to 1. Since the magnitude represented only a measure of the ratio of trace recordings made with a given instrument, it was clear that its value would be greatly enhanced if a way could be found for relating magnitudes to energy. This proved to be a difficult task. A formula was devised by Gutenberg and Richter in the form: $\log E = A + B \log M$, where E is the energy in ergs, M is the magnitude and A and B are constants. For a number of years they used values of 12 and 1.8 for A and B, respectively, and it was found later that these constants gave values for the energy of earthquakes from 100 to 1,000 times too large. The formula was later modified to provide values of the energy more nearly in line with calculations based on direct methods. From a precise scientific point of view, the magnitude scale has very serious limitations as a means for determining the energy of earthquakes. Crude as it is, however, it represents a great advance over preceding methods of rating the size of earthquakes.

Energy.—The range of energy released as seismic waves in earthquakes of various sizes is enormous. The smallest earthquakes recorded at short distances by the most sensitive instruments have energies of only a few millionths of a kilowatt hour (10^5 ergs). The largest earthquakes have energies of about 280,000,000,000 kw.hr. (10^{25} ergs). The ratio, thus, is 10^{20} to 1. During the time the earthquake is being generated, the maximum power produced in the greatest earthquakes amounts to about 3,000,000,000,000 kw. The average energy released per year in earthquakes is approximately 300,000,000,000 kw.hr. and is derived principally from a small number of the largest shocks.

See also EARTH; and references under "Earthquake" in the Index volume.

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EARTHSHINE. The earth is a luminary to the moon as the moon is to the earth; consequently the portion of the moon's disk which is not illuminated by the sun is illuminated by earthshine analogous to moonlight. It is a familiar observation that when the moon is a crescent the earthshine is powerful enough to make the whole disk easily visible. The phases of the earth and moon are complementary, so that the earth is near "full" when the moon is near "new" and the earthshine is then strongest.

JOHN MARKHAM

EARTHSTAR (GEASTER LIMBATUS)

EARTHSTAR (*Geaster*), a fungus, a kind of puffball (*q.v.*) with a distinct outer coat that, on separating from the inner, splits into several divisions that become reflexed and spread like a star. The inner coat enveloping the spores is supported, like a ball, with or without a stalk on the upper face of the star. The spores generally escape by an opening that appears in the top of the ball. Earthstars are generally distributed in temperate zone woodlands, on the ground or on decaying leaves. *See* FUNGI.

EARTHWORM, a popular name sometimes erroneously thought to be restricted to the night crawler, *Lumbricus terrestris*, but now usually applied to all segmented worms that, with the night crawler, belong to certain families of the class Oligochaeta of the phylum Annelida (*q.v.*). Other common names loosely given to various earthworms are rainworm, angleworm, garden worm, manure worm, etc.

Distribution and Abundance.—In many areas native species were exterminated during the ice ages, and more recently have been disappearing in agricultural lands of Australia, New Zealand, Republic of South Africa and southern South America. Hardy species that survived the glaciation were carried everywhere that men settled. European forms able to survive agricultural practices, successfully colonized both temperate zones, some arctic areas and tropical mountains. Oriental *Pheretima* species, common in greenhouses for more than a century, are spreading through warmer parts of temperate zones. In the tropics transported African and American species have colonized widely.

Most of the hundreds of already described species of earthworms live in soil, but any area with adequate food, moisture and oxygen may be occupied if it is not too sour or alkaline (pH between 4.5–8.4). Among sites often colonized are compost and manure heaps; sewage beds; undersides of bark and holes in trees; axils of banana leaves; staghorn ferns 40–60 ft. above ground in tropical rain forests; caves and mines; and underground waters. They are found in mud 180 ft. below the surfaces of lakes, in moss on rocks above the tree line in the Himalayas and at a height of 15,870 ft. in the Andes. Earthworms are even found in gutters at eaves of buildings. Salt is harmful to most earthworms but species of *Pontodrilus* are restricted to the shores of warm oceans. A few small spe-

JOHN H. GERARD

EARTHWORM OR NIGHT CRAWLER (LUMBRICUS TERRESTRIS) IN BURROW

cies live only on trees in the rain forests of New Guinea, Burma and southwestern China (Szechwan).

Populations of earthworms vary in density from 13,000 to 500,000 per acre in cultivated fields, 2,000,000 per acre in pastures and 3,000,000 in Oxford meadows, to possibly 5,000,000–7,000,000 in areas in Switzerland, the Netherlands and New Zealand. The combined weight of the population of worms may equal or exceed the weight of sheep that a pasture supports. Fifteen gallons of the Chinese green earthworm *Pheretima hupeiensis* were removed at one time from an American golf green without causing noticeable population decrease.

Earthworms of forest litter and similar sites feed selectively, and little or no soil is found in their guts. Others eat their way through soil but only digest organic matter. Undigestible residues, after being milled in gizzards and acted on by digestive juices, are ejected underground or cast onto the surface as piles of short pellets or long cords, as hollow towers 1 to 4 in. tall or as irregular mounds up to 18 in. high. Estimates of the yearly deposition above ground of soil by earthworms in tons per acre are: 7–16 in England, 16 near Rangoon, Burma, 20 in Nigeria, 30–40 in Germany and Switzerland, 1–41 in cultivated fields of Nebraska, according to method of tillage and amount of mulching. Tunnels of burrowing forms branch frequently and are mostly horizontal, but vertical passages may go down 20 ft. Night crawlers plug the mouths of their burrows, especially in the fall, with pebbles, feathers, string, leaves and twigs. Clearly, earthworms have considerable influence on their surroundings, but Darwin's overpublicized conclusions about their activities have been challenged or denied and the importance of earthworms to soil structure and soil fertility remains debatable. Certainly *P. hupeiensis* has been an expensive nuisance in golf greens, and other species are considered agricultural pests in parts of the world.

General Description.—*Size and Growth.*—Earthworms are long, relative to the thickness of the body, and are marked off by fine circular furrows into 50–600 segments. All the segments may be delimited before hatching or additional segments may be formed at the hind end. Growth involves increase in the size of segments. During extended fasts the segments may, however, become much smaller than normal. The size of the body varies within a species according to heredity, age, physical condition and amount or kind of available food; some well-fed individuals become much larger than those in ordinary environments. A naturally relaxed worm may be nearly twice as long as when it is uniformly contracted, and if stretched or anesthetized becomes much longer still. Published measurements in absence of information as to age and condition accordingly have little significance. In pygmy species contracted specimens at maturity average about one inch long and $\frac{1}{32}$ to $\frac{1}{16}$ in. thick. Fully contracted adults of giant species, *e.g.*, the Gippsland worm (*Megascolides australis*) of Australia, may be three to four feet long and nearly two inches thick; extended specimens have been said to attain 10–12 ft. Large species are found on each continent and are especially abundant in Ceylon, Hainan Island and New Zealand. South America has several giant species, and there is one in Texas.

Sound Production.—The slurping sound produced by rapid contraction of an Australian giant in its burrow is easily audible above ground. A large Indonesian earthworm, *Pheretima musica*, makes birdlike notes; hence, its specific name. Other worm sounds include clicking, sucking and rasping noises.

Odour and Taste.—The South African giant earthworm has a creosotic smell so unpleasant that hogs, which generally are indiscriminate eaters, will not eat it. The odour of the small manure worm or brandling worm, *Eisenia foetida*, smells foul to some persons but only pungent to others. The Chinese earthworm smells like raw carrots, and an Oregonian species delightfully like a fragrant trillium. The taste of edible worms was praised by medieval epicures in France. Choice kinds of earthworms could be eaten, among the Maori in New Zealand, only by chiefs or by a dying commoner in his last meal.

Colour.—Green colouring is rare among earthworms but in many species red or brown pigment is deposited under the skin, either uniformly or in bands, stripes and splotches arranged in characteristic patterns. Forms with a glistening metallic coloration have been mistaken, even by zoologists, for snakes. A Philippine *Pheretima* that is bright yellow mottled with light blue has a Latin name meaning snakelike. Unpigmented worms may seem dark coloured when the gut is filled with black earth; rosy if the peripheral vessels are distended with the red blood; or milky white when the body wall is opaque. Refraction of light by the transparent cuticle covering the body produces an iridescence in some species, even unpigmented ones. A golden colour at the tail end of common European earthworms results from the aggregation of yellow corpuscles. During the breeding season of some worms a bright yellow, fiery red or orange colour appears in the clitellum—a saddle- or ring-shaped band of skin that becomes swollen at maturity. At the end of the breeding season the swelling gradually disappears and then the site of the clitellum is indicated only by a yellow-brown skin coloration. Green and pinkish varieties of the temperate zone species *Allolobophora chlorotica* exist.

Reproduction and Life Cycle.—*Reproduction.*—Reproduction usually is sexual and involves simultaneous transfer of sperm from each hermaphroditic member of a copulating pair into the paired sperm receptacles (spermathecae) of its partner. Among the various organs functioning in the exchange are suckers, claspers, adhesive glands, temporary or permanent seminal grooves, special muscles, bristles with hooks or microscopic teeth, prostates of several types and protrusible penes sometimes provided with ejaculatory bulbs (*Eudrilus eugeniae*). Some or all of the male organs of the earthworm, including the testes and spermathecae, have disappeared in those races producing eggs that do not need to be fertilized.

Life Cycle.—The life history varies within certain limits for each species according to environmental conditions such as temperature and moisture. Development always takes place in a tough capsule or cocoon secreted by the clitellum. As the worm backs out of the cocoon, eggs, sperm and a nutrient fluid are passed into the cocoon. *E. foetida* may deposit a cocoon 48 hours after copulation and thereafter once every three to five days for four and one-half months without another copulation. The young, averaging two per cocoon, hatch after 16–28 days, maturity being reached 70–120 days later. In the laboratory their life span has reached four and one-half years. *L. terrestris* deposits its cocoons about eight days apart, one worm issuing from each capsule after 61–80 days incubation at 70° F.; maturity is reached five and one-half to six months after hatching. Its life span in the laboratory has attained six years. *Allolobophora longa* is even more long-lived, reaching ten years in the laboratory. The European *Criodrilus lacuum* becomes mature in the third or fourth year. *E. foetida* may breed throughout the year if conditions permit, but in many species most individuals rest during summer heat and drought as well as winter cold. Restoration of favourable conditions brings the worms to activity. Other species periodically rest regardless of conditions and cannot be brought into activity by a change in external environment. Breeding in the temperate zone usually is in the spring and fall. The rest period in the tropics occurs during the dry season, the worms emerging early in the rainy weather and breeding as rainfall decreases at the end of the season.

Although water comprises 80%–85% of the weight of an earthworm, a considerable amount can be lost without fatality. Drowning seems unlikely among earthworms as submerged individuals have lived more than three months. Emergence of hordes of worms after cold and heavy rain in spring and fall has been explained in various ways but the cause remains unknown. However, birds do not eat these emergent worms, which usually die.

Regeneration.—Regenerative capacity among earthworms varies considerably. Night crawlers can replace the first two or three segments but do not regenerate lost tail portions. A manure worm can replace the first eight segments, and a head piece of 30 or more segments can grow a new tail, but an amputated tail eventually dies. In *Criodrilus lacuum* and several oriental earthworms some fragments can form new heads and tails simultaneously to become normal worms with functional sex organs. However, a small fragment cut from the hinder part produces a new tail at each end and eventually dies of starvation, whereas pieces

cut from the front part form a head at each cut surface and eventually die of constipation.

Importance.—Earthworms have served as fish bait for more than a thousand years. Sales in North America, including specimens preserved for dissection in schools and colleges, run to millions. Two native European species provide most of the merchandise: *Lumbricus terrestris*, collected at night while the worms feed and copulate on the surface; and *Eisenia foetida*, sold by nearly all who raise worms. Two red forms, *L. rubellus* from Europe and *E. eugeniae* from Africa, have been grown by several dealers. Fishermen have contributed significantly to the dispersal of exotic species through uninhabited areas.

Earthworms, when especially abundant, may be considered pests. Among the methods of control is the addition of actual chlordane dust, alone or with fertilizer, to the soil at the rate of 1 lb. per 1,000 square feet of soil surface; the surface should be thoroughly wetted before and after application.

See also references under "Earthworm" in the Index volume.

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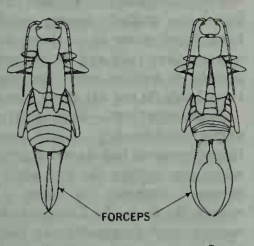
(G. E. G.)

EARWIG, an insect of the order Dermaptera, characterized by peculiar wings and a pair of horny forceps terminating the abdomen. Most species are less than one inch in length; the largest, *Titanolabis colossea* of Australia being about two inches. The large, membranous, radially veined hind wings fold both radially and transversely so as to lie hidden under the short leathery forewings (tegmina). Winged species rarely fly, and many are wingless. They are chiefly nocturnal and are frequently attracted to lights. The male forceps, larger and differently shaped from those of females, are in some species bizarre. The male forceps also usually fall into two sharply marked size classes, with few of intermediate length; *Forficula* affords a classic example of such bimodality, which, however, is more complex than was supposed (Chopard 1938); the cause may be a variable relation between time of last molt and beginning of rapid forceps growth. The name earwig comes from the Anglo-Saxon meaning "ear creature," and most European languages have an equivalent popular name because of an ancient, widespread but unfounded superstition that earwigs crawl into the ears of sleeping persons.

Several families and about 1,000 species are known, mostly from the tropics; Europe has about 30 species, North America 15 and Great Britain 7. A fossil earwig (*Protodiplatys*) from Jurassic beds in Kazakhstan seems to link Dermaptera with ancestral cockroaches (*Protoblattoidea*). The peculiar insects of the genus *Hemimerus* (family Hemimeridae), parasitic on giant African rats (*Cricetomys*), are sometimes ranked as a suborder of Dermaptera, sometimes as an order (Hemimerina). The Dermaptera were formerly placed with grasshoppers, crickets, etc., in the order Orthoptera.

The common European earwig (*Forficula auricularia*) is a well-known pest of gardens and houses. Commerce-borne from its native Europe, it has become established in North and South America, New Zealand and Tasmania, and seems destined to become cosmopolitan. It is omnivorous, feeding mainly on green plants; but it prefers anything more nourishing than it can find in nature, therefore sometimes swarms in kitchens. *Labidura riparia* and other earwigs use the forceps to catch insects and hold them for eating. When alarmed or aggressive, earwigs carry the forceps over the head in scorpion fashion; the males often use them to fight battles for the possession of a female. *F. auricularia* overwinters in small cavities in soil; 40 to 60 eggs are laid therein in fall or early spring, and the mother guards and cares for the eggs and young. Nymphs hatch in middle and late spring and remain in the nest, fed by the mother, until after the first molt. When the female opens the nest, the young wander off. Four to six molts occur; after each molt the nymph is inflated with swallowed air and appears white, but soon darkens. After the young depart the female feeds for a time and then rears a second brood.



COMMON EUROPEAN EARWIG (FORFICULA AURICULARIA): (A) FEMALE; (B) MALE

The best control is by scattering bran bait poisoned with sodium fluoride over the ground and in places where earwigs congregate; it is best done in the evening. If the bait is applied when most of the first brood of young earwigs have begun to feed at night, this brood and the adults can be poisoned before the second lot of eggs is laid. *See* also INSECT: *Dermaptera* (earwigs).

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(T. H. HL.; H. J. G.)

EASEMENT (SERVITUDE), in law, signifies a property interest giving a limited right to use or to prevent the use of the land of another. An easement may give the right to engage in a limited activity on the land of another, such as the privilege to maintain and use a driveway, a pipeline, or a railroad track (called affirmative easements), or it may involve a legal power to prevent the general owner and possessor of the burdened land from doing some act on his own land, such as a power to insist that light, air and view be unobstructed by structures (called a negative easement), or it may involve the privilege to go upon the land of another and sever some physical substance such as gravel (called more usually in England a profit a prendre). If this privilege to use the land of another is so tenuous that it is personal to the creators of the instrument, nonassignable and revocable at will or by death, it is usually called a licence, and rights and duties are governed by contract and not by property law (*e.g.*, rights of a theatre ticket-holder).

Also to be distinguished from an easement, which is basically a consensual relationship, are the natural servitudes such as the right as against one's neighbours to have a stream flow down to one's land without change. A further differentiation is made from an easement in situations where the general owner is subject to some active duty to do something on his land, such as to maintain a boundary fence in repair, which arise when an owner makes a promise with respect to the use of his land. This type of restriction on use and also many types of negative restriction for the benefit of neighbouring land are dealt with as covenants running with the land. (*See* COVENANT.)

An easement (rights in the land of another) is a burden to one parcel of land (the servient estate) and is a benefit to other land (the dominant estate) or to a person other than the owner of the burdened land. The easement is conceived of as appurtenant to (that is, as an attribute of) the dominant land itself, rather than as property of a person. Thus, transfer of the dominant land transfers the benefit of an easement without express reference to it. So strong is this idea of appurtenance that the benefit could not be transferred apart from the land; moreover, English law concluded that there could not be an easement in gross, that is, an easement without a dominant estate. In the United States, such an easement is recognized. Thus the owner of a pipe-line right of way running from Texas to Boston may be said to be the owner of an easement in gross and not appurtenant to some parcel at its terminus.

Another major difference between England and the United States concerns ancient lights (*q.v.*). In England an owner may have an implied or prescriptive right of light to the windows of his house across the land of another. In the United States this was thought to be inimical to land development and is not upheld. An easement of light in the United States must be based upon agreement.

Easements or servitudes may be acquired by express conveyance meeting the formalities required for transfer of other interests in land; by implication from the circumstances of a conveyance of a

portion of a larger parcel (*e.g.*, transfer of a parcel drained by a sewer running through land retained by the seller); by eminent-domain (*q.v.*) proceedings; and by prescription (*q.v.*), *i.e.*, by proof of uninterrupted enjoyment of the right (called user) for a prescribed period of time adverse to the interest of the general landowner.

The so-called easement of necessity is really an implied easement since it is not based on necessity alone. An easement of necessity for one parcel of land cannot arise across land of a stranger but only across land that was once in common ownership. When an owner of land conveys to another an inner portion of a larger parcel surrounded by land including other land of the conveyor, a right of access across land retained by the conveyor is implied if there is no other reasonable means of access. Such an easement may also be implied over the transferred land in favour of the retained land.

Historically, prescription created an easement through the legal fiction of a lost grant. A grant of an easement was presumed from the fact of long-continued user of the right. In early English law the enjoyment had to be "from time immemorial"; *i.e.*, from the commencement of the reign of Richard I (1189). Modern prescription statutes in England and the United States fix the period of continuous user required, usually at 15 or 20 years. To become an easement by prescription the user must be open and not hidden from reasonable inspection by the owner of the burdened land and it must also be adverse to that owner, *i.e.*, without his consent and wrongful, so that he could have brought legal proceedings to stop it.

Prescriptive user must also be uninterrupted. Owners of private streets or of rectangular parcels of urban land with buildings not built to the boundary line sometimes put up barriers on one or two days of a year in order to interrupt claims of user. Thus the path through the cemetery in Trinity churchyard in the Wall street area of New York city is barricaded from time to time to prevent the public acquiring a right of passage by prescription.

An easement may be extinguished by release, abandonment (*q.v.*), prescription, by unity of ownership of the servient and dominant estates, by conveyance of the servient estate to a third person not charged with notice of its existence, and sometimes by excessive use.

The kinds of easement which may exist, despite some language about closed categories in a few 19th-century cases, are almost as unlimited as the uses to which land may be put. Rights of pasture and footpaths of an agrarian society have given way in importance to easements of navigation (the right to unobstructed flight by an airplane at a certain height over land) and of trajectory and other easements of the age of the airplane and the missile.

In Roman and civil law the term servitude is used to describe substantially the same subject matter as easement describes in Anglo-American law. The term also includes, however, some matters which the common law classifies as covenants or equitable servitudes. (A. Dm.)

EAST, EDWARD MURRAY (1879–1938), U.S. geneticist, who helped develop hybrid corn (maize), was born in Du Quoin, Ill., Oct. 4, 1879, and was educated at the University of Illinois. After four years at the Connecticut agricultural experiment station, where he investigated the heredity and breeding of maize, tobacco and the potato, East moved permanently in 1909 to Harvard university where he became a professor in 1914. East is well known for his contributions to the development of hybrid corn, widely used in important maize-growing regions, for his investigations on the inheritance of quantitative characters and for studies on self-sterility in tobacco. His graduate students included many who became outstanding plant geneticists.

East wrote on many subjects. *Inbreeding and Outbreeding* (1919), a book written with D. F. Jones, had an important influence in genetics. His books *Mankind at the Crossroads* (1923), *Heredity and Human Affairs* (1927), plus numerous essays, express his views on the urgency of controlling the growth of human populations. (G. W. Be.)

EAST, THOMAS (*c.* 1540–1609), English music printer, who had the distinction of publishing many of the English madrigalists, became a freeman of the Stationers' company as early as 1565. William Byrd's *Psalmes, Sonets and Songs of Sadnes and Pietie* (1588) was his first venture into the field of music printing; he undertook it as the "assigne" of Byrd, who had been granted a monopoly by Queen Elizabeth I. Later, when this monopoly had been transferred to Thomas Morley, the latter also entrusted work to East, who clearly enjoyed the confidence of the best musicians of his day. Among the other composers he published were William Mundy, Thomas Weelkes, John Dowland, Robert Jones, Thomas Bateson and Francis Pilkington. In 1592 he edited *The Whole Booke of Psalmes, With Their Wonted Tunes,* in four parts, employing ten well-known musicians to supply the harmonizations, which were printed in score and not in the customary partbooks.

Michael East (*c.* 1580–1648), though probably the son of the above, did not succeed him as a printer. Understandably he appears to have been trained as a musician, and his father's connections may explain how, as a young man, he was invited to contribute to *The Triumphes of Oriana* in 1601. He became a prolific if not a very individual composer, publishing no fewer than seven sets of books containing madrigals, anthems and instrumental fantasies between 1604 and 1638. In about 1618 he was appointed organist of Lichfield cathedral and held this post until his death. His secular vocal music was reprinted by E. H. Fellowes in *The English Madrigal School,* vol. xxix–xxxi (1913–24). (J. J. N.)

EAST AFRICA, a term widely used for that part of Africa covered by the territories listed below, most of which were formerly administered by the United Kingdom. The more general term "eastern Africa" covers the area extending from Sudan and Ethiopia in the north to the Zambezi river in the south. Until 1920 Kenya was generally known as the East Africa Protectorate.

Country	Political status (1964)	Area (sq.mi.)	Population (1963 est.)	Density of population (per sq.mi.)
Burundi	kingdom	10,747	2,600,000	242
Kenya	kingdom	224,960	8,800,000	39
Rwanda	republic	10,169	2,900,000	285
Tanganyika and Zanzibar	republic	{361,784 {1,044	{9,700,000 {320,000	{27 {307
Uganda	independent sovereign state	91,134	7,200,000	79

Portuguese East Africa (*q.v.*), or Mozambique (297,846 sq.mi.; pop. 6,592,994; density per square mile 22), is sometimes included in east Africa, although in the 1960s its economic links were much closer with the Rhodesias, Nyasaland and the Republic of South Africa. Following World War I, German East Africa was divided into Tanganyika and Ruanda-Urundi (now Rwanda and Burundi); the small Kionga (Quionga) triangle was allocated to Portuguese East Africa. Ruanda-Urundi's links with its British neighbours were reinforced by extensive migration of labour from its densely populated countryside to Uganda and by special arrangements for the transit of Belgian goods through the port of Dar es Salaam, Tanganyika.

The Tanganyika mandate gave Britain a continuous territory stretching from the upper Nile to the Zambezi. There were various proposals for closer political association, but the East Africa commission (1925), whose survey covered Northern Rhodesia and Nyasaland as well as east Africa proper, emphasized the communication and other difficulties dividing east Africa from the Zambezi basin. World War II necessitated much closer collaboration and led to the establishment in 1948 of the East Africa High commission (*see* British East Africa). Following the achievement of independence by the various east African countries in the early 1960s there was some prospect that the former British territories would unite in a federal organization.

Much of east Africa is a plateau 3,000 ft. or more above sea level, crowned by some of the highest peaks in the continent such as Kilimanjaro (19,340 ft.) and crossed by the Great Rift valley containing large lakes such as Rudolf, Nyasa and Tanganyika. Similarities of climate, vegetation and soils are reflected in common agricultural and economic problems over wide areas. Attempts to study such problems for large parts of east Africa have included the East African Royal commission (1953–55), whose

report dealt with Kenya, Tanganyika and Uganda. Though there are wide cultural and other differences between the peoples of east Africa, nearly all of them have come under a greater or less degree of Hamitic influence. Swahili is widely spoken and is regarded as a common language.

Reference may be made to the appropriate sections of the article AFRICA. *See* also GREAT RIFT VALLEY; KENYA; RUANDA-URUNDI; SWAHILI LANGUAGE; TANGANYIKA; UGANDA; ZANZIBAR.

(R. W. SL.)

EAST AFRICA HIGH COMMISSION: *see* BRITISH EAST AFRICA.

EAST ANGLIA, one of the kingdoms of Anglo-Saxon England, was an area of early settlement, consisting of the north people (Norfolk), the south people (Suffolk) and parts of Cambridgeshire. Bede called the royal family Wuffingas, from Wuffa, grandfather of Raedwald (d. between 616 and 628), the first king of whom anything is known. One royal seat was Rendlesham, near which is the ship barrow of Sutton Hoo, the contents of which show the wealth of East Anglian royalty in the mid-7th century. Raedwald, who was partially converted to Christianity at the court of his overlord, Aethelberht of Kent, had begun before the latter's death in 616 to wrest from him the overlordship of the peoples south of the Humber. He supported Edwin, heir to the throne of Deira, and helped him to kill Aethelfrith and gain the throne of Northumbria at the Idle in 616, losing his son Raegenhere in the battle. Edwin soon superseded Raedwald as overlord. Raedwald's son Eorpwald was converted by Edwin (627 or 628), but killed soon after by a heathen Ricberht; three years later his half brother Sigeberht, who had become a Christian in Gaul, introduced a Burgundian bishop, Felix, giving him a see at Dunwich, and gave Burgh Castle to an Irish pilgrim, Fursa, for a monastery. Sigeberht retired into a monastery, but was unwillingly brought from it when Penda of Mercia attacked East Anglia, and both he and his successor, Ecgric, were killed. Penda also killed (*c.* 653) their successor, Anna, son of Raedwald's brother Eni, a devout Christian who converted Coenwalh of Wessex and who was remembered as the father of several saintly daughters. His brother Aethelhere, who succeeded, probably owed his throne to Penda, for whom he fought in 654 at the battle of the river Winwaed, where he was killed. He may be the king commemorated at the Sutton Hoo barrow, for which a date of about 650–660 has been suggested on coin evidence. His brother and successor, Aethelwald, stood sponsor to Swithhelm of Essex. He was succeeded in 662 or 663 by Aldwulf, son of his brother Aethelric, whom Bede (d. 735) mentions as living until his own time. Aldwulf's son Aelfwald corresponded with St. Boniface, and Felix dedicated his *Life of St. Guthlac* to him. After his death in 749, events in East Anglia become obscure. Symeon of Durham says that Hunbeanna and Alberht divided the kingdom; Florence of Worcester follows Aelfwald's name with Beorna, Aethelred, Aethelberht and Edmund. The third of these is the king beheaded by Offa's orders in 794, but between him and Edmund, killed in 869, coin evidence supplies the names of Aethelstan and Aethelweard. East Anglia was subject to the Mercian kings Aethelbald, Offa and Coenwulf, but in 825 the East Angles killed King Beornwulf of Mercia, and in 827 inflicted a severe defeat on his successor, Ludeca. East Anglia was raided by the Danes in 841, and in 865 the great army wintered there. It returned in the autumn of 869, defeated King Edmund, and killed him in circumstances that led to his being regarded as a martyr. In 875 Guthrum and two other Danish kings wintered in Cambridge, and late in 879 he and his forces settled in East Anglia and began to share out the land.

The Danish settlers supported the Vikings against Alfred, and fought for Aethelwold, a rival to Edward the Elder, in 902, when their king, Eohric, was slain. A later king was killed in 917 and toward the end of the year East Anglia accepted Edward's rule. King Aethelstan appointed as ealdorman Aethelstan "half-king," whose sons Aethelwold and Aethelwine (d. 992) succeeded him. Under Ulfcetel, the East Angles fought heroically against the Danes in 1004 and 1010. Among the 11th-century ealdormen were Harold Godwinson and Aelfgar, son of Leofric of Mercia.

East Anglia was divided into the dioceses of Dunwich and Elmham about 673, but both sees perished at the Danish conquest. Christianity was rapidly re-established, but in the first half of the 10th century the province was administered by Theodred, bishop of London. Elmham was established as the East Anglian see in 956. The monasteries of Ely, Thorney and Crowland were refounded about 970, and the secular priests of Bury St. Edmunds were replaced by Benedictine monks in 1020.

The dialect, personal names and place names, and institutions of East Anglia were much influenced by the Danish settlers, and it belonged to the area governed by the laws of the Danelaw (*q.v.*).

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(D. WK.)

EAST BARNET, former urban district of Hertfordshire, Eng., which under the London Government Act 1963 was amalgamated on April 1, 1965, with Finchley, Hendon, Barnet and Friern Barnet to form the new London borough of Barnet (*see* LONDON). East Barnet, mainly a residential area, is on the Great North road. Area 4 sq.mi. Pop. (1961) 40,641. The parliamentary constituency is Barnet. East Barnet parish church (1100) is a Norman building; the beaconed tower of Monken Hadley parish church (rebuilt 1494) is a landmark. Nearby is Hadley Green, site of the battle of Barnet, and at Hadley Highstone stands the obelisk marking the traditional spot where the earl of Warwick fell. The battle was fought on Easter day, April 14, 1471. Its result was momentous. In routing his Lancastrian opponents and in killing their leader, the earl of Warwick, Edward IV struck the Lancastrian cause a mortal blow. He completed its destruction a month later at the battle of Tewkesbury (*q.v.*).

EAST BENGAL: *see* BENGAL; PAKISTAN: *East Pakistan.*

EASTBOURNE, a seaside town, municipal and county borough in the Eastbourne parliamentary division of East Sussex, Eng., 63 mi. S.S.E. of London by road. Pop. (1961) 60,918. Eastbourne lies partly on the coastal plain and partly on the eastern slopes of the South Downs below Beachy head (532 ft.). Because of its position and easy access from London it became a health and holiday resort and also a popular conference centre as well as a residential town with a number of boarding schools, including Eastbourne college for boys (founded 1867), and convalescent homes. The accommodation and entertainment of visitors provide the chief employment; fishing, toymaking, brewing and printing are also carried on.

The earliest settlement, East Bourne, was a mile from the sea in what is now called the Old Town; there is the parish church of St. Mary, a fine Transitional-Norman building; there too can be seen the bourne or stream to which the name alludes. Subsequently two small fishing settlements grew up, South Bourne lying back from the shore and Seahouses facing the beach, but the modern development of Eastbourne dates from the early 19th century. It owes its charm as a town to the 7th duke of Devonshire; the family is one of the principal landowners, and a family seat, Compton place, lies between the old and new towns. Eastbourne was one of the first English experiments in town planning, with wide, tree-lined streets and ample open spaces. The Saffrons sports ground faces the town hall; the Manor house (18th century) houses the Towner art gallery. The sea frontage extends for more than 3 mi. and is partly built in terraced promenades; the Wish tower (a Martello tower) and the Great Redoubt date from the early 19th century. The borough includes a considerable area of the neighbouring downs, about 4,000 ac. of which are preserved.

Eastbourne was incorporated in 1883 and was constituted a county borough in 1911; the present parliamentary division was constituted in 1948.

EAST CHICAGO, an industrial city and port in Lake county, Ind., U.S., adjoining Gary, Hammond and Whiting (*qq.v.*) about 20 mi. S.E. of downtown Chicago, Ill. Expansion of the steel industry from Chicago eastward along the shore of Lake Michigan was largely responsible for its creation. A part of the Chicago-

Calumet industrialized metropolitan complex, it is included in the Gary–Hammond–East Chicago standard metropolitan statistical area. (*See* GARY.) East Chicago was laid out in 1887 and incorporated in 1889. Construction of Indiana harbour, connected with the Grand Calumet river by a 3-mi. ship canal, stimulated the city's industrial development which includes an extensive system of docks. Among its densely concentrated industries are steel mills, foundries, oil refineries, a refractory, railway equipment shops and producers of chemicals, industrial tanks and valves.

East Chicago is the site of the Calumet Extension centre of Indiana university. Population increased from 3,411 in 1900 to 19,098 (55% foreign-born) in 1910. Pop. (1960) 57,669. For comparative population figures *see* table in INDIANA: *Population.*

(P. ME.)

EAST CHINA SEA: *see* CHINA SEA.

EAST CLEVELAND, a suburb on the east of Cleveland (*q.v.*) in Cuyahoga county, O., U.S., and a part of the Cleveland metropolitan area, is situated on Lake Erie's plain and the rolling upland of the Appalachian plateau. Settlement began in 1901 as a farming community, serving the city of Cleveland 6 mi. W., with which it was connected by rail. Suburban development was aided by the streetcar and automobile. Although it is primarily a residential suburb, there are some 50 industries. East Cleveland became a city in 1911 and adopted a commission-manager form of government in 1918. In 1938 it received 180 ac. of John D. Rockefeller's scenic summer estate "Forest Hills," now a municipal park. For comparative population figures *see* table in OHIO: *Population.*

(M. M. WA.)

EAST DETROIT, a city of Macomb county, Mich., U.S., is adjacent to northeastern Detroit. A post office, designated as Halfway, was established there in 1897, in a small settlement at Nine Mile road and Gratiot avenue midway between downtown Detroit and Mount Clemens. In 1925 the community was incorporated as the village of Halfway with a population of approximately 1,000, and four years later was reincorporated as the city of East Detroit. When first incorporated as Halfway the town had no industries, but by the early 1960s a number of small plants were located there. About 70% of the manufacturing is in the fields of nonelectrical machinery and fabricated metals.

East Detroit is a rapidly growing commuters' suburb of Detroit. For comparative population figures *see* table in MICHIGAN: *Population.*

(J. L. N.)

EASTER, the principal festival of the church year (*q.v.*), celebrates the resurrection of Jesus Christ on the third day after his crucifixion; its origins go back to the beginnings of Christianity and it is probably the oldest Christian observance of the kind after Sunday, which was regarded as the weekly celebration of the resurrection. The English name Easter is of uncertain origin; Bede in the 8th century derived it from that of the Anglo-Saxon spring goddess Eostre.

Date of Easter.—Easter day in the west is the first Sunday after the full moon which happens upon or next after the vernal equinox; if the full moon occurs on a Sunday, Easter day is the Sunday after. Easter therefore can fall between March 22 and April 25 inclusive. This rule was fixed after much controversy and uncertainty, lasting in various parts of the church down to the 8th century. The difficulty was caused primarily by the fact that the Jews observed a calendar based on the lunar months (*see* CALENDAR). The Jewish Passover (Hebrew Pesach, Gr. Pascha), to which Easter, the Christian Passover, succeeded, was celebrated on the 14th of the Jewish month Nisan and was not therefore tied to any one day of the week (*see* also JEWISH HOLIDAYS). The first dispute was whether Christians should celebrate the festival on a weekday or on the following Sunday. Eusebius (4th century) in a famous passage in his ecclesiastical history describes this discussion:

> The Christian communities of all Asia [*i.e.*, the Roman province so-called] thought, according to a very old tradition, that the feast of the Saviour's pascha ought to be kept on the 14th day of the moon, on which the Jews were ordered to sacrifice the lamb, and that therefore, on whatever day of the week this might fall, it was essential to end the time of fasting then. But the churches of all the rest of the world were not accustomed to observe this practice: in virtue of an apostolic tradition they followed the custom now in force and considered that on no other day was it right to end the fast but on that of our Saviour's resurrection. Synods and councils of bishops met at this time, and all unanimously, by their letters, issued a decree of the church for those in all parts. They decided that the mystery of the Lord's resurrection from the dead should not be celebrated on any day but Sunday and that only on this day should we observe the end of the paschal fasts.

Those who kept Easter on the 14th Nisan were called Quartodecimans. As one of them, Polycrates, a 2nd-century bishop of Ephesus, explained, they appealed to local tradition including the practice of St. John to support their custom. In the late 2nd century Pope Victor excommunicated Asia, but Quartodeciman practices continued there for several centuries. The suggestion that the churches of Asia celebrated Christ's death and the others his resurrection is unfounded. Christians in the 2nd century celebrated the death and resurrection together as two sides of the same mystery of redemption. By the end of the 4th century the separate celebrations of Maundy Thursday, Good Friday and Easter had clearly emerged, and evidence of their observance in Jerusalem at this time is to be found in Etheria's account of her pilgrimage (*see* CHURCH YEAR: *Jerusalem*).

The date of Easter was again raised at the Council of Nicaea (325), when, acceptance of the Sunday celebration of the festival being almost everywhere agreed, the question of which Sunday this should be came up for decision. It was still a matter of achieving uniformity among all churches. The difficulty had occurred because some churches followed the imperfect Jewish calendar and celebrated Easter on the first Sunday that actually followed the Jewish Passover; by this reckoning, as the Jewish calendar was based on the lunar calendar (which was 11 days short), Easter sometimes occurred before the equinox (14th Nisan being the full moon in the first Jewish month after the spring equinox). Other churches settled the biblical date (full moon after the spring equinox) by their own scientific methods. At Rome (since Caesar) the equinox was fixed on March 25; at Alexandria, for astronomical reasons, on March 21. Nicaea adopted the Alexandrian reckoning, fixing the equinox on March 21, its true date in the Julian calendar.

In the 4th and 5th centuries divergencies between the Roman and Alexandrian methods of computation again caused difficulties but were usually settled by compromise. Nevertheless, until the time of Charlemagne, considerable uncertainty existed in Gaul owing to the adoption of the paschal tables drawn up in Rome in 457, with a cycle of 432 years. But these tables were not used in Rome and thus differences between Rome and Gaul occurred.

The Celtic churches followed their own method of computation, though it is difficult to determine what it was. They were not, as has sometimes been asserted, Quartodecimans. On the arrival in southern England of the missionaries from Rome under Augustine (597), disputes on the date of Easter arose between the two parties. The matter was settled by the adoption of the Roman reckoning for Northumbria by the Synod of Whitby (664 or 663) and this reckoning was ordered to be observed by the whole of England by Theodore, archbishop of Canterbury, in 669.

Easter is nowadays kept by all western Christians on the same day, in accordance with the rule stated above. In the Orthodox Eastern Church a slightly different calculation is followed, with the result that the Orthodox Easter, although sometimes coinciding with that of the west, can fall one, four or five weeks later.

In the 20th century there has been some discussion in the west of the possibility of a fixed Easter (the first Sunday in April has been suggested in all those schemes of calendar reform which fix the first day of each quarter year on a Sunday). The suggestion has found support among some churchmen and of course there is no theological objection to it; its adoption would depend on agreement being reached among the various churches.

Religious Observances.—The festival of Easter occurs on a particular Sunday, but its importance is emphasized in the worship of the church by the long preparation of Lent, by Holy Week with its solemn services and by the following seven weeks until Whitsun (or Pentecost) observed as Eastertide (or Paschaltide), a period of rejoicing. Easter is central to the whole Christian year; not only does the whole ecclesiastical calendar of movable feasts depend upon its date but the whole year of worship is ar-

ranged around it. In the liturgical texts the emphasis is laid on its being the Christian Passover. From the earliest times Christians have kept Sunday as the weekly commemoration of the resurrection of Christ. "We keep the eighth day with joy on which also Jesus rose from the dead," says the epistle ascribed to Barnabas (1st century), and Justin Martyr (2nd century) remarks in his first apology, "We all gather on Sunday because on this first day . . . Jesus Christ our Saviour rose from the dead." Sunday was a "little Easter."

By the time the liturgy had begun to take shape (2nd century) the Sunday Eucharist was preceded by a vigil service of Scripture readings and psalms. In this must be seen the origin of the Easter vigil service, one of the striking celebrations of Easter in both east and west; from being a weekly observance the vigil has turned into an annual one at Easter only. As it is now constituted in the Roman missal this vigil consists of the blessing of the new fire (a practice introduced during the early middle ages); the lighting of the Paschal candle; a service of lessons, called the prophecies; followed by the blessing of the font and baptisms and then the Mass of Easter. This pattern is quite primitive and in its principal elements can be traced back to the 3rd–4th centuries. In course of time the vigil in the west (but never in the east) came to be anticipated first to the Saturday evening then to the Saturday afternoon and finally, by the end of the middle ages, to the Saturday morning. In 1951 (optionally) and 1955 (obligatorily) throughout the Roman Catholic Church the Easter vigil was restored to its proper time, starting about 10 P.M. so that the first Mass of Easter begins at midnight.

The connection of baptism with Easter is of early date. During the first centuries the whole of Lent was not only a time of penance but also the period during which the catechumens were prepared for baptism, which was given only once a year at Easter. For the six weeks preceding Easter the catechumens were instructed in the Christian faith, and the texts of the Lenten liturgy in the Roman missal still preserve very clear indications of this practice. The catechumenate came to an end with the solemn baptisms of Easter night. This is the explanation of the present practice of the long ceremony of blessing the font on Easter night and of the great emphasis on baptism and its meaning and the many allusions to it still present in the Easter services.

In the modern rite after the blessing of the fire the Paschal candle is lighted and carried into the church, which until this moment is in darkness; when the candle is set up in the sanctuary the deacon sings the *Exultet*, which recounts the origins of the Jewish Passover and God's mercies to the Jews in bringing them safely to the promised land. This theme is continued in the lessons which are then read (especially Ex. xiv, 24–31). All this leads up to the blessing of the font and the baptisms, which after the litany may take place at this point. The congregation then renews its baptismal promises. The theme of the Passover, referring to Christ's passage through death to life, is applied also to baptism whereby the neophytes pass through the waters of baptism to Christian life and the resurrection is evoked at the same time—the resurrection of Christ and that of the neophytes rising from the waters of baptism to new life. This forms the theme of the whole Easter liturgy not only on the day itself but also throughout the following week. Low Sunday, the octave day of Easter, is called in the missal *Dominica in albis*, a relic of the earlier practice whereby on this day the newly baptized put off their white baptismal robes which they had worn since Easter day (*in albis* is an abbreviation of *in albis deponendis*, "laying aside white garments").

During the whole of Eastertide the *Alleluia*, which has not been said since Septuagesima, is added to many parts of the breviary and missal services. At the Mass of Easter day after the epistle and gradual a sequence, *Victimae paschali laudes*, is sung. In the middle ages the anticipation of the Easter vigil left a gap in the series of offices for the end of Holy Week and Easter day. In some countries therefore, especially France, Germany and England, a new ceremony was evolved. On Good Friday the cross was laid in a sepulchre where it remained until before the matins of Easter. At midnight the clergy entered the dark church, removed the cross from the sepulchre to the high altar, and when the candles had been lit a solemn procession was held. At a later date the host, consecrated on Maundy Thursday, was used instead of the cross.

Another ceremony of the same kind, known as the visitation of the sepulchre, was held in some places after matins. Two of the clergy, representing the women at Christ's tomb, went to the empty sepulchre where another priest, taking the part of the angel, announced the resurrection. The two thereupon returned to the choir and two other priests, taking the part of Peter and John, ran to the sepulchre and finding it empty held up to the people the linen representing that in which Christ's body was wrapped. The choir sang the *Te deum* and the *Victimae paschali laudes*. The dramatic quality of this hymn lent itself admirably to the purpose.

The continual elaboration of ceremonies of this nature, which date from the use of the dramatic sequence *Quem quaeritis in sepulchro* in the 10th century, led to the eventual development of the Easter mystery plays (*see* DRAMA: *Medieval Drama*). As time went on a considerable amount of vernacular dialogue was introduced, not without some burlesque and buffoonery, and bishops on occasion protested at the unsuitability of some of the plays for use in church.

Among the Greek and Russian Orthodox perhaps even greater emphasis is laid on the central position of Easter not only as an annual observance of the church year but in the whole worship and spiritual life of the church. The vigil service is preceded by a procession outside the church representing a fruitless search for the body of Christ. Then comes the joyful announcement, "Christ is risen," followed by the Easter Eucharist. When the procession first leaves the church there are no lights anywhere, but on its return hundreds of candles and coloured lamps are lighted to show the splendour of Christ's resurrection.

In the Church of England the Book of Common Prayer provides special anthems to take the place of the *Venite* (Ps. xcv) at matins. Lutheran hymn books, which contain orders of service, use special sentences at Easter. The Book of Common Order of the Church of Scotland includes prayers for Easter, and the *Divine Worship* of the Methodists has an order of worship for Easter morning, but the use of these is not compulsory. (L. C. S.)

In the Protestant churches, Easter Sunday observances are the culminating point of a series of services held during Holy Week, beginning with Palm Sunday. It is customary for the sacrament of Holy Communion to be administered during Holy Week, but the time of its observance varies. Many denominations have established the custom of celebrating Holy Communion on Maundy Thursday, others administer the sacrament on Easter morning some time before the regularly established hour of worship. Many Protestant churches hold joint interdenominational Good Friday services, prepared under the auspices of the local ministerial association. These services in many communities centre around the traditional seven last words of Christ and are conducted from 12:00 noon to 3:00 P.M. with choirs and clergy of the participating denominations. This interdenominational pattern culminates in the Easter dawn service, which is of such interest in the United States that it commands wide television and radio coverage. The origin of the sunrise service is not known, but it would appear to be rooted in the Gospel narratives describing the resurrection of Christ; *e.g.*, John xx, 1 ff., "Now on the first day of the week, Mary Magdalene came to the tomb early, while it was still dark . . . ." The congregations that gather for the sunrise service are in effect attempting to re-enact the drama described in the Gospels. Mingled with this biblical warrant is an association with the spring of the year and the idea of the new birth symbolized in nature's renewal of itself out of the death of winter. Thus the service is held out-of-doors in some scenic spot, a hilltop, a park or lake shore. The service begins at sunrise, symbolizing the end of night (death) and the revival of hope in the hearts of the congregation. The sunrise service, like the Good Friday service, is organized and conducted by the local council of churches or ministerial associations; in smaller communities it is frequently conducted by young people under the auspices of the Y.M.C.A. or Protestant youth councils. (R. W. D.)

Popular Customs.—Around the Christian observance of Easter

as the climax of the liturgical drama of Holy Week and Good Friday folk customs have collected, many of which have been handed down from the ancient ceremonial and symbolism of the pagan spring festival brought into relation with the resurrection theme. When the medieval miracle plays of northern and central Europe came to an end in the 16th century under the pressure of the Reformation, the way was open for the gradual revival of the calendar customs and folk drama, in spite of Puritan opposition to revels, acting and dancing. Thus, the liturgical portrayal of the death and resurrection of Christ enacted in the ecclesiastical Easter plays gradually found its secular counterpart in the popular survivals of the ancient seasonal ritual connected with the spring equinox.

These took a variety of forms in which Easter eggs, formerly forbidden to be eaten during Lent, have been very prominent as symbols of new life and resurrection. In Lancashire on Easter eve boys and men have been in the habit of touring the towns and villages as "Pace-eggers" begging for eggs before performing the "Pace-Egging" or *Pasch* (*i.e.*, Easter) play. This was the Easter version of the St. George mummers' play. This death and resurrection theme recurs in the sword dances which were also of frequent occurrence among the traditional ritual dances at this season. The widespread belief that the sun danced for joy on Easter morning at dawn led to the custom of going to the hills at sunrise to see and take part in this event, a practice that was still prevalent in the British Isles in the 19th century. Rolling coloured eggs down slopes on Easter Monday remains a popular observance especially in the north of England. Formerly Easter eggs sometimes were consecrated for ceremonial use in churches, and at Chester cathedral the bishop and the dean are said to have engaged in an egg-throwing match with the choir boys when the antiphon *Quem quaeritis* was sung on Easter day.

In Greece each person in a group bangs his red Easter egg against the eggs of all the others present in turn, saying "Christ is risen," and receives the reply "He is risen indeed." In the U.S. egg-rolling on the lawn of the White House has become traditional.

The hare, the symbol of fertility in ancient Egypt, a symbolism which it kept in Europe, is not found in North America and its place is taken by the Easter rabbit, the symbol of fertility and periodicity both human and lunar, accredited with laying eggs in nests prepared for it at Easter, or with hiding them away for children to find. But it was not until the latter part of the 19th century, especially during the Civil War, that Easter customs were observed in the U.S., except in a few states, such as Louisiana and Virginia, not dominated by the Puritan element. Then those who had died in the war were commemorated in the churches which were decorated with flowers on Easter day. This brought the festival into prominence and gradually some of the folk customs were revived, notably under Irish influence.

In the north of England on Easter Monday and Tuesday parties of women surrounded any man they met in the street and "heaved" him three times over their heads. Then they sprinkled him with water and each of them kissed him. In return he made an offering of money to them. The next day the men lifted the women in the same manner. Originally it would seem to have been a spring rite to promote the growth of the crops, like the leaping of the Salii in the March festivals in ancient Rome. At Hocktide on the Monday after Low Sunday the women demanded a forfeit from the men whom they succeeded in binding with ropes, the men retaliating the following day. At Hungerford in Berkshire on Low Tuesday men paraded the town carrying "tutti" poles adorned with ribbons and flowers, collecting coins from men and kisses from women, before assembling for a banquet and the initiation of newcomers to the town. The enforced payment of dues and forfeits, and the devices adopted for extracting money from wayfarers at these observances, may be relics of methods of redemption.

See also references under "Easter" in the Index volume.

(E. O. J.)

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(L. C. S.; E. O. J.)

EASTER ISLAND (ISLA DE PASCUA), also known as RAPA NUI, a dependency of Chile administered from Valparaíso province and situated in the South Pacific ocean in 27° 05′ S. latitude, and 109° 20′ W. longitude, about 2,000 mi. W. of Caldera, Chile, and 1,100 mi. E. of Pitcairn, the nearest inhabited island. Easter Island is volcanic and reaches a height of 1,765 ft. It is about 11 mi. long and 15 mi. wide (46 sq.mi. in area). The population was 1,135 at the 1960 census. Though leprosy has been endemic since 1889, the health of the islanders is good and the Chilean government has taken steps to improve conditions.

The island was discovered by the Dutch admiral Jacob Roggeveen on Easter Sunday of 1722, whence its name. Although the population of the island prior to its discovery is not known, it is unlikely that it exceeded 4,000. Death from introduced diseases, capture by slave traders, internecine warfare and voluntary emigration reduced the population to 175 in 1872, largely destroying the aboriginal culture of this agricultural people, whose ancestors carved remarkable stone monuments and incised mysterious signs on wooden tablets. Between 1863 and 1864 the islanders were converted to Catholicism by Brother Eugène Eyraud of the Congregation of the Sacred Hearts of Picpus. Easter Island was annexed by Chile in 1888, and under Chilean authority the native inhabitants were confined to the village of Hanga-roa on the west coast, where they had approximately 5,000 ac. of land for subsistence purposes. The remainder of the grass-covered island (30,000 ac.) was leased by the Compañía Explotadora de la Isla de Pascua and was devoted to the grazing of sheep and cattle.

Archaeology.—Easter Island is destitute of metal objects and pottery, although clay suitable for potting occurs in the craters. The stone remains include houses, platforms, semipyramidal cairns, circular towers, cisterns, statues, rock carvings, adzes or chisels, obsidian spearheads and fishhooks. A few small objects in shell and bone have been found. The skulls collected from graves show no traces of high antiquity.

The most striking monuments are the burial platforms, called *ahu*, and the statues surmounting them. About 260 platforms have been counted in varying degrees of preservation, fringing the coast in almost unbroken succession, while a few are also found inland. Only about 100 of these were intended to support images.

A typical image *ahu* consists of a wall parallel with the sea, measuring up to 300 ft. in length and 15 ft. in height and buttressed to landward with a slope of masonry. The images stood in a single row facing inland on the central portion of the wall, which projected toward the sea, and a single *ahu* might contain from 1 to 15 statues. The maximum extension of the landward slope was about 250 ft., and beyond this was a paved area. The masonry, of huge polygonal or rectangular blocks, is sometimes beautifully finished and fitted together but is more often of rough material. These *ahu*, which were still used within living memory, served for the exposure of dead bodies and contained vaults for the subsequent burial of the bones.

All the statues belonging to the *ahu* have been thrown down and many broken. But by the accounts of the early voyagers the greater number of them were standing in the 18th century and Roggeveen referred to religious ceremonies that appeared to him to indicate worship of the statues. The *ahu* were sacred places corresponding to the Polynesian *marae* and some if not all of the statues were erected in honour of ancestors.

The statues were cut from compressed volcanic ash, a soft and easily worked stone. All conform to a single distinctive type, representing only the upper half of the body with an upturned face and long ears. The usual height of the images on the *ahu* was from 12 to 20 ft., and they were surmounted by tall cylindrical hats or crowns (as much as 6 ft. high and 8 ft. in diameter). These consisted of a red volcanic tuff and were quarried in a different crater from the statues.

The quarry for the statues was both inside and outside the large crater of the volcano called Rano-raraku at the northeastern end of the island; there they are found in large numbers and in all stages of completion, as though the work had suddenly been interrupted and never resumed. The sculptors worked in niches surrounding the statues, and the carving was completed before the back was detached by undercutting. The stone chisels used were found *in situ*.

The means of transporting the larger images, the heaviest of which must have weighed about 50 tons, has never been satisfactorily explained. But a native account states that they were dragged into position (presumably with ropes, the native hemp and hibiscus fibre furnishing adequate materials) and that round pebbles were placed underneath to serve as rollers. Seaweed may also have been used to minimize friction with the ground. The statues probably were erected on the *ahu* by being hauled up an incline of earth or stones and then gradually up-ended into position by withdrawing the supporting material from under their bases.

Dwellings, though generally constructed of perishable materials, were sometimes provided with wrought foundation stones, resembling curbstones, sunk into the ground and provided with holes in their upper surface for inserting the wooden rods that provided the framework of the houses. Their ground plan was long, narrow and boat-shaped, and they were large enough to accommodate from 10 to 30 persons. There also are remains of stone chicken houses and round-chambered towers on the coast used as fishing lookouts. Natural caves were widely used as dwellings, some supplemented by frontal walls.

Apart from these houses, there is one sacred village at the southwestern corner of the island, called Orongo. It contains 48 houses built entirely of stone. This village was connected with a bird cult (still remembered) that once played an important part in native life. A leading feature was an annual competition to secure the first egg laid on an outlying islet by the migratory sooty tern. Orongo was occupied by the competitors, and the numerous rock carvings in the vicinity depicting a bird-headed man, sometimes holding an egg in his hand, presumably commemorate the victors.

There can be little doubt that the stone structures of Easter Island are the work of the ancestors of the present native inhabitants. The statues and platforms were actually in use at the time of discovery, and some of the sculptors' names are still remembered. But apart from traditional evidence, the occurrence of certain peculiar designs carved on the backs of some of the stone statues, as well as on small wooden figures of recent date, furnishes an unquestionable link between past and present culture.

Date of Settlement.—The date of the earliest settlers' arrival is still uncertain, as is their point of departure and whether there was more than one migration. Tradition holds that the ancestors arrived from the west in two canoes under a chief named Hotu-matua, but supplies no clear evidence of previous inhabitants or of subsequent immigrations. The story of the war between the "short- and the long-ears" has been construed as the legendary account of a struggle between early settlers and late invaders. Excavations made during the Thor Heyerdahl expedition on the island (1956–57) have shown that the earth-oven in which the long-ears are said to have perished was actually a defense ditch containing ashes. According to radiocarbon dating, the fire was lighted in the 17th century A.D., a short time before the discovery of the island. On the basis of the shortest-recorded genealogy of 22 chiefs descended from Hotu-matua the migration of the Polynesians to the island can hardly be assigned to a period later than the 14th century A.D. The archaeologists of the Heyerdahl expedition found evidence of architectural stratigraphy, but final conclusions as to the scope of this discovery require more detailed information.

FROM THOR HEYERDAHL'S "AKU-AKU". © 1958 BY THOR HEYERDAHL; PUBLISHED IN THE UNITED STATES BY RAND MCNALLY & COMPANY

GIGANTIC STONE FIGURES WHICH HAVE STOOD FOR CENTURIES ON THE SLOPES OF RANO-RARAKU, AN EXTINCT VOLCANO ON EASTER ISLAND

Physical and Cultural Affinities.—Racially and linguistically Easter islanders are Polynesian, though their heads are longer than those of any other peoples in Polynesia. This feature has been attributed to a considerable Melanesian admixture. Negroid features, however, are rarer in Easter Island than in other Polynesian islands. Moreover, the blood group frequencies on the island are typically Polynesian. The mixture with Melanesians might well date from a period prior to the arrival of the Easter islanders' ancestors in their new country. The present very heterogeneous population is rapidly increasing and spreading over formerly deserted territory. The main handicraft of the natives consists in the carving of wooden and stone images modeled on traditional patterns.

Script.—The writing engraved on wooden tablets, unique in Polynesia and first noted in 1864, is undoubtedly ancient. It takes the form of symbols, strongly stylized, representing human beings, birds, fish, crustaceans, plants, ceremonial articles and designs of a purely geometrical character. The symbols, all of the same height, are incised on both sides of the tablets in regular longitudinal channels or flutes, separated by low ridges. Each row of signs runs in the opposite direction to the one above and below it (the boustrophedon system) so that the tablet has to be turned around at the end of each line in order to have the signs in their correct sequence. Some of the chants and stories which the tablets record have been obtained from living natives, who were unable nonetheless to give a coherent interpretation of the system used by the *tangata rongorongo* (chanters and scribes). The tablets seem to have been aids to memory like the knotted bundles of the Marquesans and the notched staves of the Maori, but according to T. S. Barthel the tablets show a real script consisting of 120 elements combined in various ways to form more than 1,000 compound signs. It is mainly ideographic with rudiments of phoneticism. Russian scholars—B. Kudriavtzev, N. A. Butinov and Y. V. Knorozov—who tried to unravel the secret of the tablets, also arrived at the conclusion that the Easter script reached the stage of an elementary hieroglyphic script. Only the actual deciphering of the tablets can confirm the validity of such theories. *See* also POLYNESIA; POLYNESIAN LANGUAGE.

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EASTERN HIGHLANDS, a series of plateaus and mountain ranges running parallel with the east coast of Australia. They were for long known as the Great Dividing range, but the term is falling out of use. The various locally named ranges that rise above the general level do not form anything like a continuous chain. Nor does the watershed between streams flowing to the Pacific and those flowing westward coincide very often with any definite range. In places, indeed, the divide is indeterminate, *e.g.*, Duck Flat, New South Wales, and in places bifurcated by small interior drainage basins; *e.g.*, Lake George. (O. H. K. S.)

EASTERN NIGERIA occupies the eastern part of the Niger delta fronting the Gulf of Guinea and the country east of the river up to about 150 mi. inland. Pop. (1963) 12,388,646. Area 29,484 sq.mi. Rainfall is heavy, ranging from more than 100 in.

annually in the Niger delta, the Cross river (*q.v.*) valley and along the coast to 73 in. at Enugu, the regional capital. The rural population densities are among the highest in tropical Africa, reaching 1,500 per square mile in parts of Owerri and Calabar provinces. To support the dense population the rain forest has been cleared in many places for the cultivation of food staples (cassava, yams, coco yams). Severe population pressure on the land has caused spectacular soil erosion in parts of the western provinces of Onitsha and Owerri. Of the total population, 14% were urban dwellers in 1953. Ibo (*q.v.*) peoples, located particularly in Onitsha, Owerri and Ogoja provinces, form about 60% of the total; the next most important group, the Ibibio in the southeast, number about 750,000. Nearly half the people profess Christianity and the influence of Islam is negligible.

The chief towns are Onitsha (pop. [1960 est.] 88,358), Port Harcourt (42,553), Enugu (82,594) and Aba (66,379). Calabar (until 1904 called Old Calabar) on the Cross river delta was in the late 19th century the chief port and centre of British influence in the Oil Rivers (later Niger Coast) protectorate. In the early 19th century the port of Brass, 60 mi. W.S.W. of Port Harcourt, was the focus of European trade with the hinterland.

The fragmentary organization of the local peoples caused difficulties of administration under British rule. Eastern Nigeria (until 1951 known as the Eastern provinces) in 1957 obtained self-government within the Federation of Nigeria, with a single-chamber government elected by adult suffrage. Christian missions fostered education and literacy is higher than elsewhere in Nigeria. A university was founded in 1960 at Nsukka, 40 mi. N. of Enugu, incorporating a branch of the former Nigerian College of Arts, Science and Technology.

The oil palm grows well on the leached and acid sandy soils covering much of the region but is not deliberately cultivated; its products are the mainstay of the region's economy. Coal of poor quality is mined around Enugu but falling demands caused by a change to oil fuel reduced the output to about 700,000 tons in 1959. Oil was struck in the Brass district at Oloibiri and Afam in 1956, being carried by pipeline to Port Harcourt and to a terminal at Bonny, 22 mi. S. In the early 1960s rubber plantations near Calabar were being extended to 20,000 ac. There is a large cement factory at Nkalagu, 33 mi. E. of Enugu, and secondary industries have been developed at Aba and Port Harcourt.

Port Harcourt, which after Lagos is the second port of the federation, is the terminus of the eastern branch of the Nigerian railway, which runs north through Enugu to cross the Benue at Makurdi. Over much of the region the road network is good and in 1960 a road bridge was begun across the Niger at Onitsha as a link with Western Nigeria. Nigeria Airways provides links between Enugu, Port Harcourt and Calabar and other centres in the federation.

See K. O. Dike, *Trade and Politics in the Niger Delta, 1830–1885* (1956). (R. M. P.)

EASTERN PROVINCE, CEYLON, stretches in a band (seldom more than 25 mi. wide) down the east coast of the island. Pop. (1953) 354,410. Area 3,840 sq.mi. At Trincomalee quartzite ridges come out to sea and, a little to the south, the Mahaweli Ganga enters the Bay of Bengal through a delta. Elsewhere the coast of the province is made up of sand bars backed by shallow, muddy lagoons, in process of being filled in by alluvium, and fringed in places by mangrove swamps. Behind the lagoons the land is solid crystalline rock, mainly gneiss. Relief is generally low but broken by isolated hill masses. Some of these are high and spectacular (Friar's Hood, so called from its shape, 2,159 ft.) and give a special quality to the western sky line seen against a sunset.

Climatically, the Eastern province is wholly inside the lowland dry zone of Ceylon (*see* CEYLON: *Physical Geography*) with its marked alternation of heavy rains during the northeast monsoon and severe drought during the southwest. The drought is intensified in the south by a hot, searing wind (*kachchan*) which descends foehnlike from the highlands to the west. Much of the province is covered by forest but fairly large areas are under poor grassland (*damana*), which is perhaps the result of repeated burning. The alluvial infill, together with certain other areas, is under cultivation. Game, including the elephant, is abundant and the area round the Gal Oya reservoir is a sanctuary.

It appears that what is now the Eastern province was not densely settled or highly developed during the days of the ancient Sinhalese civilization, but there is a scattering of archaeological finds, many cave inscriptions in the interior, and a number of irrigation works (Kantalai tank behind Trincomalee) which are of ancient origin. Later, Tamils inhabited the coastal sand bars and the interior has been the home of surviving aboriginal Veddas and of poor Sinhalese. The chief towns are Trincomalee (*q.v.*; pop. [1953] 26,356), capital of a district, and Batticaloa (*q.v.*; pop. [1953] 17,439), capital of the province and of a district.

The coast and the Mahaweli Ganga delta produce rice and the sand bars, coconuts. The great Gal Oya development scheme was planned to open up over 100,000 ac. of country south of Batticaloa; to produce rice, sugar, tobacco and other crops; to generate hydroelectric power; and to develop tilemaking and other industries. The road network of the province is rather rudimentary and the only railways are branches terminating at Trincomalee and Batticaloa. (B. H. F.)

EASTERN PROVINCE (PROVINCE ORIENTALE), **REPUBLIC OF THE CONGO** (former Belgian Congo), lies for the most part north of the equator and borders on the Central African Republic, Sudan and Uganda. Pop. (1958 est.) 2,491,500, of whom 16,867 were not indigenous. Area 194,300 sq.mi. The climate is equatorial, except in the north where there is a short dry season. The southern half is covered by rain forest and the northern by savanna mixed with forest. The province includes a part of the central Congo basin, surrounded by plateaus of about 2,000 ft. elevation. Geologically it consists of Secondary, Tertiary or Quaternary deposits (sand, clays, sandstones) south and west of Stanleyville; Pre-Cambrian formations (notably the sandstones and limestones of the Lindi river) around Stanleyville; and vast stretches of metamorphic, crystalline and granitic rocks in the northeast and east, among which are some of the oldest known formations in the republic. On the Sudan frontier the Garamba National park (1,900 sq.mi.) contains some of the largest surviving land animals (elephant, hippopotamus, white rhinoceros, giraffe); okapi live in the Ituri forests.

Eastern province is occupied by very diverse tribes, including Sudanese-speaking Azande and Mangbetu (*qq.v.*) in the north, Bantu peoples (Turumbu, Bali) in the west and south and some Nilotic peoples in the northeast (Kakwa) and along the shores of Lake Albert (Alur and Babema who are shepherds). Pygmies dwell in the Ituri forests. The most populous regions are between Paulis and Niangara, and the mountainous district bordering Lake Albert.

The capital is Stanleyville (*q.v.*) at the foot of Stanley falls; it is the terminus of Congo navigation. Other towns are Aketi, Bunia, Watsa, Paulis, Buta and Yangambi. Administrative districts with their headquarters are: Upper Congo (Stanleyville), Lower Uele (Buta), Upper Uele (Paulis) and Ituri (Bunia).

Activity is mainly agricultural. Bananas, rice, cassava and vegetables are the chief subsistence crops. Cotton is grown in the northern savannas and is transported toward the Congo by the Vicicongo railway of 60-cm. gauge (Aketi-Mungbere). In the south and east coffee is grown, together with oil palms, peanuts and rubber. There is also a timber industry. Under Belgian rule the chief centre of the Congo agronomic institute was at Yangambi, about 50 mi. W. of Stanleyville. The chief mineral is gold, of which about three-quarters of the output of the republic is mined in the province, mainly in the Watsa and Kilo districts in the east. The chief river ports are Stanleyville and Aketi. A metre-gauge railway links Stanleyville with Ponthierville, 78 mi. S. (HE. NI.)

EASTERN QUESTION, a term used to describe the international problem presented by the chaotic condition of the Ottoman empire in the 19th century when it was threatened by internal disruption. The treaties of Paris (1814–15) and the final act of the congress of Vienna (1815) had provided an international system for those areas affected by the French Revolutionary and

Napoleonic Wars (*qq.v.*). The Ottoman empire lay outside this system and therefore constituted a field of potential conflict between the great powers. In the first part of the 19th century only Austria, France, Great Britain and Russia were concerned with this question, but the German empire, in virtue of its treaty of 1879 with Austria-Hungary became increasingly occupied with Balkan and Turkish affairs, while toward the end of the century Italy began to entertain ambitions at the expense of Turkey.

In the 18th century France had been the European country with the greatest interest in the Mediterranean. The battle of the Nile (1798) and British occupation of Malta and the Ionian Islands, however, reduced French naval power in that sea. The consequent decline in the prosperity of Marseilles made the French especially anxious to re-establish their prewar position after 1815. The British, having succeeded the French as the dominant power in the Mediterranean, were equally anxious to secure their interests. The basis of British policy was the Chanak peace treaty of Jan. 5, 1809, with the Turks (who in 1806 had been France's allies against Russia, at that time Great Britain's ally). The Chanak treaty laid down the principle that no vessels of war of any power whatsoever should enter the Straits (the Dardanelles and the Bosporus). For practical purposes this meant that Great Britain obtained security against the entry of the Russian fleet from the Black sea into the Aegean, Russia then being as a result of the treaty of Tilsit (1807) in accord with France.

The Russo-Turkish Wars of the 18th century had established the Russians on the Black sea; by the treaty of Kuchuk Kainarji of July 21, 1774 (this and all dates in this article are new style), they had secured the fortresses of Kerch, Yenikale and Kinburn and the independence of the Tatar state in the Crimea; then in 1783 they had annexed the Crimea; and by the treaty of Jassy (Iasi; Jan. 9, 1792) the Russian frontier had been advanced to the Dniester. Moreover, by the treaty of Bucharest (1812) Bessarabia became a Russian province. On their southeastern frontier the Russians had made progress against Persia. The eastern Georgian kingdom of Kartlia acknowledged Russian overlordship as early as 1783 and became part of the Russian empire in 1801; the western Georgian kingdom of Imeretia was joined to Russia in 1810; and all Azerbaijan north of the Aras river together with the khanate of Talysh south of the river was ceded to Russia by Persia in 1813. By 1815 therefore Russia was firmly established in the near and middle east. Russian statesmen furthermore were determined that Russia's frontiers should be covered either by client states or by countries open to legitimate Russian intervention. Under the treaty of Kuchuk Kainarji Russia had obtained the right to protect the Christian population of Turkey, especially that of the Danubian principalities (Moldavia and Walachia), and the treaty of Bucharest made Russia the guarantor of the administrative autonomy of Serbia.

In this respect Russia found that Austria had considerable reservations. Austria could co-operate with Russia in the maintenance of the *status quo* in central Europe but was very sensitive to events in the Balkans. Having driven the Turks out of Hungary in the 17th century the Austrians had established against them the so-called Military Frontier (*Militärgrenze*), populated largely by Croats and Serbs, who served in the imperial army. In the 18th century this Slav element was loyal to Vienna, but in the 19th the fear arose in the minds of Austrian statesmen that the creation of a large Slav state in the Balkans might attract the South Slavs of the Habsburg empire and cause them to secede, thus threatening the empire with dissolution. Austrian policy, therefore, was to preserve the *status quo* in European Turkey. Russian intervention there would lead to the spread of nationalist feeling and thus infringe Austrian interests.

The Eastern Question in the 1820s.—In the first years after 1815 the major powers were anxious to maintain the treaty of Vienna. There was little desire in the period of postwar reconstruction to raise the problem of the Ottoman empire. A crisis occurred when the Greek leader, Prince Alexander Ypsilantes, crossed the Prut in March 1821 and tried to raise Moldavia and Walachia in revolt against the Turks, hoping that a show of success would compel Alexander I of Russia to support him (*see* GREEK INDEPENDENCE, WAR OF). Ypsilantes in fact found little support, because he appealed first to the ruling class of Phanariote Greeks, who were as odious as the Turks to the Rumanians. In the meantime, however, there was a rising in the Morea in sympathy with Ypsilantes. Atrocities and reprisals on both sides, culminating with the hanging of the patriarch Gregorios in Constantinople (April 22, 1821), had a powerful effect in rousing Russian public opinion.

Alexander I, valuing Austria's co-operation in western and central Europe, was not anxious to fall out with Austria in the Balkans. The British government instructed its ambassador, Lord Strangford, to prevent a rupture of Russo-Turkish relations, which Strangford interpreted to mean that the Greeks must surrender unconditionally. When a Russian note to Turkey in July 1821, demanding the cessation of atrocities and the observance of the treaties, obtained no satisfactory reply, Russia broke off diplomatic relations with Turkey. The congress of Verona (Oct. 1822) virtually ignored the Greek question; the limit of Lord Londonderry's concessions before his suicide (Aug. 12, 1822) was that if the Greeks established a *de facto* government it would be difficult not to give them belligerent privileges. His successor as British foreign secretary, George Canning, was willing to concede these rights, but he was equally in favour of nonintervention and worked to restore normal Russo-Turkish relations, to which Russia agreed. In response to a request for concrete suggestions made by Francis I of Austria at Czernowitz (Chernovtsy) in Oct. 1823, Alexander proposed in Jan. 1824 that there should be created three Greek principalities, paying annual tribute to Turkey and garrisoned by Turkish troops, but this suggestion was disliked by the powers on the grounds that it opened the way to excessive Russian influence. It had been rejected in advance by the Greeks themselves who in Jan. 1822 had proclaimed the independence of all Greece.

The situation was changed by Sultan Mahmud II's decision to invoke the help of the semi-independent pasha of Egypt, Mohammed Ali. The latter's son, Ibrahim Pasha, landed first in Crete and then in the Morea on Feb. 24, 1825, acting as if he intended to exterminate the Greeks. Russian feeling in favour of independent action began to revive, and Canning began to evolve a plan of joint action with Russia as a better alternative to independent Russian intervention, but agreement was not easily obtained. On Dec. 1, 1825, however, Alexander died and was succeeded by Nicholas I. It was expected that Nicholas would adopt a more forward policy. Canning therefore sent the duke of Wellington to St. Petersburg with the dual purpose of congratulating Nicholas on his accession and paving the way for agreement with Russia.

Russian policy under Nicholas in fact did exhibit new features. Great Britain and Russia agreed under the St. Petersburg protocol of April 4, 1826, to offer mediation in the Greco-Turkish dispute on the basis of constructing a Greek state tributary to the sultan. Nicholas was careful to keep Greek affairs separate from those of the Danubian principalities and Serbia. In April 1826 a Russian ultimatum was presented to Turkey, demanding the evacuation of the principalities and the meeting of a conference to discuss the Bucharest treaty of 1812. The Turks had to agree and, on Oct. 7, 1826, concluded with Russia the convention of Akkerman. This confirmed the treaty of 1812 and stipulated that in Serbia there should be no Muslims in the administration, while in the principalities native boyars were to be appointed *hospodars* (princes).

The European powers were slow to reach agreement on the Greek question. On July 6, 1827, the treaty of London was signed between Great Britain, France and Russia. This repeated the provisions of the St. Petersburg protocol of 1826, but added that if the Turks did not accept mediation consuls would be sent to Greece and that, if an armistice were not agreed, then the fleets of the three powers would blockade the Morea and intercept Turkish and Egyptian supplies. Canning died on Aug. 8, but his policy was continued by Viscount Goderich (formerly F. J. Robinson). The Turks for their part refused mediation, and the admirals blockaded the Morea—an action which led unexpectedly to the battle of Navarino (*q.v.*), on Oct. 20, 1827, in which the

Turkish-Egyptian fleet was destroyed. Meanwhile Turkey had denounced the convention of Akkerman.

The Russo-Persian War of 1826–28.—While Russia was preoccupied in the Balkans, the Persians seized the opportunity of attacking the Russian positions in the Caucasus (July 28, 1826). The Russians now found themselves acting in concert with the British and French in the Aegean, but alone both in relation to the principalities and to Serbia and against the Persians, who moreover had the backing of the British governor-general of India. In spring 1827, Gen. I. F. Paskevich took over command of the Russian Caucasian corps and laid siege to the Armenian city of Yerevan, which the Persians surrendered in October. Unable to resist the Russians, the shah concluded the peace of Turkmanchai on Feb. 22, 1828, ceding the khanates of Yerevan and Nakhichevan. Russia had now turned the Caucasus from the east.

The Settlement of the Balkans.—In European Turkey the battle of Navarino had solved nothing, because the Greeks could not defeat Ibrahim Pasha by themselves. At the London conference of March 12, 1828, it was agreed that the blockade should continue, but Wellington, now prime minister, was surprised when the Russian ambassador, Prince C. A. Lieven, declared that Russia intended to make war, if necessary, in connection with Turkey's repudiation of the Akkerman convention. On April 26, 1828, Russia declared war on Turkey.

Eventually the French plan to send troops to the Morea was accepted. Under the protocol of July 19, 1828, authority was given for the French troops to land. This virtually assured Greece's independence, for they quickly expelled the Egyptians. All that remained was to decide the extent of the new Greek state. The northern frontier was eventually fixed on the Arta-Volos line, and in Feb. 1832 the powers offered the Greek crown to Otho of Bavaria.

Russo-Turkish relations and the political instability of the Ottoman empire still caused concern. A significant event was the Russian reappraisal of the policy to be adopted in the Balkans and near east. The Russian Gen. I. I. Diebitsch in the Balkans had taken Varna in Oct. 1828 and crossed the Balkan range to capture Adrianople on Aug. 20, 1829, but while the military operations were in progress the problem of Russia's policy toward Turkey was laid before a committee of the emperor's leading advisers and Nicholas accepted its view that Russia should now uphold the Ottoman empire, as a weak state constituting no threat to Russia, rather than let it pass into the hands of other powers. In this spirit a peace treaty was concluded at Adrianople on Sept. 14, 1829. The treaty was not onerous for Turkey: the principalities remained under Turkish suzerainty subject to the Russian guarantee; the Akkerman provisions regarding Serbia were confirmed; Russia obtained territorial access to the mouth of the Danube and was also confirmed in the Caucasus in possession of Anapa, Poti and part of the Georgian pashalik of Akhaltsikh. The terms of the treaty of London (1827), moreover, were accepted by Turkey.

The Principalities, 1829–34.—On the peace of Adrianople, Gen. Count P. D. Kiselev was appointed to supervise administration in Moldavia and Walachia. The *hospodars* were required to rule in collaboration each with an assembly of the higher clergy and boyars. Kiselev, whose policy was to build up a basis for Russian influence, did what he could to improve the lot of the Rumanian peasants, whom he tried to protect from exploitation by the boyars. At least he succeeded in bringing about an identity of conditions in Moldavia and Walachia, which was to make ultimate unification possible. After the Russo-Turkish convention of Jan. 1834 (part a fresh departure in Russian policy aimed at conciliating Turkey) the Russians evacuated the principalities.

The Treaty of Unkiar Skelessi and the Münchengrätz Agreements.—The pasha of Egypt, Mohammed Ali, had received nothing for his efforts on the sultan's behalf in Greece. The sultan could reply that the pasha had achieved nothing to merit reward. Accordingly in Oct. 1831 Mohammed Ali declared the sultan heretical and sent the Egyptian army under Ibrahim Pasha to invade Palestine. The Turks were driven back and the Egyptians occupied Syria, defeating the Turkish army in Dec. 1832 at the battle of Konya in Anatolia. It seemed that the Egyptians would occupy Constantinople itself. Nicholas now offered his assistance to the sultan. Mahmud II had appealed for British help in Nov. 1832, but Lord Palmerston, the British foreign secretary, preoccupied with problems in western Europe, could not respond. The Turks therefore had to accept Russia's offer. In Feb. 1833 the Russian fleet appeared in the Bosporus and on April 3 Russian troops disembarked on the Anatolian shore. Turkey was saved from collapse, but had to surrender Adana to Ibrahim Pasha and the pashaliks of Syria and Tarsus for the lifetime of Mohammed Ali under the convention of Kütahya (April 8, 1833). Before the Russian forces were withdrawn an eight-year treaty of alliance was concluded between Russia and Turkey at Unkiar Skelessi (Hunkiar Iskelesi) on July 8, 1833. In a secret article it was agreed that, in case of need, Turkey's help to Russia should be limited to closing the Dardanelles to all non-Russian vessels of war.

Nicholas, aware that this arrangement with Turkey was open to misinterpretation, took steps to allay the fears of Austria. When he met the Austrian emperor Francis I at Münchengrätz (Sept. 1833), he made a secret agreement with him to maintain the existing dynasty in Turkey and to prevent Mohammed Ali from acquiring any portion of European Turkey. His object was to retain for himself an exclusive right of intervention at the Straits. Nicholas and Francis also concluded an agreement, to which Prussia subsequently adhered, for the maintènance of the *status quo* in central Europe. Russia was thus given security both in the south and in the west.

Political Tension in the 1830s.—Palmerston was much dissatisfied by the treaty of Unkiar Skelessi and especially by its secret article, which he took to be a provision for the overthrow of the principle stated in the Chanak treaty of 1809. His reply was to put the British Mediterranean fleet in a state of readiness. In his instruction of March 1834 orders were issued that the fleet might be summoned to Constantinople if the sultan requested aid to ward off a Russian attack, though in no circumstances was the sultan to be informed of this decision. When Wellington in the Conservative administration of 1834–35 discovered the existence of this order he promptly canceled it as being too dangerous an instrument to be left in an ambassador's hands, but it was reissued when Palmerston came back into office. Palmerston moreover formed the quadruple alliance of April 22, 1834, with France, Spain and Portugal to bring stability to the Iberian peninsula and so to leave Great Britain free for the problems of the Aegean and the Levant.

Russia's position in Turkey under the treaty of Unkiar Skelessi was not a strong one, because the Turks might fail to renew it on its expiry. In 1838 a plan to reinforce the Black Sea fleet with ships from the Baltic was considered, but the vice-chancellor, Count K. V. Nesselrode, thought that the passage of Russian ships through the Straits would serve as a precedent for Great Britain and France to demand similar privileges. Nicholas accepted this analysis.

A crisis was eventually produced by the sultan Mahmud, who was determined to punish Mohammed Ali. In April 1839 the Ottoman army invaded Syria only to be decisively defeated at the battle of Nizip on June 24. The Turkish admiral, the kapitan-pasha Ahmed, deserted to the Egyptians and the sultan himself died on July 1, 1839. Palmerston wished to coerce Mohammed Ali in cooperation with France and, if necessary, to compel the Russians to withdraw if they intervened in Constantinople, but the French cabinet would have no part in coercing Mohammed Ali, whom it regarded as a *protégé*. In the meantime Russia formulated a new plan. In Sept. 1839 Count F. I. Brunnow was sent to London with proposals which amounted to an abandonment of the treaty of Unkiar Skelessi: Turkey was to be given a general guarantee and the Straits to be closed against all powers. Palmerston was at first suspicious of the Russian move, but in Jan. 1840 he proposed that Great Britain, France, Austria, Russia and Prussia should send troops to Turkey against Mohammed Ali, if the sultan requested them, and that the Straits should be closed to foreign warships. France, however, refused to agree. The other

powers therefore, in London, on July 13, 1840, signed an act for the pacification of the Levant, without French participation. Mohammed Ali was given ten days in which to submit: if he did so, he would receive the hereditary pashalik of Egypt and the administration of southern Syria and Acre for life; if not, he would be coerced and confined to Egypt. There followed a period of acute Anglo-French tension. In the end Louis Philippe decided against war, and Adolphe Thiers, the protagonist of support for Mohammed Ali, was compelled to resign (Oct. 1840).

Mohammed Ali refused to accept the conditions of the powers. An allied expedition under Sir Charles Napier was sent to Syria. Beirut fell on Oct. 10 and Acre on Nov. 3, 1840. On Feb. 3, 1841, the sultan, who had previously declared Mohammed Ali deposed, signed a firman appointing him hereditary viceroy of Egypt. This went some way toward satisfying the demands of French policy.

The Straits Convention of 1841.—Under the London Straits convention of July 15, 1841, France, Austria, Great Britain, Prussia and Russia agreed with the Porte that it should be forbidden for all time for vessels of war belonging to foreign powers to enter the Dardanelles and Bosporus in time of peace, with the exception of light vessels on embassy service. This meant that Russia gave up the exclusive right granted under the treaty of Unkiar Skelessi. In future no one power was to seek exclusive influence in the Ottoman empire. In 1843 Nicholas told the Austrian diplomat, Count K. L. von Ficquelmont, in Warsaw: "I shall never cross the Danube and everything between this river and the Adriatic ought to be yours." In June 1844, in conversations with Sir Robert Peel and Lord Aberdeen at Windsor, he declared his intention of acting in concert with the powers. In Dec. 1845, during a visit to Vienna, he repeated his desire to uphold the Ottoman empire and disclaimed any intention of seizing Constantinople.

The Eastern Question in 1848–49.—During the European revolutionary crisis of 1848–49 Nicholas proved as good as his word. When revolutions broke out in Vienna and in Berlin he took precautions to prevent the extension of revolutionary activity to the Danubian principalities. Troubles in Jassy and in Bucharest were curbed in Sept. 1848 by a Turkish occupation of which Russia approved. A Russo-Turkish convention of May 1849 modified the constitutions of the principalities and provided for a joint occupation. The Russians did not withdraw until 1851.

The Crimean War (1854–56).—The Crimean War (*q.v.*) may here be briefly stated to have resulted from the challenge offered by France to the principle implied in the Straits convention of 1841 that no one power should have exclusive influence in Ottoman affairs. The issue which the emperor Napoleon III chose was the question of the guardianship of the Holy Places in Palestine. Nicholas I took up this challenge and attempted to assert Russia's rights under the treaties of Kuchuk-Kainarji (1774) and Adrianople (1829). Turkish refusal led to a Russian occupation of the principalities in 1853 and then to a Franco-British ultimatum for their evacuation. Russia did subsequently evacuate the principalities as a result of an Austrian demand, but France and Great Britain, having declared war and being committed in the eyes of public opinion to achieving a great success, invaded the Crimea. Hostilities did not end until Jan. 1856, when the new Russian emperor Alexander II accepted an Austrian ultimatum that peace must be made.

The Treaty of Paris, 1856.—The peace conference met in Paris on Feb. 25, 1856, and the treaty of peace was signed on March 30. Russia surrendered part of southern Bessarabia, thus losing control of the mouth of the Danube, the navigation of which was placed under a commission of the riparian states. The Straits convention of 1841 was re-enacted, but with the provision that the Black sea should be neutralized: Russia and Turkey were permitted to maintain only insignificant naval forces on the Black sea (the Turks or their allies, however, could in fact if need arose easily introduce warships from the Aegean). Russian claims to a protectorate over the Christian subjects of the Porte were set aside in favour of a general European guarantee, while the Danubian principalities received an international assurance of their status.

The treaty of Paris had important consequences for Europe as a whole. It had been the policy of the Austrian foreign minister, K. F. von Buol-Schauenstein, that the general support which Austria had received from Russia in central Europe and which had indeed restored the Habsburg empire in 1849, when Russia had intervened in Hungary, should be replaced by a British and French guarantee of Austrian territory. In fact, all that Austria obtained was an alliance with Great Britain and France on April 15, 1856, for the maintenance of the territorial integrity of the Turkish empire. Thus Austria was left isolated in Europe, which made possible the Franco-Piedmontese successes in Italy in 1859 and the expulsion of Austria from the Germanic confederation by Prussia in 1866. So weakened was Austria that the dynasty was obliged in 1867 to come to terms with the Magyars of Hungary, who achieved administrative autonomy within the Habsburg system. The South Slav question became the major issue of Austro-Hungarian policy. The Magyars were not in favour of annexations at the expense of Turkey which would increase the number of Slavs within the territories of the crown of St. Stephen. It was imperative that the *status quo* should be maintained in the Balkans.

Russia likewise was not anxious to disturb the Balkans after 1856. Alexander II had decided that reform must be carried out in Russia, which led in 1861 to the decree emancipating the peasants, a measure that it would take many years to execute. Moreover, in 1863, Russia's position in Europe was severely shaken by the Polish insurrection.

The Eastern Question, 1856–70.—Between the treaty of Paris and the outbreak of the Franco-Prussian War (1870) important developments took place in southeastern Europe. In Bulgaria national consciousness had grown sufficiently for the Turkish government to create a Bulgarian exarchate (1870–72). In 1859 Walachia and Moldavia joined together to form the new state of Rumania; in 1866 the elected prince, Alexandru Cuza, abdicated and was succeeded by Charles of Hohenzollern-Sigmaringen (Carol I). The principalities were thus virtually detached from the Ottoman empire. In 1856 Serbia obtained a European instead of a purely Russian guarantee. After the Turkish garrison commander had bombarded Belgrade (June 1862), the powers compelled the Turks to evacuate two Serbian fortresses and, in 1867, to remove their troops from the principality.

In Austria-Hungary, the Magyars were alarmed by the growth of South Slav nationalism. The Serbian secret society, the Omladina (founded 1866), gave currency to the idea that Prince Milan Obrenovich was "the uncrowned king of Serbia." The Croats, subjects of the Hungarian crown who enjoyed a measure of autonomy from 1868, were by no means favourable to closer association with Belgrade, but extremists among them began to work for a Greater Croatia.

Russia was active in the Balkans during these years, though military weakness prevented a forward policy; but the defeat of France by Prussia in 1870 altered the balance of power in Europe, and Russia felt strong enough to tear up the Black sea clauses of the treaty of 1856. In Nov. 1870, Prince A. M. Gorchakov, the chancellor, declared that his government no longer considered itself bound by the limitation clauses. The powers gave their formal assent in London in March 1871. In 1874, when universal conscription was introduced, Russia could once more consider armed action. There were two strands of thought within the Russian ministry of foreign affairs: on the one hand the Pan-Slavist and Slavophil elements were strongest in the Asiatic department, which dealt with Balkan affairs and in which Count N. P. Ignatiev had considerable influence; on the other, Gorchakov and his associates preferred to work in concert with the other European powers. Alexander II, with whom the final decision rested, generally supported Gorchakov.

The First Dreikaiserbund, 1873.—Austria, Prussia and Russia each saw the danger of conflict over disputes in the Balkans. The German chancellor, Bismarck, wanted a period of peace in which to organize the new German empire. Russia was equally willing to end tension with Austria-Hungary. Thus a series of agreements were reached providing for mutual assistance and

concerted action, which can be said to have created the first *Dreikaiserbund*, or Three Emperors' alliance, of Oct. 22, 1873. The *Dreikaiserbund* was in effect an agreement to avoid war in the Balkans. Subjected to considerable strain during the Franco-German tension of April–May 1875, the alliance was put to the test when insurrection broke out in Bosnia-Hercegovina (*q.v.*) in July.

The European powers attempted to prevent trouble from spreading in the Balkans. The Porte accepted a six-power consular commission to assist in reaching a settlement, but this merely provided a clearing house for information. Proposals by Count Gyula Andrássy, the Austro-Hungarian foreign minister, for the better government of Bosnia-Hercegovina (the "Andrássy note") were accepted in Feb. 1876 by the Porte, which offered an amnesty to the rebels. Russian statesmen were ready to make the Andrássy note a success, but a solution was prevented by the rebels' own attitude. In April their leaders drew up a series of stiff demands which the Porte refused to accept. In May 1876 the visit of Alexander II and Gorchakov to Berlin produced the "Berlin memorandum," which declared that Austria, Russia and Germany required a two months' armistice and that, if proposals of reform failed, they would concert measures. The British cabinet refused to be associated with this measure, lest it become a party to dismembering the Ottoman empire, and the British fleet was ordered to Besika bay, where it arrived on May 26. The British attitude was bellicose, but Benjamin Disraeli sought to tone down its severity by conducting conversations with the Russian ambassador, Count P. A. Shuvalov, in June. Disraeli's policy was one of wait-and-see, which would leave the Turks and the Christians to fight out their differences.

The situation in the Balkans was out of control. In May 1876 the Bulgars rose in revolt, whereupon Muslim irregulars, the *bashi-bazouks,* took savage reprisals. The Berlin memorandum was due for presentation to the Porte on May 30, 1876, but on May 29 Sultan Abdul-Aziz was deposed by a *coup d'état* and replaced by a nonentity, Murad V. The real ruler of Turkey was Midhat Pasha, who formulated a scheme of reform for the empire. Indignation at the massacres in Bulgaria forced Milan of Serbia to deliver an ultimatum to the Porte, which was followed by a declaration of war on July 1. Montenegro declared war on Turkey on July 2. When the news from Bulgaria arrived in Great Britain, Disraeli was inclined to play down Turkish savagery, but public opinion reacted sharply against Conservative policy. W. E. Gladstone issued his celebrated pamphlet, *The Bulgarian Horrors and the Question of the Orient.*

Alexander II came under pressure from Russian public opinion to intervene in the Balkans, but was inclined to collaboration with Austria. Alexander and Gorchakov met the Austrian emperor Francis Joseph and Andrássy at Reichstadt on July 8, and on July 13 drew up the secret Reichstadt convention. Both parties agreed not to intervene for the moment, but, if the Turks won the war, to concert measures to prevent excesses against the Christians. The *status quo* was to be maintained in Serbia, Montenegro was to be granted full independence and reforms were to be carried out in Bosnia-Hercegovina on the basis of the Andrássy note. If Turkey were to lose the war, no large Slav state was to be established. Austria-Hungary was to have Bosnia-Hercegovina, while Russia was to obtain southern Bessarabia and Batum in Georgia. In the event of a complete Turkish collapse, Constantinople was to become a free city, Thessaly and parts of Epirus to go to Greece, and Bulgaria and Rumelia to be independent.

The situation became more difficult when the war went against Serbia. In Aug. 1876 Milan asked for the good offices of Russia to bring about an armistice. On Sept. 1, 1876, the Serbs were severely defeated near Aleksinac and Serbia lay at the mercy of the Turks. Alexander II was then at the Crimean palace of Livadia, where, exposed to the Pan-Slav influences, he began to put pressure on both Austria-Hungary and Germany for action in the Balkan question. On Oct. 30, 1876, Russia took the decisive step of demanding that Turkey grant Serbia an armistice, which Turkey accepted. Then a British proposal for a conference in Constantinople was accepted by the powers. In his Guildhall speech of Nov. 9, 1876, however, Disraeli emphasized Great Britain's interest in the Eastern question in a manner that seemed to threaten war. Returning from Livadia, Alexander II, unaware of Disraeli's speech, himself made a public address in Moscow on Nov. 10, in which he spoke of Russia's "sacred mission." So rare was it for an emperor to make a political speech that public opinion in Russia considered that Alexander had made a retort to Disraeli. Committed in the eyes of public opinion, Alexander gave orders for the mobilization of the army.

There was some modification of the British attitude. Lord Salisbury, nominated to be British representative in Constantinople, was at first instructed to offer only mediation, but further instructions did not rule out the possibility of coercing the Turks. Less Turcophil than Disraeli, Salisbury found it easy to reach an agreement with the Russian ambassador, Count N. P. Ignatiev, during their discussions in Dec. 1876. Ignatiev accepted Salisbury's insistence that there should be no "Big Bulgaria" while it was agreed that in Serbia and Montenegro the *status quo* should be maintained and that in Bosnia-Hercegovina an international commission should be set up. The six powers' proposals of Dec. 22 met with opposition from the Turks. Midhat Pasha declared his intention of granting a new constitution under which Muslim and Christian would enjoy equality, but insisted on maintaining centralized control. The powers modified their demands, but on Jan. 20, 1877, the Turks rejected them and the representatives of the powers left Constantinople. The new sultan, Abdul-Hamid II, dismissed and deported Midhat Pasha on Feb. 5, and issued a *hatti-sherif* promising reforms based on the conference's proposals. The British government was willing to give him a chance to prove his sincerity, but the situation created difficulties for Russia, where the financial strain of keeping a large number of troops on a war footing was heavy. At the end of February it was decided that Russia should demand the implementation of the conference's proposals, whether alone or in concert with the other powers. Ignatiev toured the western capitals, but his draft proposals were not accepted. At length agreement was reached on the "London protocol" of March 31, which demanded that the Porte put its army on a peace footing and, in the event of failure to comply, announced that the powers would themselves consider the condition of the Christian population of the Balkans. On April 9 the Porte rejected this demand and on April 24 Russia declared war.

Russia went to war in strict understanding with Austria-Hungary, who in Jan. 1877 had agreed to observe a benevolent neutrality and not to invoke the treaty of 1856 with Great Britain and France; Austria-Hungary moreover might occupy Bosnia-Hercegovina, while Russia was to confine military action to Rumania, Bulgaria and Serbia; and Montenegro was not to be entered by either party. In March the limits of the respective annexations were defined: Austria-Hungary was to take Bosnia-Hercegovina, except for the sanjak of Novi Pazar (between Serbia and Montenegro), while Russia was to recover southern Bessarabia. If the Ottoman empire were to break up, the two powers undertook to concert. No large Slav state was to be created, but Bulgaria, Rumelia and Albania were to have their independence, while Thessaly, Epirus and Crete were to go to Greece. Constantinople was to be a free city.

The Russian plan was one of rapid advance, but the Turks were not badly prepared. In June the Russian army crossed the Danube, but was held up at Plevna by the forces of Osman Pasha. Meanwhile a British note of May 6, 1877, had warned Russia that Great Britain could not stand aside indefinitely. In the Russian reply of May 30, 1877, it was proposed that Bulgaria north of the Balkans should be autonomous; that Bulgaria south of the Balkans should have a just administration; that Bosnia-Hercegovina was to have satisfactory institutions; that Russia was to have southern Bessarabia and Batum; and that Rumania was to be independent or have the northern Dobruja. Above all it was emphasized that Russia would not oppose Austro-Hungary in Bosnia-Hercegovina. The Russian government merely repeated in this note its arrangements with Austria-Hungary. A different atmosphere prevailed in

the Russian army, where the generals were determined to make the most of the situation and create a "big Bulgaria" north and south of the Balkans. In July the British government warned Russia that it would consider action if Constantinople were occupied. The key to the situation was the Turkish defense of Plevna, which fell on Dec. 10, 1877. On Jan. 20, 1878, Adrianople had fallen. The armistice of Jan. 31 did something to relieve the tension, but on Feb. 13 the British fleet entered the Dardanelles, without permission of the Porte, to protect British life and property in Constantinople. Finally on Feb. 19 Russia and Great Britain agreed that Russia would occupy neither Constantinople nor Gallipoli and that no British troops would be landed on the European shore of the Straits.

On March 3, 1878, the treaty of San Stefano was signed between Russia and Turkey. Its two most debatable points were (1) the creation of a "Big Bulgaria" north and south of the Balkan range and extending into Macedonia; and (2) the expansion of Montenegro and Serbia, by which they became contiguous. The opposition of the powers, however, compelled Russia to revert to the spirit of the previous agreements with Austria-Hungary and Great Britain. At the congress of Berlin (*q.v.*) Russia accepted the fact that the treaty of San Stefano was impossible to execute and agreed to a small Bulgaria north of the Balkan range, while Eastern Rumelia south of the range was to be a semi-autonomous province under a Christian governor. Austria-Hungary occupied Bosnia-Hercegovina and obtained the right to intervene in the sanjak of Novi Pazar. Russia, however, obtained southern Bessarabia, in return for which Rumania received part of the Dobruja.

Russia had good reason to be dissatisfied with the treaty of Berlin and sought an entente with Germany in order to have a stronger position in the interpretation of its terms, but Bismarck preferred to conclude, on Oct. 7, 1879, an alliance with Austria-Hungary.

The Second Dreikaiserbund (1881).—Germany's alliance with Austria-Hungary was valuable to Bismarck as preventing the recreation of the "Crimean coalition" of Austria-Hungary, France and Great Britain, but it presented him with problems in the near east. He did not want to alienate Russia merely to please Austria. Luckily for him, Russian policy aimed at avoiding a clash. Alexander II and his successor, Alexander III, together with N. K. Giers, Gorchakov's successor as foreign minister, believed that an association with Germany was a wiser course than opposition, which could only commit Bismarck more closely to Austria-Hungary. On June 18, 1881, was concluded the second *Dreikaiserbund*, an arrangement for mutual assistance and concert which for Russia was an instrument for avoiding conflict in the near east. Austria-Hungary, however, finding little profit in the *Dreikaiserbund*, went on to conclude a secret treaty of mutual assistance with Milan of Serbia (June 28, 1881), which gave Vienna virtual control over Serbian foreign policy. A similar treaty was concluded with Rumania in Oct. 1883; but the Rumanians insisted that Germany should be a party to this treaty. Bismarck's adherence to this treaty meant that Germany was henceforth closely identified with Austro-Hungarian policy in the Balkans. Even so, the *Dreikaiserbund* was renewed for a further three years in 1884. The Bulgarian crisis of 1885–87, however, broke it up.

The Middle Eastern Question.—The Russo-British conflict over the Straits was complicated by Russian expansion in central Asia. Russia had taken Samarkand and subdued Bukhara in 1868, occupied Khiva in 1873 and taken Kokand in 1876. As long as it was directed toward Samarkand, this Russian penetration did not threaten British interests in India, because the Hindu Kush presented an insurmountable obstacle; but penetration in the direction of Afghanistan did constitute a danger. The Trans-Caspian railway had reached Ashkhabad in 1885 and was extended through Merv to Chardzhou on the Amu-Darya (Oxus) in 1886. The Russian position in the middle east could henceforth be quickly reinforced from the Caucasian command. Great Britain had to consider how to protect the Afghan city of Herat, which was thought vital to the defense of India. The current view was that, if war broke out with Russia in the middle east, British vessels would have to force a passage at the Straits to attack Russia in the Black sea and the Caucasus. When the Russians defeated the Afghan army at Panjdeh on March 30, 1885, Great Britain prepared for war. The crisis was solved amicably mainly because German influence in the near east was thrown on to Russia's side. Russia's own willingness to halt in central Asia at that moment was no doubt caused by preoccupation with events in Bulgaria.

The Union of the Two Bulgarias and the Reinsurance Treaty, 1885–89.—On Sept. 18, 1885, as a result of a *coup d'état* at Plovdiv (Philippopolis), Bulgaria and Eastern Rumelia were united. Though Russia had supported the "Big Bulgaria" policy in 1878 Alexander III did not look with favour on the new Bulgarian state, which was by no means subservient to Russian interests. Russia therefore proposed a conference of the signatory powers of the treaty of Berlin. The Serbs, however, were dissatisfied with a situation from which they had obtained little and on Nov. 13, 1885, King Milan, assured of Austro-Hungarian support, invaded Bulgaria—only to be defeated at the battle of Slivnitsa on Nov. 17–19. This led in its turn to a Bulgarian invasion of Serbia. The struggle was ended by the peace of Bucharest on March 3, 1886. Russia obtained some satisfaction from this episode, because Bismarck had informed the Austro-Hungarian foreign minister, G. S. Kálnoky, in Dec. 1885 that there could be no modification of the *status quo* in the Balkans without the consent of the powers and thus refused to support unilateral action by Austria-Hungary. Russia had less success in bringing the Bulgars to heel. Despite the abdication of Prince Alexander (*q.v.*) of Battenberg in Sept. 1886, a Russian mission under N. V. Kaulbars failed to secure Bulgarian acceptance of Russian control, and in November Kaulbars and the Russian consuls were withdrawn from Bulgaria. This step seemed to be the prelude to Russian armed action in the Balkans.

Bismarck, not willing to support Austria-Hungary openly against Russia, encouraged Great Britain to do so instead. Italy, hostile to France on account of Tunisia and (since May 20, 1882) a member of the Austro-German alliance, entered into an agreement with Great Britain in Feb. 1887 for the maintenance of the *status quo* in the Mediterranean, to which Austria-Hungary adhered in March. This accord was enlarged to cover the Straits in December. The so-called Mediterranean agreements of 1887 thus gave Austria-Hungary a powerful accretion of strength in the near east. Meanwhile Alexander III had decided that the *Dreikaiserbund* could not be renewed and that Russia could associate only with Germany. On June 18, 1887, was concluded the "Reinsurance treaty" by which Bismarck undertook to support Russian policy in Bulgaria and at the Straits; Russia was to remain neutral unless Germany attacked France, while Germany was to remain neutral unless Russia attacked Austria-Hungary.

In 1887 Bismarck was in a very difficult position. On the one hand he was required to support Russia at the Straits, on the other he was associated with Austria-Hungary and Italy, whose agreements with Great Britain were designed to frustrate Russian policy. If this situation had been generally known by the contending powers, Bismarck's system might well have fallen to the ground. Indeed, Russia had few illusions about the Reinsurance treaty, which was rather a guarantee against active German hostility than an instrument of policy. Visiting Berlin in Nov. 1887, Alexander was confronted by Bismarck with a series of demands amounting almost to an ultimatum to abandon warlike intentions in the Balkans. In December the Russian government informed Austria-Hungary of its peaceful intentions in the Balkans. To make this situation palatable, Russia was allowed in Feb. 1888 to demand that the Porte should declare illegal the election of Ferdinand of Saxe-Coburg as prince of Bulgaria. The sultan agreed to this demand, but took no action to depose Ferdinand. The crisis had nevertheless been so acute that Bismarck, in order to quiet demands for a preventive war against Russia, had published on Feb. 3, 1888, the text of the Austro-German alliance of 1879 in order to show that Germany's commitments were purely defensive.

Thereafter Russia had little faith in the value of German support in the near east. Alexander entered into negotiations for

the renewal of the Reinsurance treaty in Dec. 1889, but without serious conviction. After the fall of Bismarck in March 1890, Alexander III and Giers tried to get Germany's support for Russian policy in Bulgaria and at the Straits, but Germany was unwilling to give written assurances.

Changes in Russian Policy in the 1890s.—At the beginning of the 1890s Russian attention began to turn away from the near and middle east to Siberia and the far east. Capital was needed for development, and from 1888 Russia was already borrowing heavily in France. In May 1891 a beginning was made to the construction of the Trans-Siberian railway. In Aug. 1891 Russia concluded an *entente* with France, enlarged into a military alliance which came into force in Jan. 1894. The *entente* in general strengthened the diplomatic position both of Russia and of France. Secured by the French Mediterranean squadron from the risk of British surprise action at the Straits, Russia could concentrate on the far east (the opening of the Chinese-Japanese war in July 1894 was an embarrassment, because Russian influence could not be effective in China until the Trans-Siberian railway was completed). For the time being, however, Russia could not afford to excite suspicion in the near east. By 1895 Great Britain had allowed the Mediterranean agreements of 1887 to lapse, while Germany was ready to concentrate on the colonial field.

The Armenian Question and Crete, 1894–97.—In 1894 the Turkish persecution of the Armenians gave cause for international anxiety. Massacres in Erzurum and Diyarbakir in Nov. 1895 excited fears lest Russia should intervene at the Straits in retaliation. Austria-Hungary was especially anxious that all the powers should act in concert, to which France and Russia refused to agree. In Dec. 1895, however, when the Russian foreign minister, Prince A. B. Lobanov-Rostovski, asked what the French attitude would be if Russia intervened in Turkey, France replied that the matter was of too small importance for France to support Russia. Russia was therefore disposed to caution.

After an outbreak of violence in Canea in May 1896, the powers presented a demand to the Porte for reform on the island of Crete. The sultan appointed a Christian governor for Crete on June 28 and then made proposals for reform, but the Cretan Greeks refused to submit, and the powers had to put pressure on mainland Greece to stop shipment of arms to the insurgents. On Aug. 25 the ambassadorial conference in Constantinople proposed autonomy for Crete. Next day, however, Armenian revolutionaries tried to seize the Ottoman bank in Constantinople—an attempt that provoked the massacre of 6,000 Armenians, whereupon the powers made fresh representations. Because union with Greece, which the Cretan Greeks demanded, would serve as a precedent for the partition of the Ottoman empire in Europe, the powers finally decided to impose their own solution and landed marines at Canea in Feb. 1897. In March 1897 the blockade of Greece was announced and Cretan autonomy under the sultan was proclaimed.

Under pressure of public resentment at this solution the mainland Greek government ordered its army to attack the Turks in the north on April 17, 1897. The Turkish army, however, had undergone reorganization under the German general, Colmar von der Goltz. The Greek army was thrown back and the Turks poured into Thessaly. The Greek government had to renounce Crete and ask for the good offices of the powers to produce a settlement with Turkey, which was achieved in the peace treaty of Dec. 4, 1897.

The eastern crisis of 1895–97 caused the powers to reconsider their attitudes. Lord Salisbury would have been willing to assign the Straits to Russia in return for Russian recognition of the British position in Egypt (occupied since 1882), but the emperor Nicholas II rejected this course on the grounds that it would be the first step in the break-up of the Ottoman empire, the consequences of which Russia was not strong enough to face. After Lobanov-Rostovski's death in Aug. 1896 there was a reconsideration of Russian policy. In November the Russian ambassador in Constantinople, A. I. Nelidov, proposed that Russia should be prepared to seize the Straits and in Jan. 1897 the emperor actually approved the plan of operations, but when the French foreign minister, Gabriel Hanotaux, refused to support the project Russia tried a different course of action. Austria-Hungary, perturbed by the British withdrawal of interest at the Straits, turned to Germany for help in the Balkans, but William II and his advisers suggested conciliation with Russia. Rather than rely on the uncertain aid of Italy alone, Austria-Hungary therefore sought a settlement with Russia. In April 1897 Francis Joseph and his foreign minister, Count Agenor Goluchowski, visited St. Petersburg. Russia and Austria-Hungary then agreed to maintain the *status quo* in the Balkans for ten years. This agreement permitted Russia to concentrate on the far east in order to combat Japanese influence in Korea and Manchuria. It was not until 1908 that Russia again considered forward action in the near east.

The Annexation of Bosnia-Hercegovina.—During 1902 a fresh revolutionary situation arose in European Turkey. Macedonian and Bulgarian guerrilla bands took up arms against the Turks, and the Austro-Hungarian government began to fear that Russia might intervene in spite of the agreement of 1897. Russia, however, had to consider the situation in the far east, on which as yet no final decision had been taken. The Russian foreign minister, Count V. N. Lamsdorff, met Goluchowski in Vienna in Dec. 1902 and declared his readiness to co-operate with Austria-Hungary in pressing the Porte to undertake reforms. Germany, France, Great Britain and Italy approved of this policy, and Abdul-Hamid accepted the proposals made by the powers in Feb. 1903, but the situation deteriorated. In June pro-Russian revolutionaries assassinated the pro-Austrian ruler of Serbia, Alexander Obrenovich, and elected the head of the rival house, Peter Karageorgevich. Nevertheless, Austria-Hungary and Russia continued to co-operate for the maintenance of the *status quo*. On July 13, 1903, a joint *démarche* was made in Sofia to prevent the Bulgarian government from giving aid to the Macedonian revolutionaries. In Oct. 1903 Francis Joseph and Nicholas II conferred in the Austrian Alps at Mürzsteg and agreed to present a program of reform to the Porte. When the Russo-Japanese War broke out in Feb. 1904 Russia was even more disposed not to exacerbate the situation and therefore in Oct. 1904 signed a fresh accord with Austria-Hungary for the maintenance of the *status quo* in the Balkans. The war with Japan went badly, and Russia was disorganized by internal revolution in 1905. It was therefore in Russia's interest to play down difficulties in Europe.

The re-entry of Russia into Balkan politics depended upon the diplomatic settlements in the far and middle east. The new Russian foreign minister, A. P. Izvolski, decided that Russia's differences with Japan and Great Britain must be settled. Compromises were reached with Japan by the convention of July 30, 1907, which divided Manchuria into fields of influence, and with Great Britain by the convention of Aug. 31, 1907, which provided for the maintenance of the *status quo* in Tibet, for the recognition of Afghanistan as being outside the Russian sphere of influence and for the division of Persia into three spheres, Russian, Persian and British. With these successes to his credit, Izvolski attempted to apply the same principles of agreement to the Balkans. In Aug. 1907 he conferred with the Austro-Hungarian foreign minister, A. Lexa von Aehrenthal, in Vienna on possible joint action, whereby Austria-Hungary would annex Bosnia-Hercegovina and Russian warships would have passage through the Straits. Nothing was decided, and at a meeting of the Russian council of ministers in Feb. 1908 Izvolski was warned that Russia would not undertake a forward policy.

In July 1908 the Young Turk revolution broke out in Turkey and a constitution was proclaimed. For Austria-Hungary this meant that the Slavs of Bosnia-Hercegovina under Austrian occupation would henceforth have a forum in which to express their grievances. Aehrenthal therefore thought that the time had come for Austria-Hungary to annex Bosnia-Hercegovina in full sovereignty. Accordingly Izvolski, who had already sent an *aide-mémoire* to Aehrenthal on their conversation in the previous year, was invited for further conversations, and the two ministers met at Buchlau (Buchlovice) in Moravia. By a verbal arrangement of Sept. 15–16, Austria-Hungary was to annex Bosnia-Hercegovina and Russia was to have the Straits opened. Izvolski, however,

had not yet consulted the other countries interested in the Straits. In fact, there was no backing for him either from France or from Great Britain.

In the meantime, on Oct. 6, Aehrenthal announced that Bosnia-Hercegovina would be annexed. Izvolski was furious that Austria-Hungary should have thus stolen a march on him. He had no formal evidence that an agreement had been reached with Austria, and now that Austria-Hungary had acted unilaterally he could scarcely reveal to the Serbs, who were equally outraged by the annexation, that he was prepared to betray their interests. On Feb. 26, 1909, however, Turkey formally recognized the annexation, and on March 14 Germany intervened to invite Russia to agree to the face-saving device, by which Austria-Hungary was to invite international recognition of the annexation provided that Russia promised assent beforehand. In this way it would be possible to avoid giving Russia public humiliation. On March 21 Prince Bernard von Bülow, the German chancellor, instructed the German ambassador in St. Petersburg, F. von Pourtalès, to inform Izvolski that Germany expected an answer—Yes or No. In other words, Russia was informed that Austria-Hungary could invoke the alliance with Germany. Russia submitted, with bad grace.

The Bosnian crisis was of great importance. Germany had taken the decisive step of underwriting Austro-Hungarian policy in the Balkans, a decision which Bismarck had sought to avoid. In March 1909 Serbia promised to follow a good-neighbour policy toward Austria-Hungary but in fact decided to increase propaganda among the Slavs of the Austro-Hungarian empire. The Russians were determined never again to endure humiliation in the Balkans and began to devise methods of retrieving their position. On Oct. 24, 1909, an agreement was made between Russia and Italy at Racconigi, near Turin, by which the two powers undertook to support the principle of nationality in the Balkans, Italy recognizing Russia's special position at the Straits, while Russia would support Italy's claims on Tripoli and Cyrenaica, the last remaining dominions of Turkey in Africa. Austria-Hungary soon saw that the annexation of Bosnia-Hercegovina had been a mistake; the addition of 2,000,000 Slavs to the Habsburg empire had not solved but enlarged the South Slav question. There was a growing feeling in Austria-Hungary especially in military circles that the integrity of empire was in danger. Thus in 1908–09 there had been created the situation in the Balkans which brought about World War I (*q.v.*).

See also references under "Eastern Question" in the Index.

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(R. F. Le.)

EASTERN REGION, GHANA, lies in the southeast part of the republic fronting the Gulf of Guinea, being bounded eastward chiefly by the Volta river. Pop. (1960) 1,094,196. Area 7,698 sq.mi. Its dominant features are: (1) the Akwapim ranges of folded Pre-Cambrian quartzites, phyllites, shales and sandstones trending northeast from Accra to the Volta gorge at Ajena; (2) transverse to these ranges, the Kwahu plateau of Voltaian sandstones across a saddle at Koforidua; (3) a range of Pre-Cambrian metamorphics between Kibi and the Kwahu plateau. These highlands (1,000–2,500 ft.) are surrounded southward by the Accra plains, northward by the Afram plains and below the Kwahu scarp by the Densu and Birim river basins.

Except in the drier Afram and Accra plains, where savanna and scrub occur, the predominant vegetation under a well-distributed annual rainfall exceeding 45 in. is moist semideciduous forest ideally suited to cocoa, oil palm, yams, plantains, cassava, maize. The forest soils are chiefly loamy, but along the coast ironstone laterites studded with anthills are commoner.

Although there is evidence of earlier habitation, ancestors of the modern inhabitants appear to have arrived between the 11th and 16th centuries in several distinct ethnic groups. In 1879 cocoa was introduced from the Spanish island of Fernando Poo.

The region, whose population density is the highest in Ghana, has as its largest town Accra (*q.v.*), the capital of the country from 1876. Other towns are Koforidua, the regional capital (pop. [1960] 34,856), Nsawam, Asamankese, Teshi, Achiase, Akwatia, Suhum, New Tafo and Nkawkaw. There are eight administrative districts with headquarters at Anum, Mpraeso, Kibi, Koforidua, Asamankese, Oda, Ada and Accra.

Cocoa is the chief product. The Accra plains, comparatively free from tsetse, support numerous beef cattle. Fishing takes place along the coast and in the creeks of the lower Volta. Akwatia in the Birim basin is Ghana's leading diamond-producing centre. There are bauxite deposits on the Kwahu plateau and the range near Kibi and stone is quarried in the Accra plains. Most manufacturing industry is in Accra and Tema, but matches are made at Kade, in the heart of the timber area. Accra has a roadside port and 17 mi. E. at Tema (pop. 14,937) a new port was opened in 1961. The Volta dam at Akosombo was designed to supply power to an aluminum smelter at Tema and irrigation to the Accra plains. Railways link Accra and Tema with Kumasi and Sekondi-Takoradi, and there is a good road network. Accra has an international airport and airline connections with Sekondi-Takoradi, Kumasi and Tamale. (Er. A. B.)

EASTERN REGION, KENYA, established at the beginning of 1963 following a reorganization of administrative units in Kenya (*q.v.*), comprises Marsabit Isiolo, Meru, Kitui, Embu and Machakos districts.

The region is bounded north by Ethiopia, east by North-Eastern and Coast regions, south by Coast region and west by Rift Valley and Central regions. Area about 65,000 sq.mi. Pop. about (1962) 1,557,500.

EAST FLANDERS (Flemish Oost-Vlaanderen; French Flandre Orientale), one of the nine provinces of Belgium, consists of 6 administrative *arrondissements* (Aalst, Dendermonde, Eeklo, Ghent, Oudenaarde and Sint-Niklaas), 34 judicial cantons and 297 communes. Pop. (1961) 1,272,005, nearly all Flemish speaking. Area 1,150 sq.mi.

The province lies within interior Flanders, which rises inland from the coastal plain at about 15 to 150 ft. above sea level. It is drained by the Lys and Scheldt rivers, which converge at Ghent to form the lower Scheldt, itself joined farther east by the Dender. Their valleys are 2–3 mi. wide, filled with alluvium, across which the rivers meander in great loops; many have been cut off naturally or by regularization. Between the rivers, the low interfluves are covered with Eocene deposits, Flanders clay in the south, more sandy deposits in the north and a few patches of Oligocene sands and clays. In the northeast, to the west of the Scheldt estuary, are reclaimed polderlands.

Agriculture is practised intensively, much of it on a horticultural scale, for holdings are small, particularly in the north. The proximity of large towns has encouraged market gardening, and vegetables, hops, potatoes, sugar beet, chicory, flax and even some wheat are grown, often by spade cultivation. On many holdings more than one main crop is grown each season. Yields are high, the result of heavy manuring. Clover and fodder crops are included in the rotations to feed dairy cattle; each holding usually has a herd of a few animals, sometimes stall fed, to produce milk, butter, cheese and veal. In the early 1960s there were about 340,000 cattle (of which less than one-third were dairy animals) and 280,000 pigs. The Waasland or Pays de Waes, west of the Scheldt estuary, is particularly fertile; there market gardens specialize in cauliflowers and tomatoes, and there are orchards of bush fruits, dairy farms and poultry farms.

Inland Flanders has long possessed a flourishing industrial and commercial economy, and industry is carried on in close association with agriculture. Many factory workers live in the country, owning a small holding and traveling daily to work. Textiles are

the chief manufacture. In early times wool was the most important product, then linen developed along the Lys valley, based on local flax and soft water. Later on it was cotton that became pre-eminent. Other textiles (jute, rayon and nylon) are also produced, and yarns and cloths are used by a vast range of associated industries. At one time the industry was largely domestic, then gradually it congregated in the towns. The chief centre is Ghent (*q.v.*), which contains half the country's cotton spindles, but other towns—Deinze on the Lys, Oudenaarde (*q.v.*) and Ronse on the Scheldt, Geraardsbergen (French, Grammont), Aalst (*q.v.;* French, Alost) and Ninove on the Dender and Dendermonde (French, Termonde) at the Scheldt-Dender junction—are important. Many of these towns also have metallurgical (notably textile machinery), chemical, fertilizer, leather and glassware manufactures.

The province is well served with rail and road communications. The rivers are regularized and carry a heavy traffic (lower Scheldt, more than 4,000,000 tons of freight annually), a canal links Ghent with Bruges and Ostend and a ship canal runs north from Ghent to the Wester Schelde at Terneuzen (more than 8,000,000 tons of freight annually).

This has been for centuries one of the most closely settled areas in Europe. The average density of population in 1958 was 1,098 per square mile. Ghent is the biggest city, with 160,669 people in 1958; several contiguous communes bring the population to over 200,000. Of the other textile towns, the largest is Aalst (44,478). There are several market towns such as Sint-Niklaas (*q.v.;* 47,015), the centre of the Waasland, and Eeklo (18,129) in the northwest, and 35 communes with between 5,000 and 10,000 people. Within these communes, many single houses are situated within small holdings; this is an area scheduled for dispersed rural settlement. (F. J. M.)

EAST GRINSTEAD, a market town and urban district of East Sussex, Eng., lies 30 mi. S.S.E. of London by road. Pop. (1961) 15,448. East Grinstead stands on a hill in an agricultural and wooded area overlooking the Medway valley and Ashdown forest to the southeast. The urban district contains East Grinstead and the villages of Ashurst Wood and Kingscote. Agriculture and timber production are the chief occupations of the people, though a few light industries have been established. A great number of houses were built after 1951 and many of the new residents travel daily to work in London.

The buildings in East Grinstead are of all periods from Tudor timber-framed houses onward, the loveliest being Sackville college, built as an almshouse in 1608 or 1609 by Robert, 2nd earl of Dorset, and still used for that purpose. St. Swithin's church, on the site of St. Edmund's (960), was rebuilt between 1789 and 1813 after the collapse of the tower in 1785. It stands on the hilltop and contains unusual fluted, concave pillars and iron grave slabs, the oldest of which is dated 1570.

The Queen Victoria hospital, founded in 1889, became in 1939 a centre for plastic surgery and treated members of the Allied armed forces during World War II. In 1944 the Canadian government built and equipped a large plastic surgical wing as a memorial to those members of the Royal Canadian Air Force who had been patients of the hospital. Later the British War Relief Society of America provided the American wing surgical unit. The hospital was taken over in 1948 under the National Health Service act, 1946, and made a regional centre for plastic surgery. Pioneering work in the field of corneal graft surgery was done there.

Originally a clearing in the great forest of Andredsweald, Grenestede ("green place") was granted a charter in 1121. Since it lay directly between London and Pevensey, William I included it among the royal domains that went with Pevensey castle. Iron was discovered early and at the time of William the Conqueror there was an iron mine there. Furnaces for the ironworks were fed from surrounding forests until Henry VIII and Elizabeth I passed laws to preserve the trees. East Grinstead is an ancient borough which from 1307 until 1832 returned two members to parliament. In 1285 the king ordered the market to be held on Saturday instead of Sunday, and in 1516 a yearly fair was granted.

The first Mormon temple in Great Britain was completed in 1958 at nearby Newchapel. Sheffield park lies about 9 mi. S. and is a National trust property (from 1954) famous for its garden and lakes laid out by Lancelot "Capability" Brown in the 18th century and redesigned by Arthur G. Soames in the 20th.

EAST HAM, a county borough of Essex, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with West Ham, a small part of Barking and two small parts of Woolwich to form the new London borough of Newham (*see* LONDON). East Ham county borough, with the Thames as part of its southern boundary and the Roding as part of the eastern, is 6 mi. N.E. of London bridge. Pop. (1961) 105,359. Area 5.2 sq.mi. It includes all or part of the districts of Wanstead Park, Manor Park, Forest Gate, Little Ilford, North Woolwich, Upton Park and East Ham itself. The northern part is mainly residential but along the Thames are many industries including the Beckton works of the North Thames Gas board; there, too, are the major portions of the Royal Albert dock and the King George V dock. East Ham is intersected by the two main highways out of east London—the Romford and the Barking roads; a bypass road cuts off the southern angle of the borough nearer the river on the way to Grays and Tilbury. Its growth during the end of the 19th and beginning of the 20th centuries was very rapid, and it now forms, geographically, part of the eastward extension of London. Under a development plan (1956) thousands of people were moved to other towns in Essex that were scheduled for expansion (*e.g.,* Basildon New Town and Brentwood).

East Ham belonged before the Conquest to Waltham abbey, whose possession of it was confirmed by Edward the Confessor. The parish church of St. Mary Magdalen contains Norman work in the chancel and also a monument to Edmund Nevill, who claimed the earldom of Westmorland in the 16th century. William Stukeley, the antiquary (d. 1765), is buried in the churchyard. East Ham was incorporated in 1904, became a county borough in 1915 and has been represented by two members of parliament (for East Ham North and East Ham South) since 1918.

EAST INDIA COMPANY, a company formed for the exploitation of trade with India and the far east. In the 17th and 18th centuries East India companies were established by England, the United Provinces (Dutch), France, Denmark, Scotland, Spain, Austria and Sweden. By far the greatest of these was the English East India company, the subject of this article, although the Dutch East India company (*q.v.*) and for a time the French company were also very powerful.

Early Development.—In Sept. 1599 a group of London merchants formed an association for direct trade with the East Indies, in order to compete with the Dutch and break their monopoly of the lucrative spice trade. A capital of £30,000 was immediately raised, and on Dec. 31, 1600, Elizabeth I granted a charter for 15 years to "the Governor and Company of Merchants trading into the East Indies," conferring a monopoly of the East Indian trade together with limited authority to make laws and punish interlopers. The first 12 voyages of the company, known as the "separate voyages" (1601–13) because they were individually financed and the subscribers took the whole profits, proved very successful. The voyages reached as far as Japan, and factories were established in Java at Bantam in 1602, in India at Surat in about 1612 and on the Indian mainland at Masulipatam (Masulipatnam) and at Pettapoli in the Bay of Bengal. James I proved a firm supporter of the company and in 1609 he renewed its charter "for ever" with a proviso that it could, if necessary, be terminated on three years' notice.

The attempt to break the Dutch monopoly in the spice islands was unsuccessful. A series of conflicts between the English and Dutch companies ended in uneasy truce in 1619, but the Dutch company, with its powerful government backing and territorial bases, was the stronger. When in 1623 some English merchants in the Moluccas were massacred by the Dutch at Amboina, the English company abandoned its attempted intervention, and concentrated on Surat and the other Indian factories. Good relations had been established with the Mogul emperor by Sir Thomas Roe, whom James I had sent on an embassy in 1615, and the Indian trade in calicoes, indigo, raw cotton and silk, saltpetre and some

spices proved generally profitable. Trading relations were also established with Persia. In England, the company's resources grew. After 1613 capital was raised for several voyages at a time, permitting more flexible enterprises; a permanent joint stock was not created until 1657. The company quickly built up a trading fleet; by 1614 it possessed 24 ships. Throughout the company's history, the armed East Indiamen were world-famous, and their development gave a general stimulus to English shipbuilding and navigation. Under Charles I the company suffered some reverses. The king did not revoke its charter, but in 1635 gave a licence to an association formed by Sir William Courteen, the "Assada merchants," to trade in India. The piratical methods of this rival syndicate destroyed the company's credit in India, and Courteen's traders continued to harass the East India company until 1649. It was not until Oliver Cromwell granted a new charter in 1657 that the company's monopoly was secured.

Expansion and the "Interlopers."—After the Restoration, the East India company began to develop into more than a merchant association. Charles II granted it five important charters, the first in 1661, which gave it extensive sovereign rights. New and profitable sources of trade were opened up, notably the China trade. The decline of the Mogul empire in India necessitated active protection of the company's settlements, and gradually the original principle of peaceful trade based on local alliances without territorial responsibilities had to be abandoned. The three presidencies of Madras, Bengal and Bombay (which were ceded by Charles II in 1668) had been established by 1680. In 1684 it was found necessary to fortify Bombay, and with fortification came the beginnings of an administrative and fiscal system. From the 1680s the history of the company's Indian settlements becomes that of British India (*see* INDIA-PAKISTAN, SUBCONTINENT OF: *History*). Here only the company's history in England will be traced.

Sir Josiah Child, who dominated the company from 1674 to 1695, understood and met the changing conditions. With no desire for territorial dominion he appreciated that an active policy was needed for security of trade. He also established excellent relations with Charles II and James II by large gifts of money, and the East India company became closely identified with the court interest. This gave protection against the growing demands of merchants wanting a share in the enormous profits of Indian trade. The revolution of 1688, however, left the company vulnerable both to the Whigs, its political enemies, and to its opponents in the City of London. By 1691 the company's rivals had formed a new society, and demanded a new charter. The dispute between the two factions went on both inside and outside parliament, until in 1698 an act of parliament granted the monopoly of Indian trade to those who contributed to a loan of £2,000,000. The old company retained its supremacy; it contributed £315,000 and kept its forts and privileges in India, but the new company gained a foothold in the Indian trade. Finally in 1702 it was agreed that the companies should be jointly managed for seven years. By the Godolphin award of 1708, the companies were amalgamated (1709) as the United Company of Merchants trading to the East Indies. The new company's charter was only granted for three years, but in return for loans it was extended in 1711 until 1733, in 1730 until 1769 and in 1744 until 1783.

The constitution of the United company was very similar to that which the old company had gradually evolved. It was governed by a court of 24 directors, with a stock qualification of £2,000. Government was carried out largely by committees, and the chairman, who had great power, and vice chairman were elected annually. From the earliest days of the old company, the general court of proprietors had been active; in 1709 it was laid down that the general court should meet every quarter, or on the demand of nine proprietors. The stock qualification for proprietors was £500 and their decisions could overrule those of the directors. In times of peace and prosperity the system worked well, but the struggle with the "interlopers" left an unfortunate legacy of internal faction and political intrigue.

The Ruling Company.—Under Sir Robert Walpole, the company prospered; it had its established place as a pillar of the London money market, and became an important part of Walpole's governmental machine. The victories over the French in India during the Seven Years' War, however, brought about great changes in the company's functions, and in its relationship with the government. The conquests of Robert Clive (*q.v.*), and his assumption of the government of Bengal by the treaty of 1765 made the East India company the ruler of rich and extensive territories. The government could not ignore the problems this raised. After many intrigues, the company forestalled government interference in 1767 by promising an annual payment of £400,000 which it could ill afford. Further negotiations led to Lord North's Regulating act of 1773 which gave the governor of Bengal the title of governor general. His appointment was subject to government approval, and with his council of four he was given legislative powers. Furthermore a supreme court was established and its judges appointed by the crown. Warren Hastings (*q.v.*) became governor general. The new system soon revealed many flaws; in India the governor general's powers were not clearly enough defined, and in practice inadequate; in England, the government had established no machinery to keep check on Indian affairs. For many reasons—jealousy of the rich "nabobs" returned from India and undue fear of their political influence, evidence of misgovernment in India, and the campaign against Hastings which was powerfully supported by Edmund Burke—the question of the East India company's future became an issue of the first magnitude, an issue in which political faction and individual interests were mixed with a genuine demand for reform.

A solution was found in William Pitt's India bill of 1784. A government department, the board of control for India, was set up to govern British India. The India board ultimately had complete authority over the board of directors, but the directors in practice still retained considerable powers in the inauguration of policy and especially in commercial affairs. Under the board's first president, Henry Dundas, the system was made to work fairly smoothly. Gradually the government tightened its control over the Indian administration. In 1813 an act was passed ending the company's monopoly in India and in 1833 the China trade was opened. The 1833 act left the company with no real administrative or commercial functions, an anomalous position ended by the act of 1858, after the Indian mutiny, when the East India company reluctantly transferred its possessions to the crown. *See* also references under "East India Company" in the Index volume.

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EAST INDIES, a term used loosely to refer to the islands of the Republic of Indonesia (formerly known as the Netherlands Indies or Dutch East Indies), to all the islands of the Malay archipelago, or to the foregoing plus all of southeast Asia and India. Modern practice generally limits the term to the Malay archipelago. It is the largest group of islands in the world and extends in a wide belt along the equator for more than 3,800 mi. between Asia and Australia. *See* MALAY ARCHIPELAGO; INDONESIA, REPUBLIC OF.

EAST KAZAKHSTAN OBLAST (VOSTOCHNO-KAZAKHSTANSKAYA OBLAST), a province situated in the Altai mountains at the extreme northeast of the Kazakh Soviet Socialist Republic, U.S.S.R. Pop. (1959) 734,924; area 37,568 sq.mi. It is bordered on the east and southeast by China (Sinkiang Uigur autonomous region) and on the northeast by Altai *krai* and the Gorno-Altai autonomous *oblast*. It is drained by the upper Irtysh river and its affluents, the Narym and the Bukhtarma. In the south lies Lake Zaisan (*q.v.*) in the middle of a large depression. The cli-

mate is continental, with high pressure in the winter giving clear cold weather. In the summer the weather in the plains is often hot and cloudless. Precipitation in the foothills is considerably higher.

The capital of the *oblast* is Ust-Kamenogorsk. Other important cities are Leninogorsk, Zyryanovsk and Zaisan.

The *oblast* is an important mining region, the main deposits being zinc, lead and silver, with some copper and gold. The principal mining centres are Ust-Kamenogorsk, Zyryanovsk and Belousovka. The nonferrous industries are powered by hydroelectric plants at Ulba, near Leninogorsk; at Ablaketka, just south of Ust-Kamenogorsk; and at Glubokoye.

Agriculture is mainly concerned with stock raising, but wheat and beets are also grown. There are considerable fisheries in the rivers and lakes.

The only railway in the *oblast* is the branch from the main Turksib line running through Ust-Kamenogorsk and terminating at Zyryanovsk. The Irtysh river is navigable from May to October.

In the early 1960s there were more than 700 schools in the *oblast*, as well as various technical institutes. (G. E. WR.)

EAST KILBRIDE, a New Town (*q.v.*) built around an old village of the same name in Lanarkshire, Scot., 8½ mi. S.S.E. of Glasgow, from which it is divided by the Cathkin Braes (700 ft.). The town was designated in 1947 to cover nearly 16 sq.mi. and the proposed population was 50,000. Pop. (1951) 5,136; (1961) 31,972. East Kilbride lies in a dairying area and an annual cattle show has been held there since 1816. Milk bottling and the making of agricultural and mining machinery are old industries; the biggest new ones are aeroengineering and the making of domestic electrical appliances. The town is the site of the new National Engineering Laboratory of Great Britain.

EASTLAKE, SIR CHARLES LOCK (1793–1865), English painter, art historian and museum director, was born at Plymouth, Devonshire, on Nov. 17, 1793. He went to Plympton grammar school (concurrently learning drawing from Samuel Prout) and briefly to the Charterhouse, London. But in 1809 a resolve, "unalterably fixed," to become a painter of "history" (*i.e.*, of scripture allegory, antiquity or literature as opposed to everyday life or portraits) brought him as pupil to B. R. Haydon and to the Royal Academy schools. By 1812 he had finished his first commission, the "Raising of Jairus's Daughter," and in 1815 came the famous "Buonaparte on Board the Bellerophon," the proceeds of whose sale took him to Rome in 1816. There till 1830 he worked in a congenial society that included Sir Thomas Lawrence, J. M. W. Turner, William Etty, Sir Humphry Davy and Thomas Moore. Rome and the Campagna deflected him for a while from history to landscape, his skill in which appears in his later "banditti" pictures; then also were begun his copious notebooks, many of which are preserved in the National gallery, London. He was elected an associate of the Royal Academy in 1827 and to the Royal Academy in 1830; in 1850 he succeeded Sir Martin Archer Shee as president of the Royal Academy and was knighted.

With his appointment in 1855 to the new directorship of the National gallery—whose keeper he was from 1843 till his resignation in 1847 in face of unjust criticisms—the artist was finally displaced by the writer, administrator and arbiter of national and court taste; and Eastlake is best remembered for his part in raising the status of the gallery and for his books *Materials for a History of Oil Painting* (1847) and *Contributions to the Literature of the Fine Arts* (2 series, 1848, 1870). He died at Pisa, Italy, Dec. 24, 1865.

In 1849 he had married Elizabeth Rigby, author of *Letters From the Baltic* (1841). LADY EASTLAKE (1809–93) was also a considerable diarist and translator of G. F. Waagen's *Treasures of Art in Great Britain* (1854–57). Their nephew CHARLES LOCK EASTLAKE (1836–1906) was keeper of the National gallery, 1878–98, and a writer on painting and industrial art.

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EAST LANSING, a city of Ingham county, in south-central Michigan, U.S. The city has been council-manager governed since 1944. With neither industry nor railroad connections, it grew up around Michigan State university (pioneer land-grant school, 1855) and expanded with the student enrollment. Chartered in 1907 as a college city, its name, a subject of controversy, was settled by the U.S. post office, which designated the postal area East Lansing as it was a few miles east of Lansing (*q.v.*), through which its mail was routed. It became in the 1920s a residential suburb, offering homes to state officials and to Lansing automobile factory executives. To the south of its central avenue lies the mile-square campus, spanning the Red Cedar river, with more than 20,000 students. To the north lies a community of fine homes and quiet streets, participating in all aspects of university life but alert to the index of automobile sales and to the fate of its citizens in state elections. For comparative population figures *see* table in MICHIGAN: *Population.* (M. KU.)

EASTLEIGH, a municipal borough in the Winchester parliamentary division of Hampshire, Eng., 4 mi. N.N.E. of Southampton. Area is 9.8 sq.mi. Pop. (1961) 36,577. Incorporated in 1936, it includes the districts of Chandler's Ford, Allbroke, Bishopstoke and parts of North Stoneham, Otterbourne, Fair Oak and Stoke Park. Lying in well-wooded country, it is in part residential and in part industrial, the chief industry being the works of the British railways (Southern Region).

The church of St. Nicolas at North Stoneham is one of the earliest ecclesiastical foundations in England, though it shows no trace of the old Saxon building. It contains the memorial to Sir Thomas Flemyng, who sentenced Guy Fawkes to death, and for centuries a celebration took place every Nov. 5.

EAST LIVERPOOL, a city of Columbiana county in eastern Ohio, U.S., is noted for its pottery. Nearly equidistant between Pittsburgh, Pa., Youngstown, O., and Canton, O., it is situated on the Ohio river near the intersection of the Ohio, Pennsylvania and West Virginia boundaries.

First settled in 1798 by an Irish Quaker, Thomas Fawcett, the village was variously known as St. Clair, Fawcettstown and Liverpool before its incorporation as East Liverpool in 1834. In the nearby hills an English potter from Staffordshire, Eng., James Bennett, found a clay which was suitable for the manufacture of crude yellowware and established the first kiln in 1840. Other potteries were soon built, but it was not until federal import duties were placed on earthenware goods, commencing with the Morrill tariff of 1861, that the village emerged as one of the nation's foremost pottery centres. The manufacture of whiteware began in the 1870s; of semivitreous china in the 1890s. There is an outstanding collection of pottery ware, ranging from pioneer patterns to modern designs, in the East Liverpool Historical Association museum. Though many of its potteries were transferred across the Ohio river into Newell and Chester, W.Va., the city remains a centre of the industry. In addition to ceramics, East Liverpool produces a wide range of manufactured products, including steel, asphalt roofing, wood and fibre containers, paper, tin and chemicals. A village of 1,308 inhabitants in 1860, its population increased to 20,387 by 1910, after which the city's rate of growth was much slower. For comparative population figures *see* table in OHIO: *Population.* (P. R. S.)

EAST LONDON (Afrikaans OOS-LONDEN), a city and the fourth port of the Republic of South Africa, lies on the southeast coast of the Cape of Good Hope province, 695 mi. E. of Cape Town and 433 mi. S.W. of Durban by road. Pop. (1960) 113,258, of whom 47,793 were Europeans. It stands at the mouth of the Buffalo river and is built chiefly on the east (left) bank, which rises steeply from the water front. The city has wide straight streets of which the chief is Oxford street; the Esplanade runs northeast along the sea front with beaches for surf bathing. Among the principal buildings are the city hall (1899), law courts (1883) and the fine municipal market (1955). A double-deck road and rail bridge 1 mi. from the river mouth leads to the west bank, where stand Ft. Glamorgan and the old powder magazine, built in 1847. The city has a technical college, art gallery, aquarium and zoo. The museum is notable for a specimen of the primeval fish *Latimeria chalumnae* (*see* COELACANTH). Queen's park (80 ac.) lies

between the city centre and the river. The mean temperature is 59.4° F. in July and 70.2° in January, with about 32 in. annual rainfall. East London is a popular resort and the South African Grand Prix motor race is held there annually.

East London is a terminus of the South African railways and is linked by air services from Collondale (8 mi. W.) with the main centres of the Republic. The port, on which is based a considerable fishing industry, has wharfage on both banks and a turning basin at the river mouth sheltered by breakwaters, with a 732-ft. dry dock. Mail vessels on the London-Cape Town-Durban route call weekly in both directions. The city is a market and distribution centre for the eastern part of the province. Its chief business is the wool industry and its manufactures include confectionery, furniture, textiles, clothing, footwear, soap, glass, storage batteries, pharmaceuticals, fruit canning and automobile assembly. The port's principal imports are general cargo, petroleum fuels, timber and grain; the main exports are maize, wool and fruit.

The place was first named Port Rex after George Rex of Knysna, whose brig anchored off the estuary in 1836. In 1847 it was used as a supply base for the seventh Kaffir War and in the following year was annexed to Cape colony as the "Port of East London." It became a municipality in 1873 and a city in 1914.

(H. H. Dr.)

EAST LOTHIAN (formerly Haddingtonshire), a south-eastern county of Scotland, one of the three surrounding Edinburgh, is bounded on the north by the Firth of Forth, northeast by the North sea, south by Berwickshire and west by Midlothian. Area 267.1 sq.mi.

Physical Features.—In the south is part of the Lammermuir hills, broad undulating grouse moors, clad in heather or bent grass, or in cotton grass, deer grass and sphagnum over peat. Occasionally there are shelter-belts of conifers. The main plateau surfaces at 1,200–1,300 ft., swelling to 1,733 ft. in Lammer Law and 1,750 ft. in Meikle Says Law, are planed across steeply inclined, tightly folded but lightly metamorphosed Silurian shales and grits, but in the east across Old Red Sandstone conglomerate infilling an ancient valley. Through steep-sided, flat-floored, gravel-bottomed dales, small clear trout streams like Whiteadder and Faseny waters flow south to the Tweed. The northern edge of the Lammermuirs, a steep fault-line scarp of the system flanking the mid-lowland from Dunbar to Girvan, is gouged deeply by hill streams like the Hopes, Birns and Gifford waters, which are tributaries of the Tyne. These streams caused great havoc on Aug. 12, 1948 (rainfall 5.5 in. in 24 hr.), when the Tyne flooded low-lying areas in Haddington. To the north is a plateau at about 500–600 ft., planed across Old Red Sandstone and Carboniferous rocks, mantled in easily tilled red boulder clays and in parts (mainly wooded) stiff intractable boulder clays.

Farther north lies a softly undulating lowland plateau at 200–300 ft., similarly mantled, and then the broad, gently sloping, flat-floored vale of the sluggish river Tyne, running 27 mi. from Borthwick in Midlothian east-northeast across the county, the greatest of many similarly oriented glacial spillways. The northern slope of the vale rises gently to the small wooded crags of the Garleton hills, of andesitic lavas, tuffs and intrusions of Carboniferous age. These rocks separate two synclines in Carboniferous sediments—limestones, sandstones and, in the west, some coal. All the rocks are planed across by the boulder-clay-plastered rolling plateau (200–300 ft.) already noted, and by post-glacial raised beaches mainly at 25 ft. above mean sea level. A fluvio-glacial gravel delta, largely wooded, overlooks the quicksands of the modern Tyne mouth.

The coast has some fine cliffs, as east of North Berwick, facing the bold volcanic crag of the Bass rock (*q.v.*), breeding place of gannets. East and west are some good beaches, a fringe of dunes or links and, inland, a sand-apron. The Aberlady bay nature reserve includes many of the distinctive coastal flora. The northern area is dry and sunny (Dunbar averages 1,400 hr. of sunshine annually), especially in the spring, but the Lammermuirs have 35–40 in. mean annual rainfall.

(A. T. A. L.)

History.—In the Iron Age, Celtic people lived in the county and left many hill forts, as well as a hill-top town, Dunpender, on Traprain Law, which was occupied until the 4th century A.D. They were succeeded by Angles in the 7th–8th century, and the Lothians formed part of Northumbria. The area was introduced to Christianity by St. Baldred in the 8th century. At the Battle of Carham (*c.* 1016) the Lothians were finally incorporated in Scotland. In the 12th century much of the land passed to Anglo-Norman families, who developed cereal and fruit growing and the wool trade. Haddington (*q.v.*) was founded by David I, and later royal burghs were Dunbar (1317) and North Berwick (1370) (*qq.v.*). At Prestonpans (*q.v.*) coal mining and salt panning had started in the 12th century.

The county, however, lay in the path of the English invaders and was subject to much destruction during the 14th, 15th and 16th centuries. In this period the feudal castles of Dirleton, Tantallon and Hailes were built. There were also nunneries at Haddington and North Berwick, friaries at Haddington, Luffness and Dunbar, and the Holy well at Whitekirk, a place of pilgrimage. John Knox (*q.v.*) was a native of East Lothian and by 1560 people had turned to the Reformed Church. The last battles fought in the county were those of Dunbar (1650) and Prestonpans (1745).

Conditions were more settled in the 18th century and there was a further development of agriculture. The land was enclosed and drained, industries were started and woods planted. The old settlements of group holdings gave way to centralized farms, each with a slated farm house, large pantiled steading buildings and a group of rubble and pantiled cottages. Mansion houses were built and parks were walled and planted. Some new villages were established (Gifford, 1722, and Ormiston, 1732, are both of architectural interest) and Haddington and Dunbar developed as market towns. Farming reached the height of prosperity in the 1870s. In the last years of the 19th century golfing and holiday facilities were developed at North Berwick, Gullane and Dunbar. Also, deep coal mines were sunk in the west of the county, notably at Prestonpans, which now became a mining town.

Population and Administration.—The population of East Lothian, which was about 30,000 in 1801, rose slowly throughout the 19th century and increased by about 10,000 to 47,487 between 1901 and 1921, mainly as a result of the mining development. By 1961 the population was 52,653. Land tenure is in a state of transition, from mainly tenant occupation of the generally large farms on the estates of such landowners as the earls of Wemyss and Haddington toward a much larger proportion of owner-occupied farms. East Lothian is probably the best-housed rural county in Scotland, and the villages are delightful. There are seven small burghs, those with the largest population in 1961 being Tranent (6,317), Haddington, the county town (5,506), Dunbar (4,003) and North Berwick (4,161). The shire, which returns one member to parliament with Berwickshire, forms part of the sheriffdom of the Lothians and Peebles, and a sheriff substitute sits at Haddington.

Agriculture and Industry.—About one-quarter of the employed population is engaged in agriculture, forestry or fishing, but the proportion is declining. The 400–600-ac. farms are largely arable. Traditionally, cash crops (wheat, barley, potatoes) are produced, together with fodder for bought-in stock which are sold fat after winter feeding and also provide dung vital for high yields of cash crops. Dairying, however, is increasing, as is market gardening. The hill pasture of the Lammermuirs carries one Cheviot or Blackface ewe to every two acres. Fishing is confined to the Port Seton fleet of ring- and seine-net boats, together with local lobster-fishing boats out of North Berwick and Dunbar.

Coal mining declined by the 1960s as the shallower mines closed and is confined to the Prestonpans area. Manufacturing consists mainly of food and drink products, textiles and light engineering. The main trade is carried on with Edinburgh, although North Berwick, Dunbar and Haddington are local retail as well as social centres. By the 1960s traveling shops were replacing the village shops which, with village crafts, were declining.

Cars are the main form of transport but there are good bus services on the radial routes to Edinburgh. The main railway line serves Dunbar.

(F. P. Ti.)

EASTMAIN, a river of Quebec province, Can., rises south of

Lake Nichicun in central Labrador-Ungava and flows nearly due west for 510 mi., discharging into James bay. The valley is shallow and irregular, and the river is full of falls and rapids. A Hudson's Bay company post (founded 1865) is situated in the tidal section of its mouth, which is 1½ mi. wide and obstructed by shoals. The river was explored in 1892 by A. P. Low, Canadian government geologist. (J. D. I.)

EASTMAN, GEORGE (1854–1932), U.S. inventor and manufacturer of photographic materials and cameras, was born at Waterville, N.Y., July 12, 1854. While Eastman was still a boy the family moved to Rochester, N.Y., where he was educated in the public schools and then worked briefly in an insurance company and a bank. In 1880 he perfected a process for making dry plates and began their manufacture. He originated transparent film and organized the Eastman Dry Plate and Film company in 1884. The Kodak camera was placed on the market in 1888. By 1927 Eastman had a virtual monopoly of the photographic industry in the United States. He was one of the first to introduce profit sharing as an employee incentive.

One of the most generous philanthropists in America, he gave away half his fortune in 1924. His total benefactions amounted to more than $75,000,000, the University of Rochester and the Massachusetts Institute of Technology being the chief beneficiaries. He died in Rochester on March 14, 1932, by his own hand. (J. R. Lt.)

EASTON, a city in eastern Pennsylvania, U.S., and seat of Northampton county, at the junction of the Lehigh and Delaware rivers, 55 mi. N. of Philadelphia and 70 mi. W. of New York city. The city is connected with Phillipsburg, N.J., across the Delaware river, by two automobile and two railway bridges, and many civic groups and churches have members from both cities. With a population (1960) of 31,955, Easton is a central city of the Allentown-Bethlehem-Easton standard metropolitan statistical area, comprising Northampton and Lehigh counties in Pennsylvania, and Warren county in New Jersey (*see* Allentown). (For comparative population figures *see* table in Pennsylvania: *Population.*)

The Easton area is endowed with quantities of limestone and slate, as well as iron ore, lumber and serpentine. The city is surrounded by diversified farm land and is about 50 mi. from large anthracite coal and zinc fields. Among its manufactured products are air valves, cement, crayons, farm machinery, flour and feed, industrial cars and quarry trailers, metal castings, paper cups and containers, pigments and oxides, portable tools, pumps, steel products and textiles. It is also a printing and publishing centre.

Northampton county and Easton were established simultaneously in 1752, and Easton has always been the county seat. Originally the county included most of northeastern Pennsylvania. The streets of Easton were laid out by William Parsons at the request of the proprietor, Thomas Penn, and the city was named to honour the latter's father-in-law, the Earl of Pomfret, whose estate in Northamptonshire, England, was called Easton-Neston. Settlement at the forks of the Delaware had begun even earlier, and the land was obtained from the Indians in the notorious Walking Purchase of 1737. During the French and Indian War Easton was the scene of several Indian treaties; during the Revolution it served as a frontier outpost. In 1826 some local citizens founded Lafayette college, and named it for the Revolutionary hero, who had revisited the United States two years earlier. Easton was incorporated as a borough in 1789, and chartered as a city in 1887. (J. M. Co.)

EAST ORANGE, a city of Essex county, N.J., U.S., adjoining Newark. The site was originally settled in 1666 by 30 families from New Haven, Conn. Along with West Orange, South Orange (*qq.v.*) and Maplewood, it was once a part of Orange (*q.v.*). East Orange was separated from the latter and established as a municipality in 1863; it acquired its city charter in 1909.

It is mainly a residential suburb for commuters to New York and Newark. The industrial section has been called Ampere since Francis B. Crocker and Schuyler S. Wheeler began the manufacture of electric motors there in the 1890s. The city's industry includes electrical equipment, food products, precision instruments, cosmetics, signal and sound equipment, and aeronautical and automotive parts. Upsala college, a Swedish Lutheran institution, was founded there in 1893. Panzer College of Physical Education and Hygiene was founded in Newark in 1917 and eight years later moved to East Orange, where it remained until its consolidation with Montclair State college in 1958.

A source of civic pride is the municipal centre, completed 1929. Pop. (1960) 77,259 by federal census. For comparative population figures *see* table in New Jersey: *Population.* (E. R. D.)

EAST POINT, a city of Fulton county in north-central Georgia, U.S., originated in 1857 as the eastern terminus of the Atlanta and West Point railroad at its junction with the Central of Georgia. During the American Civil War it was the site of an important military supply depot for the Confederate army. East Point adjoins, but is politically independent of, Atlanta (*q.v.*), of whose metropolitan area it is a part. It comprises a compact industrial area, producing textiles, fertilizers, paper, machinery, furniture, metal products, foods and chemicals, and is also a storage warehouse centre. The principal business area lies along the railroad tracks, and outside this area are attractive residential neighbourhoods. The city schools are operated by Fulton county. For comparative population figures *see* table in Georgia: *Population.* (Js. C. B.)

EASTPORT, the easternmost city of the United States, and a port of entry, is located in Washington county, Me., on Moose Island in Passamaquoddy bay, and connected by bridge with the mainland. Originally settled around 1780, Eastport was incorporated as a town in 1798, as a city in 1893 and adopted the city-manager form of local government in 1936. The town was captured by British troops during the War of 1812 and remained under martial law until 1818, when it went to the United States under the terms of the treaty of Ghent. Eastport was the scene of considerable activity during the 1930s when the federal government began work on the Passamaquoddy Tidal Power project, a plan to harness the exceptionally high tides of Passamaquoddy bay for hydroelectric power. The project was abandoned in 1937 prior to completion, due to congressional failure to provide funds, and its facilities were transferred to the War Assets administration, but interest in the development occasionally was renewed.

Eastport's economy is heavily dependent on fishing and fish processing. Herring, the main catch, are canned as sardines and used in making other sea products, such as pearl essence, fish meal and fish oil. It has a population of about 3,000. (H. A. Pe.)

EAST PROVIDENCE, a city of Providence county, R.I., U.S., on the east side of the Seekonk and Providence rivers, opposite Providence. There are four major sections: Watchemoket, the largest; Phillipsdale, containing most of the manufacturing; Rumford, which has a large chemical works; and Riverside, with well-developed summer resorts. Major products include wire and cable, jewelry, machinery and chemicals. Refined petroleum products are stored there for distribution.

Roger Williams (*q.v.*) established himself in East Providence in the spring of 1636, but left when he learned it was within the jurisdiction of the Plymouth colony. About 1644 it was settled by a company from Weymouth as part of the town of Rehoboth in Massachusetts. In 1812 Rehoboth was divided and the west part was made the township of Seekonk. In 1861 it was decided that the west part of Seekonk belonged to Rhode Island and that part was incorporated as the township of East Providence in 1862. In 1958 the town was chartered as a city and adopted a city-manager form of local government. For comparative population figures *see* table in Rhode Island: *Population.* (G. H. Bs.)

EAST PRUSSIA (Ostpreussen), a former German province bounded, between World Wars I and II, north by the Baltic sea, east by Lithuania and south and west by Poland and the free city of Danzig. The name Prussia is linguistically of Baltic origin; its ancient inhabitants, exterminated by the Knights of the Teutonic Order, called themselves *Prusi* (*see* Prussia). When the Knights conquered the Polish province of Pomorze in 1308 the name Prussia was extended westward covering the whole territory administered by the Teutonic Order. In 1466 Poland recovered Pomorze (and the region of Warmia, or Ermeland, in the Old

MAP SHOWING THE CHANGING BOUNDARIES OF THE AREA OF FORMER EAST PRUSSIA AND ITS MAJOR TOWNS

Prussia); and between that date and 1701 (when the elector of Brandenburg became king in Prussia) the country held directly by the crown of Poland was called Royal Prussia to distinguish it from the land retained by the Knights as Poland's vassals, which became a secular duchy (Ducal Prussia) in 1525 and was freed from Polish suzerainty by the treaty of Wehlau (1657). From 1815 the name East Prussia was given to the easternmost province of the kingdom of Prussia. The boundaries of this province remained unchanged until World War I. Its area was then 14,284 sq.mi., and its population in 1910 was 2,064,175.

As a result of the treaty of Versailles (1919) the Memel (Klaipeda) territory was taken from Germany (in 1924 it was incorporated into Lithuania); the district of Soldau (Dzialdowo) was given to Poland, while the regency of Marienwerder (Kwidzyn), formerly part of the province of West Prussia, joined East Prussia, now territorially separated from the rest of Germany. The new area of East Prussia (1920–39) was 14,304 sq.mi., and its population (according to the census of 1925) was 2,256,349,, of which total 83.8% were Lutheran and 15% Roman Catholic.

After World War II East Prussia was partitioned between Poland (the southern part) and the U.S.S.R. (the northern part), the frontier running north of Goldap, Bartenstein (Bartoszyce) and Braunsberg (Braniewo). With the exception of the Klaipeda territory which was reincorporated into Lithuania, the northern part was incorporated into the Russian federation and colonized by Russians. Königsberg became Kaliningrad; Insterburg, Chernyakhovsk; and Tilsit, Sovetsk. In the southern part about 400,000 indigenous Poles (whom the Germans had called *Masuren*) remained, and immigrants from pre-1939 Poland replaced the Germans, who either had fled in 1944 or were evacuated after 1945.
(K. Sm.)

EAST SAINT LOUIS, city in St. Clair county, Ill., U.S., on the Mississippi river, opposite St. Louis, Mo. A ferry station was established on the site in 1797 and 20 years later a village was platted. Originally known as Illinoistown, it was incorporated as a town in 1859 and, after amalgamation with adjacent East St. Louistown, it was reincorporated as East St. Louis in 1865. The first railroad to reach there, in 1855, foreshadowed the city's transformation from an undistinguished river town into a component of a virile industrial region. By 1866 ten railways, seeking the trade of St. Louis, were stopped at East St. Louis by the barrier of the Mississippi river. The completion of Eads bridge in 1874 allowed limited rail traffic across the river but not before the position of East St. Louis as a railway centre and freight depot was established.

The superior transportation facilities and nearby deposits of coal, phosphate rock and limestone began to attract manufacturing in the late 19th century. Between 1880 and 1910 the city's population increased sixfold; the rate of growth slowed thereafter. Pop. (1960) 81,712 by federal census (for comparative population figures *see* table in Illinois: *Population*). Rapid development blighted many historic sites in the vicinity, among them the village of Cahokia, founded by a French Jesuit mission in 1698. (*See* Cahokia Mound.)

Huge stockyards are located at National City (National stockyards), economically a part of East St. Louis. Besides meat packing, the city depends heavily upon the manufacture of chemicals, pigments, steel products, glass, building materials and the refining of oil.
(R. E. M.)

EATON, DORMAN BRIDGMAN (1823–1899), U.S. lawyer and civil service reformer, was born in Hardwick, Vt., June 27, 1823. Following graduation from the University of Vermont, Burlington, in 1848 and the Harvard law school in 1850, he became a noted New York lawyer. He retired in 1870 to pursue civil service and municipal reform. His legal work with the New York Citizen's association of 1864, and after, led to creation of the department of health, the fire department, the department of docks, and the police judiciary. These agencies became models for others throughout the country. In 1873 Eaton succeeded George W. Curtis as chairman of the federal Civil Service commission and, defying sharp political opposition, worked for a merit system of government appointments. At Pres. Rutherford B. Hayes's request, in 1877, he studied and later reported upon the British civil service. Among others of his influential writings in the field was *The "Spoils" System and Civil Service Reform* (1881). Eaton helped found the National Civil Service Reform league in 1881. He drafted the Pendleton Civil Service act (1883) and under it served on the U.S. Civil Service commission. He continued to press for municipal reform in New York, where he died Dec. 23, 1899.

Bibliography.—*Dorman B. Eaton, 1823–1899* (1900); Stephen Smith, *The City That Was* (1911); F. M. Stewart, *The National Civil Service Reform League* (1929).
(L. Fr.)

EATON, MARGARET O'NEALE (1796–1879), a beautiful and vivacious woman whose marriage in 1829 to a man soon to be appointed to President Jackson's cabinet caused a political uproar in the U.S. She was the daughter of William O'Neale, a Washington tavern keeper. (The name is sometimes also spelled O'Neill or O'Neil.) After an irregular schooling, she married at an early age John B. Timberlake, a navy purser. They had a son and two daughters. When Timberlake was with his ship, his wife, "Peggy," as she was called, often stayed at her father's tavern. There her beauty, wit and vivacity charmed many notables, including Andrew Jackson and his friend John H. Eaton, a wealthy widower, who came to Washington as senator from Tennessee in 1818. Gradually, gossip connected Peggy's name with that of Eaton.

When Timberlake died on sea duty in 1828, rumour had it that he had cut his throat because of his jealousy of Eaton. The latter consulted Jackson, who believed Peggy to be virtuous and advised his friend to marry her. The marriage took place Jan. 1, 1829, and a few weeks later Jackson made Eaton secretary of war.

Floride Calhoun, wife of Vice-Pres. John C. Calhoun, snubbed Peggy, and the wives of other cabinet members followed her example. Jackson was outraged. Secretary of State Van Buren, a widower, was courteous to Peggy, and his stock rose with Jackson as that of Calhoun fell. It was the beginning of the break between Jackson and Calhoun.

Eaton resigned from the cabinet in 1831. In 1836 he was appointed minister to Madrid, and for four years his wife enjoyed the brilliant society of the Spanish court. The Eatons then returned to Washington, where Eaton died in 1856. Not long thereafter

his wealthy widow married a young Italian dancing master, Antonio Buchignani. During the next few years her husband ran through her property, eventually eloping with her granddaughter. Peggy died in Washington, Nov. 8, 1879.

See Queena Pollack, *Peggy Eaton, Democracy's Mistress* (1931); M. L. Eaton, *Autobiography* (1932). (G. G. V. D.)

EATON, THEOPHILUS (*c.* 1590–1658), co-founder and for many years governor of New Haven colony in colonial America, was born in Stony Stratford, Buckinghamshire, Eng. The son of a minister, Eaton was schooled in Coventry and then apprenticed to a London merchant. He became a wealthy trader, was elected deputy governor of the East-Land company and was once agent of the British sovereign to Denmark. As a wealthy merchant, he became interested in New England colonization, being among the original Massachusetts company patentees. When his friend of boyhood days Rev. John Davenport was persecuted for nonconformist views, Eaton joined with Davenport and others to found the American colony of New Haven. Probably the wealthiest group to emigrate to 17th-century America, they arrived at Boston in 1637, settling in New Haven the following year. After establishing a church and government based on Puritan doctrines in 1639, they annually elected Eaton governor until his death on Jan. 7, 1658. In 1655, Eaton helped prepare a new code of laws for the colony. Eaton married twice and had two children by his first wife and five by his second. Never successful as a merchant in New Haven, he finally devoted himself to agriculture. (B. K. B.)

EATON, WILLIAM (1764–1811), U.S. army officer and adventurer, who in 1805 led an expedition across the Libyan desert in an effort to overthrow the pasha of Tripoli during the so-called Tripolitan War was born in Woodstock, Conn., Feb. 23, 1764. At the age of 16 he ran away from home to join the colonial army.

After the Revolutionary War ended he alternately taught school and attended Dartmouth college, Hanover, N.H., until he graduated in 1790. He taught for a time at Windsor, Vt., and, with Senator Bradley's influence, secured appointment as an army captain in 1792. In that year he married the widow of Gen. Timothy Danielson, of Brimfield, Mass., and made his home there, near his native Woodstock. Five children were born to them.

In service against Indians and conspirators in Ohio, Georgia and Tennessee, William Eaton distinguished himself in the eyes of Timothy Pickering (*q.v.*) in the war department by his effective investigations, actions and racy reports. In the department of state, Pickering persuaded Pres. John Adams to appoint Eaton consul at Tunis and instruct him to study and report on north African affairs and prospects for trade, a matter of interest in maritime New England.

In north Africa Eaton found the possibilities of trade encouraging, but it appeared that the pashas were dominated by the piratical interests; one, Pasha Hamet Karamanli of Tripoli, had been dethroned. Eaton returned to the United States (1803) and won Pres. Thomas Jefferson's approval of a plan to restore Karamanli. Back in north Africa, Eaton, with ten U.S. marines and a rabble of Arabs with Karamanli, marched from Egypt westward and, with the help of U.S. naval bombardment, took Derna, Libya, (April 27, 1805). When the pasha at Tripoli agreed to a treaty with the United States, Eaton was obliged to end his operation unfinished. He returned to the United States and died at his home in Brimfield, Mass., on June 1, 1811.

BIBLIOGRAPHY.—*See* sketch in *Historical Celebration of . . . Brimfield, . . . Mass. . . . 1876* (1879); L. B. Wright and J. H. Macleod, *First Americans in North Africa* (1945); and S. F. Bemis, *Diplomatic History of the United States*, 3rd ed. (1950). (T. P. MA.)

EATON, WYATT (1849–1896), U.S. painter, whose portraits of many of the foremost 19th-century figures were noted for their delicacy and feeling, was born at Philipsburg, Que., on May 6, 1849. He was a pupil of the schools of the National Academy of Design, New York city, and in 1872 went to Paris, where he studied in the École des Beaux-Arts under J. L. Gérôme. He made the acquaintance of J. F. Millet at Barbizon and was also influenced by his friend Jules Bastien-Lepage. After his return to the United States in 1876, he became a teacher in Cooper institute and opened a studio in New York city. He was one of the organizers (and the first secretary) of the Society of American Artists. Among his portraits are those of William Cullen Bryant and Timothy Cole, who engraved many of Eaton's works. Eaton died at Newport, R.I., on June 7, 1896.

EAU CLAIRE, a city of Wisconsin, U.S., and seat of Eau Claire county, is situated at the confluence of the Eau Claire (named "clear water" by 18th-century French trappers and traders) and the Chippewa rivers. The village was settled in the 1840s and platted in 1855. From lumbering days persons of Scandinavian descent have been predominant in the population. It was chartered as a city in 1872 and grew rapidly with the development of the northwestern lumber trade between 1870 and 1880. A city-manager form of local government was adopted in 1949.

Eau Claire is the principal trade centre for west-central Wisconsin's dairy land. There is abundant water power, and its diversified manufactures include rubber and metal products, paper and pulp products, meat packing and food processing. Carson park, almost surrounded by Half Moon lake, with Paul Bunyan camp, a replica of logging days, is a local recreational attraction. Winter sports include ice fishing, skiing, especially at Hendrickson hill jump, and skating. The municipal airport provides facilities for commercial and privately owned planes.

It is the location of a Wisconsin State college (established 1915), a county hospital for the mentally ill and a county tuberculosis hospital. For comparative population figures *see* table in WISCONSIN: *Population.* (F. H. HY.)

EAU DE COLOGNE: *see* PERFUME.

EAU DE VIE: *see* BRANDY.

EAVESDRIP (EAVESDROP), that width of ground around a house or building which receives the rain water dropping from the eaves. By an ancient Saxon law, a landowner was forbidden to erect any building at less than two feet from the boundary of his land, and was thus prevented from injuring his neighbour's house or property by the dripping of water from his eaves. The law of eavesdrip had its equivalent in the Roman *stillicidium*, which prohibited building up to the very edge of an estate. This prohibition has been adopted by some countries which follow the Roman civil law. From the Saxon custom arose the term "eavesdropper"; *i.e.*, anyone who stands within the eavesdrop of a house, hence one who pries into others' business or listens to secrets. At common law an eavesdropper was regarded as a common nuisance, was presentable at the court leet and indictable at the sheriff's tourn, and was punishable by fine and by having to provide sureties for good behaviour. Though the offense of eavesdropping still exists at common law, there is no modern instance of prosecution or indictment.

EBBINGHAUS, HERMANN (1850–1909), German psychologist, who was primarily responsible for showing that, contrary to the beliefs then prevailing, the methods of science could be applied to the study of the "higher thought processes," was born at Barmen, Jan. 24, 1850. While the "higher thought processes" with which Ebbinghaus was concerned were later called simple rote-learning processes, they were sufficiently more complex than the phenomena with which other psychologists were working to make his contribution a major advance. That memory could be shown to be orderly was viewed as an achievement of the highest order, and, apparently as a consequence of his report of this work (*Über das Gedächtnis*, 1885), Ebbinghaus was made professor at the University of Berlin. Many of the methods and materials developed by Ebbinghaus for the study of memory are still used in research in verbal learning. The nonsense syllable (three-letter unit in which the middle letter is a vowel, the other two consonants, and which does not form a word) is a notable example.

Ebbinghaus was a masterful writer; his scientific prose was lucid and sparkling, retaining nevertheless the rigour and precision expected of a scientist. His textbook (*Grundzüge der Psychologie*, 1897) was a great success. He was an eloquent and forceful spokesman about an important and growing need felt by many psychologists, namely, the need to divorce psychology from philosophy.

After completing his work on memory, Ebbinghaus turned to other topics, most notably to colour vision and to methods for testing mental capacity of children. In 1894 he left Berlin for a post at Breslau and in 1905 went from Breslau to Halle. He died suddenly of pneumonia at Halle on Feb. 26, 1909. *See* also PSYCHOLOGY, EXPERIMENTAL: *Early Period.* (B. J. U.)

EBBW VALE, an urban district in the Ebbw Vale parliamentary division of Monmouthshire, Eng., 28 mi. W. of Monmouth by road. Pop. (1961) 28,631. The town lies near the head of the Ebbw valley, nearly 1,000 ft. above sea level and, like the mining towns of South Wales built in the second half of the 19th century, it straggles untidily along the valley. Christ Church (1870) is its chief building. Its position on the northern outcrop of the South Wales coal field made it first an important iron-smelting area and later a coal-mining centre.

The extended use of coal and new processes in smelting made Ebbw Vale one of the most important steel centres in South Wales, but distance from the coast and trade depression in the 1930s caused great decline and distress. In 1935, however, a vast new steelworks, covering approximately 2½ mi. by ¾ mi., was established on an old but much smaller foundation. It started working in 1938–39 and after 1945 it was enlarged. Its capacity is now about 600,000 tons of sheet steel and tin plate a year. Attached to the Ebbw Vale steelworks are limestone quarries, brickworks and an iron ore field in Northamptonshire. The industries of the district also include coal mining.

EBEDJESUS: *see* ABHIDISHO BAR BERIKHA.

EBEL, HERMANN WILHELM (1820–1875), German Celtic scholar, studied at Berlin and Halle, and, after holding other professional posts, became professor of comparative philology at the University of Berlin. He died at Misdroy on Aug. 19, 1875. His most important contribution to Celtic philology was his revised edition (1871) of Kaspar Zeuss's *Grammatica Celtica.* A selection of his papers was published in English as *Celtic Studies,* edited by Sullivan (1863).

EBEL, JOHANN GOTTFRIED (1764–1830), German-born writer whose affection for Switzerland caused him to settle there and to write the first Swiss guidebook, was born at Züllichau, Prussia, Oct. 6, 1764. He became a scientist and physician with wide interests and the political views of an early liberal. During a stay in Switzerland (1790–92), and influenced by Albrecht von Haller, Rousseau and German philhelvetic trends, he developed a liking for the Swiss people, history and landscape. In 1793 he published his *Anleitung, auf die nützlichste und genussvollste Art die Schweiz zu bereisen,* which dealt systematically with all aspects of the country. Many revised editions and translations show its great renown for almost 50 years. All his books deal with Switzerland; they include *Schilderung der Gebirgsvölker der Schweiz* (2 vol., 1798–1802) and *Über den Bau der Erde im Alpengebirge* (2 vol., 1808). In 1801 he was naturalized and in 1810 settled in Zürich, where he died on Oct. 8, 1830.

See H. Escher, "J. G. Ebel," in *80. Neujahrsblatt zum Besten des Waisenhauses in Zürich* (1917). (A. BX.)

EBENACEAE, a family of dicotyledonous trees and shrubs including the ebony (*q.v.*) and other valuable timber trees. It has 5 genera, with about 325 species, chiefly tropical or subtropical, and especially abundant in Malaya. The fruit is usually a berry. Several tropical species are cultivated for their edible fruits, whereas the oriental persimmon (*Diospyros kaki*) is one of the most important fruits of China and Japan and is also cultivated in various parts of North America. The family is represented in the United States by two species of persimmon (*q.v.*).

EBERHARD (d. 939), duke of Franconia from 918 to 939, was the brother of Conrad, duke of Franconia and German king (911–918). In 915 Eberhard supported his brother's ineffectual action against the rebellious duke of Saxony, Henry the Fowler. On Conrad's death Henry became king as Henry I, probably at Conrad's wish. Eberhard renounced all claim to the kingship, but in exchange was almost completely independent in Franconia. In 936 Eberhard rebelled against Henry's son Otto I (king from 936), but was defeated and fined; he allied himself with Henry of Bavaria, the king's brother, and Giselbert of Lorraine. In 939 he launched a new rebellion. His forces were surprised by King Otto at Andernach on the Rhine and Eberhard was killed in the battle.

EBERHARD IM BART (1445–1496), count and later duke of Württemberg, was born at Urach on Dec. 11, 1445, the second son of Louis I, count of Württemberg-Urach (d. 1450). He succeeded his brother Louis II in 1457 under the regency of his uncle Ulrich of Württemberg-Stuttgart (d. 1480) and came of age in 1469. In 1468 Eberhard made a pilgrimage to Jerusalem, returning through Italy. In 1474 he married Barbara di Gonzaga, daughter of Lodovico III of Mantua. Keenly interested in the new learning of the Renaissance, he founded the University of Tübingen in 1477.

In 1473 Eberhard had acquired the countship of Sulz. The crucial treaty of Münsingen (1482) between him and his cousin Eberhard VI the Younger, of Württemberg-Stuttgart, established the law of primogeniture and made him the sole count of Württemberg as Eberhard I; if he left no heir he was to be succeeded by his cousin. However, the latter was incompetent and irresponsible, and in 1485 Eberhard disinherited him. At Esslingen, in 1492, he provided for a regency by the estates after his own death. Eberhard granted charters to Stuttgart and Tübingen and reformed the convents (secularizing some) and the administration. In 1488 he joined the Swabian league and soon became a leading member. In 1495 the German king Maximilian I constituted Eberhard duke of Württemberg and Teck and confirmed the law of primogeniture in the duchy. Eberhard died at Tübingen on Feb. 24, 1496. Despite the settlement of Esslingen, Eberhard the Younger succeeded him.

See F. Ernst, *Eberhard im Bart* (1933).

EBERHARD, JOHANN AUGUST (1739–1809), German philosopher and lexicographer, a defender of Leibniz' system against Kant's and the compiler of a dictionary that remained in use for 100 years, was born on Aug. 31, 1739, at Halberstadt, where his father was a singing master and schoolteacher. Graduating at Halle, he took holy orders, but became somewhat estranged from orthodox Lutheranism through the influence of Moses Mendelssohn and C. F. Nicolai, whose acquaintance he made in Berlin. In his *Neue Apologie des Socrates* (1772) and in his *Allgemeine Theorie des Denkens und Empfindens* (1776) he advocated (1) the free examination of religious doctrine and (2) epistemological rationalism in the manner of Leibniz and Christian Wolff. In 1778, however, he was appointed professor of theology at Halle. Eberhard attacked Kant's critical philosophy as being superfluous in view of what Leibniz and Wolff had already done. His later philosophical work, including *Sittenlehre der Vernunft* (1781), *Theorie der schönen Künste und Wissenschaften* (1783), *Allgemeine Geschichte der Philosophie* (1788) and *Handbuch der Aesthetik* (1803–05), is less noteworthy than his German dictionary, *Versuch einer allgemeinen deutschen Synonymik,* 6 vol. (1795–1802). The abridged version of the dictionary, *Synonymisches Wörterbuch der deutschen Sprache* (1802), was republished in the 10th edition in 1903–04, with English, French, Italian and Russian translations. Eberhard died at Halle on Jan. 6, 1809.

EBERSWALDE, a town of Germany which after partition of the nation following World War II became a regional capital of the *Bezirk* (district) of Frankfurt an der Oder, German Democratic Republic. It is situated 61 km. (38 mi.) N.E. of Berlin on the Berlin-Pasewalk railway. Pop. (1959 est.) 31,969. The Finow canal runs through it and about a mile to the north the Oder-Havel canal, which takes large vessels, flows through the heavily wooded area of the Eberswalde forest and the Mönchs heath. A forestry school was founded in Eberswalde in 1830 and the town has the forestry faculty of Berlin university. Eberswalde became industrialized in the 19th century and produces cranes that are exported throughout the world. The town received its municipal charter in 1257 and was sacked during the Thirty Years' War. In the middle of the 18th century Thuringian cutlers settled there. In World War II the town was occupied by Soviet forces in April 1945.

EBERT, FRIEDRICH (1871–1925), German Social-Democratic statesman and president of the Weimar republic from 1919 to 1925, was born in Heidelberg on Feb. 4, 1871, the son of a tailor. By upbringing a Catholic, Ebert later left the church. Apprenticed to a saddler he visited Karlsruhe and Munich as a journeyman and

in 1889 went to Mannheim, where he entered a circle of Social Democrats influenced by Ferdinand Lassalle. He was an active trade unionist and, despite repeated police warnings and spells of unemployment, he established branches of his union in many north German towns, including Bremen. He settled there in 1891 and soon became chairman of the Bremen Saddlers' union. During 1893 he worked on the editorial staff of the Social Democratic newspaper *Bremer Bürger Zeitung*. As an untiring and effective speaker he quickly reached a leading position in the local party organization. Although familiar with the popular writings of Marx and Engels, Ebert went by the 1891 Erfurt program of social democracy. Ideologically he belonged to the Marxist centre and had an optimistic Marxist faith in "progress." His special talent lay in party organization and practice; the fierce theoretical contests within the party hardly interested him.

After his marriage in May 1893, Ebert opened a tavern, which became a centre of political and trade union activity. In 1900 he was elected to the Bremen city council, where he gained a sound grasp of municipal politics and rose to be president of the Social Democratic party (S.P.D.) faction. In March 1900 he became labour secretary to the newly founded trade union cartel in Bremen. As a specialist in social affairs and in labour and insurance law, he won a respected position in Bremen politics. He gave special attention to the feminist movement, the condition of schools and the electoral law. His attempt to abolish the existing class suffrage in Bremen failed; but he won over important Liberal elements for a common struggle against the powerful position of the senate. As co-chairman of the S.P.D. party convention in 1904 he became more widely known, and in 1905 he was elected as secretary to the party central committee in Berlin, where he remained until his death. Always objective in argument and bent on compromise, Ebert won the confidence of all groups in the party (except for the radical left, to which he always felt alien). He was thus able to compose many serious differences between party and trade unions, as well as conflicts with, or within, regional party bodies. He supported close collaboration with the unions, as in the question of mass strikes, and attained their reconciliation with the S.P.D.

As secretary of the party committee Ebert dealt with financial matters and also with the party's youth department (from 1908 he directed the central office for Germany's young workers), but his main work was in party organization. He remodeled the central office and district branches and radically improved the party's electoral machine, thus being partly responsible for the S.P.D.'s great electoral victory of 1912 (from 43 seats in 1907 to 110), when he became *Reichstag* member for Elberfeld-Barmen. In 1911 Ebert had declined the co-chairmanship of the party congress, but accepted when at Jena in Sept. 1913, he was elected by a large majority to succeed August Bebel (d. Aug. 1913) as co-chairman with Hugo Haase. Ebert, though basically opposed to war, supported the S.P.D.'s vote for the war credits in 1914. Shortly before the crucial vote on Aug. 4, 1914, however, he was sent together with Otto Braun, the party treasurer, to Zürich so that they might conduct the party from Switzerland, should it suffer a wartime ban. Back in Berlin by Aug. 6, he resumed the party leadership along with Haase. At first he was not prominent in the *Reichstag* group, where Eduard David and Philipp Scheidemann dominated. Always aiming at compromise, Ebert nevertheless insisted on the block vote once a majority decision in the party group had been taken. When Haase resigned (Dec. 1915) Ebert became chairman of the group with Scheidemann on Jan. 11, 1916. Because of his high office as leader of the party and of the *Reichstag* group Ebert now won dominating influence in the S.P.D. In March 1916, the party's leftist minority voted in the *Reichstag* against the war credits. On Ebert's initiative they were expelled. Then, at Easter 1917, they founded the new Independent Socialist party (U.S.P.D.) under Haase.

Firmly against German wartime annexations, Ebert was equally insistent that the pre-1914 frontiers of the *Reich* should be preserved even in the border lands of Alsace-Lorraine. He upheld compulsory military service throughout the war, though two of his sons were killed in action. In June 1917, Ebert led the German delegation to the Socialist peace conference in Stockholm. From then on, Ebert led his party into close collaboration with the *Reichstag's* so-called majority parties which were aiming at parliamentary government. In this way he restored the S.P.D., weakened by the leftist defection, to a position of influence. He was a leading member of the interparty committee which prepared the peace resolution of July 19, 1917, and took part in the defeat of the chancellor, Georg Michaelis, in October. Dragged against his will into the ammunition workers' strike of Jan. 1918, he successfully worked for its swift resolution.

Ebert's chairmanship of the central committee of the *Reichstag* (from July 1918) further strengthened his own and the party's position. He supported Prince Max of Baden as chancellor from Oct. 3. By the end of October some measure of parliamentary government had been achieved; thus the Social Democrats had attained their longstanding aim. Ebert however continued to advocate the maintenance of the monarchy. At noon on Nov. 9, anticipating the abdication of the emperor William II (Nov. 28, 1918), Prince Max handed over the chancellorship to Ebert, who even now hoped to establish a regency; later the same day, however, Scheidemann, to Ebert's dismay, proclaimed a German republic, and Ebert, fearing that extremists would take charge, accepted the *fait accompli*. To maintain order he allied himself with the army under Chief Quartermaster General Wilhelm Groener, a decision of fatal consequence to the Weimar republic. On Nov. 10, Ebert (with Haase) became co-chairman of the Council of People's Representatives, the new cabinet formed by the S.D.P. and U.S.P.D. He overrode the Independents and pressed for a national assembly, successfully quashing the U.S.D.P. plan for oligarchic rule by the council. After some hesitation Ebert put down the extreme leftist risings of the winter of 1918–19 and later. This led to a further break with the Independents and earned him the hatred of the radical left, who accused him of betraying the workers. On Feb. 11, 1919, the national assembly, meeting at Weimar, elected Ebert provisional president, and in Oct. 1922 the *Reichstag* extended this term until June 30, 1925.

As president, Ebert, frequently present at cabinet meetings, strongly influenced the choice of chancellors and general policy. Supported by Braun, now the prime minister of Prussia, he overcame many crises. Under his leadership the government survived Wolfgang Kapp's ineffective *Putsch* in March 1920, moving to Dresden and then Stuttgart. Determined to maintain the constitution and German national unity, especially during the Bavarian crisis of 1923, he did not hesitate to call in the army's assistance as permitted under article 48 of the constitution. Yet, fully aware of the dignity of his office, he never exceeded its constitutional powers. In foreign affairs he strongly disapproved the treaty of Rapallo (April, 1922) with Russia; over this he fell out with Walter Rathenau, the foreign minister. He supported the policies of Rathenau's successor, Gustav Stresemann, though distrusting the man. Later he took account of the growing trend to the right (visible especially in the election of 1924) by nominating rightist chancellors (W. Cuno, W. Marx and H. Luther).

Through his unobtrusive and objective conduct of office, his conciliatory spirit and his tact and dignity, Ebert won above all the esteem and respect of the educated middle class, but became increasingly estranged from his party. He became the target of a callous and systematic nationalist agitation mainly intended to prevent his re-election. Mocked as the "saddlers' apprentice," he was accused of treason for his part in the ammunition workers' strike of Jan. 1918. A court decision at Magdeburg (Dec. 1924) took up these defamations. This unjust decision was widely and indignantly rejected. Ebert was nevertheless shaken by the course and result of the case; he had received inadequate support even from sections of the S.P.D. where his impartiality was not understood. Though gravely ill he declined to go to a hospital so that he might be available as witness. The postponed treatment caused his death of appendicitis on Feb. 28, 1925.

The death of Ebert, "the Abraham Lincoln of German history" (Theodor Heuss), was a great blow for the young Weimar republic; the civilian was succeeded by the imperial General-Fieldmarshal von Hindenburg. His son F. Ebert published a collection

of Ebert's writings and speeches, *Schriften, Aufzeichnungen, Reden*, 2 vol. (1926).

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EBIONITES (Heb. *ebionim*, "poor men"), a title given to an early Christian sect which retained and exaggerated the Jewish interpretation of Christianity probably provided by the "Judaizers" opposed by the apostle Paul. Explicit mention of them is first found in Irenaeus (*c.* 185), who says that they believed in one God, the Creator, taught that Jesus (son of Joseph and Mary) was the Messiah, used only the Gospel of Matthew, rejected Paul as an apostate from the Jewish Law, interpreted the prophets in a singular fashion and venerated Jerusalem as the house of God. Later writers state that the Ebionites were founded by a certain Ebion and that Jesus became Messiah because he obeyed the Jewish Law. They denied the pre-existence of the *Logos*, although some of them finally accepted the virginal conception of Jesus. By the 3rd or 4th century, when their doctrines are reflected in the *Clementine Homilies* and (to a lesser extent) *Recognitions* (*see* CLEMENTINE LITERATURE), they were describing Jesus as the "Son of Man" and the true "prophet" of Deut. xviii, 15; they were removing what they regarded as interpolations from the Old Testament in order to uphold their teaching, which included vegetarianism, holy poverty and frequent ritual washings. They rejected sacrifices and the Jewish Temple, regarding its destruction as due to God's condemnation of it. At the same time some, at least, among them came to accept Gnostic doctrines of cosmic dualism.

Most of the features of Ebionite doctrine find anticipations in the teachings of the Qumran sect, as revealed in the Dead sea scrolls. It would appear that the movement arose after the destruction of the Temple in A.D. 70 and for a time came close to Jewish Christianity; though Christianity, especially under the influence of the apostle Paul, was developing as a universal religion, the Ebionites insisted on views like those held in conservative sectarian Judaism. They finally found the Gospel of Matthew unsatisfactory and developed their own literature, including the Gospels of the Ebionites and of the Nazarenes (*see* APOCRYPHA, NEW TESTAMENT; NAZARENES).

Attempts made in the 18th and, especially, the 19th century to find primitive Christianity reflected among the Ebionites are generally regarded as misguided. While the early church was influenced by sectarian Judaism such as that reflected in the Dead sea scrolls, it contained within itself a more "catholic" germ and, well before the fall of Jerusalem, had turned toward the gentile world. When the Ebionites rejected Paul they were not following the example of the Jerusalem church.

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EBNER-ESCHENBACH, MARIE VON, FREIFRAU (1830–1916), Austrian novelist known for her sensitive portrayals of Austrian life in village and castle, was born at Zdislavič, Moravia, on Sept. 13, 1830, the daughter of Count Dubsky, and was brought up there. In 1848 she married the Austrian captain, later field marshal, Moritz von Ebner-Eschenbach, and lived first at Vienna, then at Klosterbruck, where her husband had a military appointment. In 1863 she returned to Vienna where she remained until her death on March 12, 1916. Her first literary venture was the drama *Maria Stuart in Schottland*, produced at the Karlsruhe theatre in 1860, but she found her true sphere in narrative. Beginning with *Die Prinzessin von Banalien* (1872), she graphically depicted in *Božena* (1876) and in her masterpiece, *Das Gemeindekind* (1887; Eng. trans. *The Child of the Parish*, 1893) the surroundings of her Moravian home, and showed a true sympathy with the poor and their problems and an unsentimental understanding of children. *Lotti, die Uhrmacherin* (1879), *Zwei Comtessen* (1885; Eng. trans. 1893) and *Unsühnbar* (1890) described with equal insight the life of the Austrian aristocracy. She also published collections of aphorisms, parables, fairy stories and poems. Her wit and masterly character-drawing make her one of the outstanding German women writers of her time.

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EBONY, the wood of trees of the genus *Diospyros* (family Ebenaceae), widely distributed in the tropical parts of the world. The best kinds are very heavy, deep black, and consist of heartwood only. On account of its colour, durability, hardness and susceptibility of polish, ebony has been used for cabinetwork and inlaying, piano keys, knife handles and turned articles.

Ebony was among the articles of merchandise brought to Tyre (Ezek. xxvii, 15), and Herodotus states that the Ethiopians every three years sent a tribute of 200 logs of it to Persia. By the ancients it was esteemed of equal value for durability with the cypress and cedar. According to Gaius Solinus in his *Polyhistor*, it was employed by the kings of India for sceptres and images, also, on account of its supposed antagonism to poison, for drinking cups.

The hardness and black colour of the wood appear to have given rise to the tradition, alluded to by Robert Southey in *Thalaba, the Destroyer* (1801), that the tree produced neither leaves nor fruit, and was never seen exposed to the sun.

The best Indian and Ceylon ebony is furnished by *D. ebenum*, which grows in abundance throughout the flat country west of Trincomalee, in Ceylon. The tree is distinguished by the width of its trunk, and its jet-black, charred-looking bark, beneath which the wood is perfectly white until the heart is reached. The wood is stated to excel all other varieties in the fineness and intensity of its dark colour. Although the centre of the tree alone is employed, reduced logs one to three feet in diameter can readily be procured. Much of the East Indian ebony is yielded by the Coromandel ebony (*D. melanoxylon*), a large tree attaining a height of 60 to 80 ft., and 8 to 10 ft. in circumference, with irregular rigid branches, and oblong or oblong-lanceolate leaves. The wood of *D. tomentosa*, a native of north Bengal, is black, hard and of great weight. *D. montana*, another Indian species, produces a yellowish-gray, soft but durable wood. *D. quaesita* is the tree from which is obtained the wood known in Ceylon as *Calamander*. Its closeness of grain, great hardness and fine hazel-brown colour, mottled and striped with black, render it valuable for veneering and furniture making. *D. dendo*, a native of Angola, is a valuable timber tree, 25 to 35 ft. high, with a trunk 1 to 2 ft. in diameter. The heartwood is very black and hard and is known as black ebony, also as billetwood, Gabun, Lagos, Calabar or Niger ebony.

What is termed Jamaica or American ebony, and the green ebony of commerce, is produced by *Brya ebenus*, a leguminous tree or shrub, having a trunk rarely more than 4 in. in diameter, flexible spiny branches, and orange-yellow, sweet-scented flowers. The heartwood is rich dark-brown, heavier than water, exceedingly hard and capable of receiving a high polish.

EBRO (anc. IBERUS or HIBERUS) is the only one of the five great rivers of the Iberian peninsula to flow into the Mediterranean. It drains the largest catchment area, about one-sixth of Spain. The river rises in springs at the foot of Peña Labra (Reinosa) in the Cantabrians and flows for 576 mi. in a southeasterly direction to its delta in the province of Tarragona. To Haro, its upper valley is steep and narrow, but by the time it reaches Tudela it has been joined by powerful affluents. According to the Spanish proverb, "the Arga, the Ega and the Aragon made the full-grown Ebro." Wide terraces flank the river down-

stream and many fast Pyrenean tributaries join it, some exceeding 100 mi. in length (Segre, 160 mi.). Except for the Jalón (145 mi.), the right-bank tributaries from the Iberian mountains are short and unimportant. At Mequinenza the Ebro enters a deep gorge and many defiles through the Catalan mountains, finally entering its delta below Tortosa. Barges can navigate the Ebro to Tudela in the rainy season, but navigation stops at Mequinenza with low water and only small boats can sail up the 15 mi. from the delta to Tortosa.

The Ebro collects 222 tributaries, the largest of which have been utilized for hydroelectric power and irrigation. By the mid-1950s a system of 35 major dams could store 1,673,600,000 cu.m. of water, produce 789,300,000 kw.hr. of electricity and irrigate 919,715 ac. of land. By far the largest dam is the Pantano del Ebro (near Reinosa), followed by those of Tremp and Camarasa and Escales. The right bank of the Ebro valley from Tudela to 5 mi. below Saragossa is irrigated by the Imperial canal (begun by Charles V), and the Tauste canal skirts the opposite bank for a shorter distance.

See also references under "Ebro" in the Index volume.

(J. M. Ho.)

EBROÏN (d. A.D. 680 or 683), Frankish statesman of the Merovingian period, prominent in the struggle between Neustria and Austrasia and also remembered for the martyrdom of St. Leger. Becoming a mayor of the palace for Neustria on the death of the previous mayor Erchinoald (*c.* 664), Ebroïn forthwith took absolute control of affairs and completely overshadowed the king, Clotaire III, who had just come of age. As certain public offices had been usurped as hereditary perquisites by a few old families, Ebroïn proceeded to expel the members of these families from court. This policy provoked lasting resentments, which he suppressed ruthlessly. When Clotaire died (673), Ebroïn, without consulting the assembly of bishops and magnates, took it on himself to designate Clotaire's younger surviving brother Theuderic (Thierry) III as king, but the Neustrians rose in revolt and appealed to the elder brother, Childeric II of Austrasia. Theuderic and Ebroïn were imprisoned for a time, but Childeric soon lost the affection of the Neustrians and was assassinated (675). Theuderic then recovered his throne, but a son of Erchinoald was appointed mayor instead of Ebroïn. While Leger, bishop of Autun, influenced the Burgundian nobles to declare themselves for Theuderic, Ebroïn went over to the Austrasians and put forward a new king, Clovis III. As soon, however, as he had subdued the Neustrians and made himself mayor of the palace again, he broke with Clovis. To save Autun from siege, Leger gave himself up to Ebroïn, who put his eyes out, cut his tongue off and, two years later, had him beheaded.

On the assassination of Dagobert II, who had been restored to the Austrasian throne in 676, the new Austrasian mayor of the palace, Pepin II, resumed the struggle against Ebroïn and the Neustrians, but was defeated at Bois-du-Fays near Laon *c.* 679. Ebroïn was eventually killed by an act of private vengeance.

Nineteenth-century historians credited Ebroïn with great projects, but the only ancient author to speak favourably of him was the author of the *Miracles of St. Martial:* "By crushing the proud and the wicked . . . , he restored peace everywhere."

(Je. H.)

EBURACUM: *see* York (England).

EÇA DE QUEIRÓS (Queiroz), **JOSÉ MARIA** (1845–1900), the greatest Portuguese novelist, was born on Nov. 25, 1845, at Póvoa de Varzim in the north of Portugal. He was the illegitimate son of a young magistrate, José Maria de Almeida Teixeira de Queiroz, and Carolina Augusta Pereira de Eça, the daughter of a lieutenant colonel. His parents did not marry until 1849; the young Eça de Queirós was brought up by relatives and spent little time at home until his undergraduate days were over. After attending the Colégio da Lapa in Oporto he proceeded in 1861 to the University of Coimbra, where his main interests were reading widely in French and acting in plays presented by the university's dramatic club. On graduating in the faculty of law in 1866, Eça de Queirós went to join his parents in Lisbon where his father, a prominent magistrate, helped him to make a start in the legal profession. Queirós' enthusiasm was for literature, however, and he was busy writing stories, ironic, fantastic, macabre, often gratuitously shocking, and essays on a wide variety of themes for the *Gazeta de Portugal;* many of these were collected later in *Prosas Bárbaras* (1903). In Oct. 1869 he sailed for a tour of the near east with his friend, Count Resende. His impressions of the tour, which did much to awaken his passion for exact description, hitherto subordinate to a taste for the fantastic, are to be found in *O Egipto* (1926). He was back in Lisbon on Jan. 3, 1870, and in July was appointed to a post in the municipal service of Leiria. Toward the end of his stay there, in May 1871, appeared the first number of *As Farpas,* pamphlets of social and political criticism written by Queirós and his close friend, Ramalho Ortigão. In 1871 also he was closely associated with the group of forward-looking intellectuals, often known as the "generation of '70," which organized the Conferências do Casino ("Casino lectures"); one of the lectures, on realism in art, was delivered by Queirós who denounced contemporary Portuguese literature as "unoriginal, conventional, hypocritical and false."

He was appointed consul in Havana, Cuba, toward the end of 1872. His activity in Cuba on behalf of the exploited Chinese labourers, who came under Portuguese protection because they had embarked at the Portuguese south China port of Macao, merits praise, though he was unable to provide a final solution for their difficulties. His reports on the welfare of Portuguese immigrants in the U.S. and Canada whom he visited in 1873 also show his deep concern for social amelioration. Late in 1874 he was appointed consul in Newcastle upon Tyne. The articles he contributed to the Portuguese press on English life and letters during his residence in England from 1874 to 1888 are collected in the *Cartas de Inglaterra* (1903) and *Crónicas de Londres* (1945). In 1875 there appeared in the *Revista Ocidental* the first version of his powerful novel *O Crime do Padre Amaro,* a vivid revelation of the ruinous effects of clerical celibacy and a clerical education on a weak nature and of the dangers of ignorant fanaticism in a provincial backwater. Fuller, revised editions appeared in book form in 1876 and 1880. In 1878 came another outstanding novel, *O Primo Basílio* (Eng. trans. by Roy Campbell, *Cousin Bazilio,* 1953), a biting satire on so-called "romantic" passion and its tragic consequences which recalls the theme of Flaubert's *Madame Bovary.*

Queirós was transferred to the consulate in Bristol in 1879. In 1880 he published *O Mandarim,* a fantasy or satirical farce of less weight and power than the preceding novels. A similar novel, compounded of fantasy and farcical humour, is *A Reliquia,* published in book form in 1887 (Eng. trans. by A. F. G. Bell, *The Relic,* 1954). On Feb. 10, 1886, Queirós married Dona Emília de Castro Pamplona, a sister of Count Resende. In June 1888 appeared what is probably his masterpiece, the long, substantial *Os Maias.* In this detailed, broad picture of mainly upper-middle-class and aristocratic society the social satire is still effervescent; the theme, as in the two chief earlier novels, is based on unlawful sexual relations, but the ending is, surprisingly, less calamitous.

Queirós was appointed consul in Paris in Aug. 1888. In the last decade of his life his critical verve and his ability to create characters diminished and, in the view of some critics, a sentimentalism crept into his work which was alien to the earlier Eça de Queirós. Nevertheless, his last novels, *A Ilustre Casa de Ramires* (1900) and especially *A Cidade e as Serras* (1901; Eng. trans. by Roy Campbell, *The City and the Mountains,* 1955), both extolling the beauty of the Portuguese countryside and the joys of rural life, have many devoted readers.

Queirós died in Paris on Aug. 16, 1900.

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(N. J. L.)

ÉCARTÉ, a game of cards, invariably played for a stake. It was probably first played in Paris in the first quarter of the 19th

century. It is one of a family of "short" games developed from *triomphe* or trump and is related to euchre (*q.v.*).

The play is two-hand, though three or more players frequently participate by chouette, or betting with or against either player. The pack of 32 cards is used, the cards of each suit ranking K (high), Q, J, A, 10, 9, 8, 7. Each player receives 5 cards, and the 11th card is turned for trump. Either player may "stand," whereupon the original hands are played out. If neither player stands, each discards his unwanted cards and receives enough new cards to restore his hand to five. Again each player has opportunity to stand—and so on, until one decides to play. If neither player stands and the pack is exhausted, the hand must be played. The card turned for trump is never changed during the deal. Either player holding the king of trumps may score one point by showing it before the opening lead. The play is largely mechanical, since the second player must win the lead if he can. A trick is won by the higher trump or the higher card of the suit led. The object is to win three or four tricks, counting one point, or all five tricks (vole), counting two. If the original hands are played and the one who stood fails to take at least three tricks, his opponent scores two points. The game is five points.

See A. H. Morehead, R. L. Frey and G. Mott-Smith, *The New Complete Hoyle*, rev. ed. (1956). (G. Mh.)

ECBATANA (Old Persian Hangmatana), an ancient city on the site of which stands the modern town of Hamadan (*q.v.*). Ecbatana was the capital of Media and the summer residence of the Achaemenid kings, being afterward also one of the residences of the Parthian kings. According to the Greeks it was founded by the half-legendary Deioces (*q.v.*; 8th–7th century B.C.), the first king of the Medes (*cf.* Herodotus i, 96 ff.). Ecbatana is not mentioned in extant Assyrian inscriptions. In the Old Testament it is mentioned in the book of Ezra (vi, 2). A description of the city is given by Herodotus and by Polybius (x, 27). Though surrounded by seven walls and possessing a citadel that was at the same time a treasure house, it was captured by Cyrus the Great from Astyages in 550 B.C. and was taken from the last Achaemenid by Alexander the Great in 330 B.C. Ecbatana is mentioned by Herodotus as the place where Cambyses died, but this is probably a mistake for Hamath (in Syria). The only Achaemenid kings known to have built at Ecbatana are Darius I and Artaxerxes II. Found on the site were two inscribed foundation plaques of Darius and inscribed column bases of Artaxerxes.

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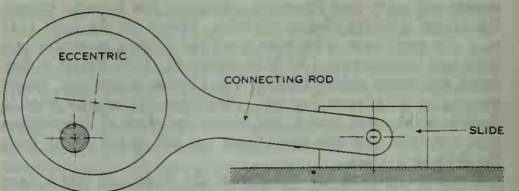
ECCARD, JOHANN (1553–1611), German composer known for his setting of the year's cycle of Lutheran chorales, was born at Mühlhausen in 1553. After serving Jacob Fugger in Augsburg (1577–78), he joined the Königsberg chapel of Prince Georg Friedrich of Preussen-Ansbach in 1579, becoming *Kapellmeister* in 1604. From 1608 till his death in Berlin in autumn 1611, he was *Kapellmeister* to the electors of Brandenburg. Eccard wrote in a narrow range of forms, his songs and early Masses recalling Lasso. He favoured short sacred pieces, vocal and instrumental, culminating in the cycle of chorale settings, *Geistliche Lieder auf den Choral* for five voices (1597). These represent a fusion of choral song and polyphonic motet and avoid the stark economy advocated by some Lutheran extremists. (B. L. Tr.)

ECCENTRIC, from two Greek words, meaning literally "out from the centre," and thus used to connote generally any deviation from the normal. In ancient astronomy the word denotes a circle round which a body revolves, but whose centre is displaced from the visible centre of motion. In early times the ellipses in which the planets revolved around the sun as focus could not be distinguished from circles, but the unequal angular motion due to ellipticity was observed. A point, however, can be found on the major axis of the ellipse (namely the empty focus) such that the angular velocity of the planet about it is nearly constant. It was therefore supposed that the deferent of the epicycle of the planet moved uniformly in a circle about this point.

In engineering, an eccentric is a disk mounted out of centre on a shaft, to give reciprocating movement to a lever; it is an agent much used in steam engines and other mechanisms. An eccentric is often employed to work a pump and to operate the slides of certain machines, such as those for shearing and punching.



FROM HALL AND AZPELL, "MECHANISM PROBLEMS," BY PERMISSION OF PITMAN PUBLISHING CORP.

DIAGRAM OF AN ECCENTRIC MECHANISM

The eccentric, mounted off centre, rotates inside the connecting rod and gives a reciprocating motion to the slide

Eccentrics are used to work the jaws of powerful rock and stone crushers, and to close quick-acting clamps and safety mechanisms that check slipping. Where a large offset is desired, however, a linkage generally is preferred.

ECCHELLENSIS (Echellensis), **ABRAHAM** (*c.* 1600–1664), a learned Maronite, was born at Eckel, Syria. Educated at Rome, he became professor of Arabic and Syriac in the college of the Propaganda at Rome, and in 1646 professor at the Collège de France. Invited to take part in the preparation of an Arabic version of the Bible, Ecchellensis returned in 1652 to Rome, where he died. Of his Latin translations of Arabic works, the most important was the *Chronicon Orientale* of Ibnar-Rāhib (1653), a history of the patriarchs of Alexandria. With Giovanni Borelli he wrote a Latin translation of the 5th, 6th and 7th books of the *Conics* of Apollonius of Perga (1661). He also published *Eutychius vindicatus, sive Responsio ad Seldeni Origines* (1661). To Le Jay's polyglot Bible he contributed the Arabic and Latin version of Ruth and the Arabic version of the third book of Maccabees.

ECCLES, the name of an English family of musicians the most important of whom are referred to below.

Solomon Eccles (1618–1683) was born in London. A teacher and composer, he wrote the music for Thomas Otway's *Venice Preserved* (produced in 1682). In 1660 he became a Quaker and publicly burned his instruments and music, claiming in his most important work, *A Musick Lector* (1667), in the form of a discussion between three churchmen, that only "musick that pleaseth God" can be approved of. In 1671 he joined a Quaker mission to the West Indies led by George Fox and was later expelled from Barbados for speaking seditious words. He returned to England and died in London on Feb. 11, 1683.

John Eccles (1668–1735), Solomon's eldest son and pupil, succeeded Nicholas Staggins in 1700 as master of the King's Band of Music and in the same year was second in a competition for the best setting of William Congreve's *The Judgement of Paris*. He published three volumes of theatre music and a collection of over 100 songs. He wrote the music for Queen Anne's coronation in 1702. He died at Kingston-upon-Thames, Jan. 12, 1735.

See J. Jeffreys, *The Eccles Family* (1951). (C. A. L.)

ECCLES, SIR JOHN CAREW (1903–), Australian physiologist, who shared with Alan Lloyd Hodgkin and Andrew Fielding Huxley (*qq.v.*) the 1963 Nobel prize for physiology and medicine for researches on the mechanisms of nerve impulses and the modes of their transmission, was born in Melbourne, Vict., on Jan. 27, 1903. After graduating from Melbourne university, he took up a Rhodes scholarship at Magdalen college, Oxford, in 1925, obtaining first-class honours in natural science (physiology) in 1927. He spent 1927–37 at Exeter and Magdalen colleges, Oxford, in physiological research and teaching under the leadership of Sir Charles Sherrington. In 1937 he returned to Australia as director of the Kanematsu Memorial Institute of Pathology, Sydney, New South Wales; he became professor of physiology at the University of Otago, Dunedin, N.Z., in 1944 and professor of

physiology in the Australian National university, Canberra, in 1951. He was elected a fellow of the Royal Society in 1941, was knighted in 1958 and served as president of the Australian Academy of Science in 1957–61.

From the beginning, Eccles's researches were concerned with the detailed mechanism of nervous activities and, latterly, with the help of numerous pupils and collaborators, he dealt especially with the phenomena of excitation and inhibition in the central nervous system. His special achievements were (1) the first recording of the electrical responses to excitation of individual nerve cells, by the use of intracellular microelectrodes; (2) the recognition of two different levels, presynaptic and postsynaptic, at which responses can be inhibited; and (3) the production of evidence for the intervention of pharmacodynamic chemical agents in the transmission of excitation or inhibition across the synapses of the central nervous system.

See J. C. Eccles, *The Physiology of Synapses* (1964). (H. H. Da.)

ECCLES, a municipal and parliamentary borough of Lancashire, Eng., lies on the Manchester ship canal, 4 mi. W. of Manchester. Pop. (1961) 43,173. Before the Reformation the monks of Whalley abbey had a grange there at what is still called Monks hall, and in 1864 thousands of silver pennies of Henry III and John of England and William of Scotland were discovered near the spot.

From eary times "wakes" were held at Eccles, and bullbaiting, bearbaiting and cockfighting were carried on. Under Elizabeth I these were abolished but were revived under James I and maintained until the late 19th century. The church of St. Mary, believed to date from the 12th century, has been much restored. Industries include engineering and metalworking. Eccles cakes, made of pastry with currants, have a wide reputation. The town was incorporated in 1892. Eccles and the borough of Swinton and Pendlebury form the borough constituency of Eccles, which returns one member.

ECCLESIA, by etymology a gathering of those summoned (*eccletoi*), was the most general word for an assembly of citizens in a Greek city-state, and in the early Christian church became the word for "church." As an institution it had its roots in the Homeric *agora* (*q.v.*), the meeting of the people. All normal Greek city-states probably had something to correspond to it, but its composition and powers differed widely from city to city and from time to time. The most detailed evidence for the development and working of the institution comes from Athens.

Development at Athens.—The earliest recorded activity of the Athenian people as a body was when it nipped in the bud Cylon's attempted *coup d'état* about 632 B.C. It may have given a mandate to Draco for the first codification of the law (*c.* 621) and it certainly did to Solon for his (probably 594). Solon extended membership of the *ecclesia* and of the *heliaea* (in effect the people sitting as a court of appeal) to the *thetes,* the lowest of the four property classes into which he had divided the citizens. As this class probably comprised all who had not enough land to qualify as *zeugites,* the class immediately above, the *ecclesia* became coterminous with the body of male citizens of 18 years or over. Apart from the right to hear appeals (in what type of cases we do not know) in the *heliaea,* the only indisputable powers exercised by the people at this stage were a part in the elections of the chief magistrates (*see* Archon) and the conferring of extra-legal rights on individuals. It may have had the final decision in making war and peace. Legislation was at this stage infrequent and administration was largely in the hands of magistrates drawn from the top, or the top two, property classes. But if Solon did set up a new council (*boule, q.v.*) of 400 beside the old aristocratic council of the Areopagus (*q.v.*), his aim must have been to secure for the *ecclesia* a wider share in public business by providing it with a steering committee. After the constitutional interlude of the tyranny (561–510 B.C.) Cleisthenes in 508 revived and increased the power of the *ecclesia* by setting up a *boule* of 500, selected by lot on a genuinely representative basis. Between this date and the completion of Ephialtes' reform in 462 the *ecclesia* became the dominant organ of the state.

Composition, Procedure, Powers at Athens and Elsewhere.—In full democracies all male citizens of age were entitled to attend meetings and sometimes a quorum was required for all or for certain types of business. In Athens a quorum of 6,000 was laid down for a resolution on an individual or for an ostracism (*q.v.*). In Magnesia on the Maeander a quorum of 600 is mentioned, and in Gortyna in Crete one of 300. In some states, for example Iasus and Rhodes, the attendance of poorer citizens was encouraged by paying them. At the beginning of the 4th century B.C. pay was introduced at Athens, at first one obol for each meeting, rising during the century to one and a half or one drachma according to the type of meeting. In order to ensure that the *ecclesia* played its full part, provision was often made for regular, as opposed to specially summoned, meetings. At Athens in the 4th century B.C. four regular meetings were prescribed for each tenth of the year; one of these four was designated the "master" assembly (*kyria*). For each of them there was certain prescribed business, the most important (such as the confirmation of the magistrates in their offices, consideration of ways and means, the safety of the realm) being reserved for the master assembly. Such a provision for regular meetings was widespread, being found for example in Delphi, Delos, Thera, Samos and Miletus.

At Athens the *ecclesia* was summoned, both for regular and for special meetings, by the *prytaneis,* a committee of the *boule,* and they fixed the agenda, insofar as it was not legally prescribed, and advertised it. In the late 5th century one of the *prytaneis* was chosen to be chairman, *epistates,* of the *boule* and the *ecclesia,* holding the position for one day only. In the 4th century nine *prohedroi* were chosen by lot out of the councilors whose tribes were not for that turn providing the *prytaneis* and this board presided over the *ecclesia,* their *epistates,* also chosen by lot, putting the motions to the vote. These extreme steps to prevent a politician from exploiting the chairmanship of the *ecclesia* were not universal. Elsewhere than at Athens, and probably at Athens too at an earlier date, magistrates or politicians presided, generals at Syracuse for example, "leaders of the people" at Argos, polemarchs at Orchomenus. At Athens motions had to originate in the council, which formulated any proposal made into a preliminary resolution (*probouleuma*). This was then laid before the *ecclesia* either as a recommendation or without prejudice. After discussion, open to all members, a vote was taken, usually by show of hands (*cheirotonia*), sometimes by pebbles (*psephoi*). Whichever method was used the measure was called a *psephisma.* A simple majority determined the result. There was no group voting. The *ecclesia* could amend a *probouleuma* freely, but could only initiate new business by instructing the council to bring a specific matter before the next meeting of the *ecclesia.* In 4th century theory laws (*nomoi*) were more sacrosanct than *psephismata* and the *ecclesia's* power to make or amend them was therefore more rigorously controlled. Changes had to originate in the *boule* or *ecclesia,* but final decision rested with a large panel of jurors, called when so acting *nomothetai.* A similar institution is found at Chios, Samos and Teos among other places. At Athens the distinction was breaking down a few decades after its inception at the end of the 5th century B.C. A more effective check on the *ecclesia's* legislative sovereignty was the suit for illegal procedure (*graphe paranomon*) under which, if the proposer of a *psephisma* or *nomos* was arraigned and condemned, the *psephisma* or *nomos* was annulled. Finally at Athens impeachments (*eisangeliai*) for serious political offenses might be brought before and decided by the *ecclesia.*

Assemblies of this type continued throughout the Hellenistic and Roman periods, though with gradual atrophy of their powers under the Roman empire.

The leagues, which came much to the fore from the 4th century B.C. onward, usually had assemblies, voting either by heads or cities. The Aetolian league (*q.v.*) had a primary assembly called *ecclesia* to which all citizens of the constituent communities belonged. It met at least twice a year, once for the election of magistrates. From the 3rd century B.C. the Achaean league (*q.v.*) had both regular and extraordinary meetings of an *ecclesia,* at which voting was by heads. In Lycia a primary assembly gave way in the 2nd century B.C. to an assembly at which voting was by

cities in proportion to their population.

Early Christian Church.—The word *ecclesia* only gradually acquired the specialized sense of "church." It probably came to the New Testament by way of the Septuagint, where it occurs about 100 times, almost always to render the Hebrew *qahal*, "gathering." It is found only twice in the Gospels, in highly controversial passages (Matt. xvi, 18; xviii, 17). In Acts it is frequent, being used of pagan gatherings, of gatherings of Christians in individual places (Jerusalem, Antioch, Ephesus) and houses and of the Christian community as a whole. Where the reference is Christian the attribute "of God" is always to be understood, if not expressed. In Colossians and Ephesians refinements are developed, leading on to the speculations of the Apostolic fathers and concepts like the twofold nature of the church, as militant and triumphant. *See* also GREEK LAW; CHURCH.

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(A. R. W. H.)

ECCLESIASTES, one of the wisdom books of the Old Testament (*see* WISDOM LITERATURE), is a collection of aphorisms divided into 12 chapters. In the Hebrew Bible it belongs to the so-called "festal scrolls" (*megilloth*) and is placed between the Song of Solomon and Lamentations; in the Septuagint and later versions it stands between Proverbs and the Song of Solomon because, like these two books, it was associated with King Solomon.

Authorship and Contents.—Unlike the series of sayings in Proverbs, which belong to different periods and are ultimately popular lore, Ecclesiastes is presented as the work of a single author. The writer uses a pseudonym, which is unusual in the Old Testament, calling himself *qoheleth* ("preacher"; Gr. *ecclesiastes*). In the first two chapters the author claims to be "the son of David, King in Jerusalem" (i, 1; *cf.* i, 12), which can mean only Solomon. Solomon was of course well known as a wise man, and the author may have identified himself with this famous wise man of the past as a device to give greater authority to the book.

Ecclesiastes consists of nearly 40 loosely arranged aphorisms, varying from 3 to 15 lines in length. They may have been a collection from a sage's notebook, perhaps edited and arranged by the original writer, the preacher. Important skeptical utterances are placed at the beginning (i, 3–ii, 23), followed by advice to enjoy the day (ii, 24–26) before death makes an end of everything (iii, 19 ff.). The key word "death" connects iii, 18–22 with iv, 1–3 and v, 9–17 with v, 18–vi, 9. In vii, 1–ix, 12 there are five maxims on unjust events, each with its own special point but fitting well together. Particular attention is given to the concluding sections: xi, 1–8 is an exhortation to lead a full life though death is the end, and xi, 9–xii, 7 describes allegorically the decay of the aging man and his way to the "eternal home" of the grave. (In xii, 1, "Remember also your creator," the word "creator" is probably a false reading for "pit"; *i.e.*, "grave.")

Main Themes.—First and foremost among the themes of Ecclesiastes is the preacher's skepticism. Claiming the support of experience, he constantly questions the ordering of this world in which a man does not get his deserts; a good example is the early death of a just man, who should have had a long life (vii, 15). The senseless intervention of death makes men like cattle (iii, 19). All the attempts of man to mold his happiness are limited by predestination (vi, 10) and by the chances of time (ix, 11). A man does not know what time is favourable to his purposes (viii, 2–8; ix, 12).

Recognition of these terrible truths, however, does not make the preacher deny the rule of God. On the contrary, he conceives of God as an awful majesty, but hidden and incomprehensible. Though in comparison with the deism of the "enlightened" wisdom writings the preacher approaches the prophetic view of God, he is still far removed from it. He advises prudence in visiting the temple and in vows and prayers (v, 1 ff.; iv, 17 ff. in Hebrew text). In contrast to the Book of Proverbs he never uses "Yahweh," the name of God used in worship and prophecy; he always speaks of God in an almost impersonal sense. It may be that God has given his good creation a time plan clear to himself (iii, 11) and unalterable (iii, 14). What troubles man is that he can never comprehend God's plan. God blesses those that please him and lets unhappiness befall those that displease him; it is his pleasure alone that decides to which group a man belongs.

When the preacher speaks of the good fortune of the dead in comparison with the living, and still more of those who (being aborted) have never seen the light of day (iv, 2–3), this extreme phraseology is not intended to drive the hearer to complete nihilism or suicide; its aim is to counteract a naïvely "enlightened" attitude by a call to wholesome sobriety. A man should not give himself up to illusions, but in spite of his basic skepticism should enjoy gratefully his small day-to-day pleasures. Death is the final end (ii, 16; xi, 8); the preacher questions the belief in a life after death in "heaven" (iii, 21). The body is given to dust, and the spirit, which thereby loses its individuality, is taken back by God (xii, 7).

The repeated phrase "Vanity of vanities [*i.e.*, absolute vanity], all is vanity" is often regarded as the keynote of Ecclesiastes and may indeed have been part of the preacher's own teaching, but this maxim on the emptiness of existence, stressed at both the beginning and the end (i, 2; xii, 8), is, like the introductory verse (i, 1), an addition made by a pupil. It corresponds, however, to the preacher's phrase "all is vanity and striving after wind" (i, 14, 17, etc.). But this theme of the emptiness of life is not the keynote of the book, and it would be a mistake to try to attribute to another author all sayings in Ecclesiastes that take a more positive attitude.

The preacher affirms the relative value of wisdom as against foolishness but, in contrast to the tradition of the schools which saw in wisdom security for life, he recognizes its limitations. He cannot countenance the naïve optimism of the schools for he knows the other side of existence: the impenetrability of fate, the incalculability of death, etc. Even if one concedes a certain breadth of range to the aphorisms, that does not exclude the possibility of later alterations, made with the aim of softening maxims which might cause offense. This is shown most clearly by the passage added at the end (xii, 9–14). Here, most probably, two editors have been at work, the first (xii, 9–11) affirming the hard but true sayings of his master and acknowledging himself his master's pupil in the work, the second (xii, 12–14) deeply disturbed by the preacher's skeptical and impious attitude and regretful that such a heretical book should be made public. Reading it is justified only if, by making a great effort, one perceives in it the call to obedience under a God who acts justly. The aphorisms in iii, 17; vii 29–viii, 1; viii, 5; viii, 12b–13; xi, 9c, probably also derive from this second "corrective" editor.

No direct quotations from Ecclesiastes are found in the New Testament.

Sources and Parallels.—Aphorisms often traveled a great distance in the ancient east and were a kind of nomadic possession. Parallels to the preacher's aphorisms—for instance, the call to enjoy life in the face of death, as well as the skeptical utterances—are found particularly in Egypt but also in Akkadian wisdom literature.

Attempts have been made to find traces of Greek philosophy in Ecclesiastes (especially in ch. i), but i, 4–11 is not about the elements discussed by the early Greek philosophers, nor has the eternal sameness in the succession of mankind on earth or of wind, sun and rivers anything to do with Heraclitus' aphorism "all is flux" or with the doctrine of Stoic cycles. In iii, 1–15, too, it is alternative activities, each of which has its appropriate time, that are spoken of, not an ordered rotation. A more probable theory is that Greek gnomic teaching became known in Jerusalem at the time of the preacher through bilingual coastal dwellers. An attempt has been made to trace connections with the aphorisms of Theognis of Medara (6th century B.C.), but this too is hardly successful; Theognis' largely political skepticism is directed against the rise of the lower classes, a point on which the preacher is indifferent. The gulf between Ecclesiastes and Greek wisdom becomes

particularly plain in the light of the demotic wisdom literature of Egypt of the 1st century A.D.; in this are found aphorisms that are indeed Egyptian in form but that none the less breathe the Greek spirit in their fundamental outlook.

Date and Provenance.—The writer's period and origin can be deduced only indirectly. The language is late Hebrew in syntax and vocabulary; there are a relatively large number of Aramaic forms, although the book has certainly not been translated from Aramaic. Attempts have been made to read into iv, 13–14, ix, 13 ff. and x, 16 ff. allusions to certain events under the Ptolemies or Seleucids (3rd century B.C. onward), but these verses may merely be giving typical illustrations unconnected with history. (This of course is no argument against the date as such.) Since there were Greek sympathizers in Jerusalem in the first 30 years of the 2nd century, some scholars, assuming Greek influence, would advance the date to that time. This cannot be categorically refuted but it is improbable because in that same period in Jerusalem Ecclesiasticus (*q.v.*) was produced, a strictly "orthodox" book of maxims expressing a similar attitude to that of the second epilogue to the preacher's work (Eccles. xii, 12–14). . In addition, a fragment of Ecclesiastes was found in a cave at Qumran that has been dated mid-2nd century. Ecclesiastes thus must have had a semi-canonical appearance as early as *c.* 150; otherwise the Qumran Essenes would not have taken it over. That being so, a date around about 250–200 B.C. is more probable.

The book must have been written in Jerusalem. It certainly cannot be derived from Phoenicia and hardly from Alexandria. It was long doubtful whether Ecclesiastes was worthy of inclusion in the Hebrew canon, and an origin outside Jerusalem would probably have been a decisive factor against such an inclusion.

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(KU. G.)

ECCLESIASTICAL LAW (ENGLISH) is a body of law concerned with the constitutional position of the established Church of England vis-à-vis the rest of the state and with the church's internal constitution, with the appointment, rights and obligations of its ministers and other officers, with the functioning of the church's courts, with forms of service and with proprietary rights so far as the church's property is concerned. It is administered largely by the ecclesiastical courts.

Within the framework of the divine law, the Church of England claims the right to make regulations, and these cover a wide variety of subjects including matters liturgical, pastoral, proprietary and disciplinary. These form part of the canon law (*q.v.*) and as such were accepted as part of a body of law binding on all Englishmen. In the middle ages it was not doubted that within the realm of England the law of the church and the common law were both of binding force; spiritual courts and temporal courts alike exercised jurisdiction. At the Reformation and with the Act of Supremacy (1534) the authority of Rome terminated, and by the end of the 17th century the royal supremacy thus established had come to mean effectively the supremacy of parliament. But the law of the land and the church's courts continued to function. What is more, the whole of pre-Reformation canon law remained, save insofar as it was expressly or by implication altered by legislation, but legislation by, or by the authority of, the temporal power, and not legislation emanating from Rome. In England, therefore, the ecclesiastical law of the established church includes both pre-Reformation canon law and post-Reformation acts of parliament. It also has to take account of canons passed by the two convocations of Canterbury and York (*q.v.*), which, after receiving the royal assent, have a limited authority over the clergy; and it has to take account of measures of the church assembly which, under the Church of England Assembly (Powers) act, 1919 (the Enabling act), may pass measures which, though subject to parliamentary scrutiny, have, on receiving the royal assent, all the force of an act of parliament.

Ecclesiastical law is for the most part administered in the ecclesiastical courts, which are as much royal courts as are the temporal courts; but, just as a point of temporal law may fall incidentally to be decided in an ecclesiastical court, so may a point of ecclesiastical law occasionally arise for decision in a temporal court. By the Ecclesiastical Courts act (1855) the ecclesiastical courts lost their jurisdiction in defamation; by the Court of Probate act (1857), they lost their jurisdiction in testamentary matters; and by the Matrimonial Causes act (1857) they lost it in matrimonial cases. By far the greater part of their work is concerned with faculties for the introduction or removal of things to or from consecrated buildings or land or for alterations to such buildings. But they still also exercise a criminal jurisdiction over the clergy for ecclesiastical offenses.

The supremacy of the crown in church and state (which, as has been said, means in practice a parliamentary supremacy), resulting in the fact that the law of the church and of the state is one law and that all courts, ecclesiastical and temporal, are alike courts of the land with their decrees enforced by the same temporal power, is perhaps the most obvious distinguishing mark of the establishment. Other religious bodies exist and have freedom of worship and freedom to run their own affairs. In the eyes of the law, however, they are simply associations of like-minded persons, as in a club, whose relationship, *inter se,* is essentially a matter of contract between them. This does not mean that they escape the law. It means that they manage their affairs and determine their own disputes in their own way according to their own rules, insofar as these do not run counter to the law. But, as in the case of any club, in the ultimate resort their rules can be tested and enforced only by recourse to the courts of the land, which involves a secular court in the task of considering doctrinal points, as, indeed, happened in the Scots case of *The General Assembly of the Free Church of Scotland* v. *Lord Overtoun and others* (1904). Like everyone else, too, they cannot escape parliamentary control, if and insofar as parliament wishes to control them.

The present freedom of non-Anglicans, however, has been conferred upon them by parliament, which has by stages removed from them various disabilities, the two main landmarks in history being the Toleration act (1689), which applies to Protestants, and the Roman Catholic Relief act (1829). Nor have all differences between Anglicans and non-Anglicans been removed. For example, the occupant of the throne may be neither a Roman Catholic nor married to one; a Roman Catholic may not be lord chancellor; nor may a Roman Catholic present to a living in the Church of England; nor (in strict law, not in practice enforced) may Roman Catholics assume various ecclesiastical titles, such as bishop of a diocese. The nonconformist layman is under no legal disability, and such minor disabilities as still in theory apply to nonconformist ministers are a dead letter. Privileges, too, have been conferred on non-Anglicans. Their priests or ministers, for example, are exempt from jury service; and the place of worship of any religious denomination is exempt from rates.

Courts.—In Anglo-Saxon England ecclesiastical causes were heard in the court of the shire or the hundred, in which the bishop (or, in the hundred court, the bishop or archdeacon) sat with the temporal judges. But William the Conqueror removed ecclesiastical causes from the temporal courts and thereafter they were heard in ecclesiastical courts, whose jurisdiction, however, was wide. The main courts were, in ascending scale, those of the archdeacon, of the bishop and of the archbishop, with appeal lying ultimately to the pope or his delegates. There was not, however, a close adherence to this tidy arrangement. Frequently a higher court claimed concurrent original jurisdiction with a lower one, and there were many peculiars that did not fit into any neat scheme.

Originally the archbishop, bishop or archdeacon was the chief judge in his own court; but from about the middle of the 12th century professional judges, clerks in at least minor orders, began more and more to exercise the judicial function. As such they came to be known as the official principals of the courts over which they presided, and toward the end of the middle ages the bishop's judge was also his vicar-general with authority to exercise various

administrative functions not demanding the possession of bishop's orders. These ecclesiastical lawyers in the first decade of the 16th century formed themselves into a society, analogous to the Inns of Court and known as Doctors' Commons (*q.v.*). In 1545 Henry VIII removed the necessity for orders as a qualification for ecclesiastical judicial appointment. Henry VIII also put an end to all appeals to the pope (Statute of Appeals, 1532) and substituted a final appeal to the king in chancery (exercised by the high court of delegates). Some causes were in fact entertained at first instance by the court of high commission.

In the 20th century the ecclesiastical courts exercise both a criminal and a civil jurisdiction. The latter, known as the faculty jurisdiction, is concerned with the oversight of consecrated land and buildings and of everything upon or in them. The archdeacon's court is virtually obsolete so far as judicial functions are concerned. Civil causes begin in the consistory court of the diocese, presided over by a judge who in practice is a barrister and who still combines in his person the functions of official principal and vicar-general and who is called the chancellor (or, in the diocese of Canterbury, the commissary). From the consistory court an appeal lies to the court of the province, known in Canterbury as the Court of Arches and in York as the Chancery Court of York. A final appeal lies from the provincial court to the privy council. Some criminal cases against clergymen for ecclesiastical offenses are tried in the consistory court with an appeal to either the provincial court or the privy council; others are tried in the provincial court with an appeal to the privy council.

Apart from the fact that the high court may by a writ of prohibition restrain an ecclesiastical court (including the privy council) from exceeding its jurisdiction, the temporal courts do not exercise control over the ecclesiastical courts. The chief officer (under the judge) of an ecclesiastical court is the registrar, and barristers and solicitors have a right of audience. (E. G. Mo.)

ECCLESIASTICUS (The Wisdom of Jesus the Son of Sirach) is one of the Old Testament books called apocryphal or deuterocanonical. In Hebrew its author is called ben Sira (*i.e.*, the son of Sira); in Greek Sira became Sirach, and the work is often called by this name. The origin of the Latin name Ecclesiasticus, which was given it as early as the time of Cyprian (d. 258), is uncertain.

Contents.—Ecclesiasticus may be divided into four main parts (enumeration according to the Revised Standard version): (1) ch. i–xliii, wisdom as a revelation of God and as a guide to conduct; (2) ch. xliv–l, praise of the ancients of Israel; (3) ch. li, 1–12, appendix, a prayer of thanksgiving for deliverance from mortal danger; (4) ch. li, 13–30, conclusion, an acrostic poem on the rewards of the study of wisdom. In the (Greek) Septuagint the book is headed by a prologue written by the translator (beginning "Whereas many great teachings have been given to us . . ."). In the Authorized (King James) version an additional, spurious prologue is prefixed to this.

Themes.—Ecclesiasticus ranks with the wisdom books of the Old Testament and shows dependence on the Book of Proverbs. Moral commonplaces couched in proverb form and arranged on no clear plan predominate in ch. i–xliii. Interspersed are passages of sustained reflection on the bases of morality and the deeper aspects of wisdom. The principles of a divine moral law imprinted on the conscience of mankind, of free will, of moral responsibility for sin and of divine retribution are emphatically asserted (xvii, 1–12; xv, 11–20; xvi, 6–23; xvii, 15–23). There is no question, however, of retribution after death, ben Sira retaining the older view of Sheol (the underworld, the home of all departed spirits). Characteristic is his insistence that the Law of Moses is the main channel by which divine wisdom comes to Israel (xxiv, 23–34). He is exceptional too, among the wisdom writers, in his expansive admiration for the spiritual value and beauty of the Temple worship with its Aaronic priesthood (xxxv, 1–11; xlv, 6–24; l, 5–21). Passages in his eulogy of wisdom as God's agent in the universe (xxiv) and in his hymn to the creator (xlii, 15–xliii) are worthy to go alongside the corresponding ones in Job and Psalms. In the New Testament, borrowings of Ecclesiasticus' thought and phraseology are found chiefly in the Epistle of James.

Authorship and Date.—A comparison of the data of Ecclus. l, 27 and the Hebrew colophon at the end of the book identifies the author as "Simeon the son of Yeshua, the son of Eleazar, the son of Sira." The words "Simeon the son of" are suspect, and the author's name was probably Yeshua—*i.e.*, Joshua or, in Greek, Jesus. He was called ben Sira, the "son" of Sira, after his grandfather. In his prologue the translator of the Greek version, the grandson of ben Sira, implies that he set about the translation "in the 38th year of Euergetes the king." This is taken to mean the 38th year of Ptolemy VII Euergetes II; *i.e.*, 132 B.C. The grandfather would have flourished 60 or 50 years before, about 190–180 B.C. This fits in with the reference in l, 1 ff. to the high priest Simon the son of Onias (or Ionias), whom the author had known but who was dead at the time of writing. This high priest was Simeon II, who died in 196 B.C., a date which confirms 190–180 B.C. as the approximate period in which ben Sira wrote.

Text and Versions.—Written in Palestine, Ecclesiasticus early won authority in certain Jewish circles, but was expressly excluded from the Palestinian biblical canon about A.D. 100. The original Hebrew text gradually dropped out of sight and was not rediscovered until 1896, when Solomon Schechter and others found extensive manuscript fragments in the genizah of an ancient synagogue at Cairo. The Hebrew manuscripts, which cover in all about two-thirds of the book, help to eliminate false readings of the Greek version, but because of their fragmentary nature and corrupt state they leave many textual problems unsolved.

The Greek version made by the author's grandson was admitted among their Scriptures by the Jews of Alexandria. Through the Septuagint, it passed on to the Christian church. Down the centuries the Greek has held the position of standard text. From it was made the Old Latin version (north Africa, 3rd century) incorporated in the Vulgate. Ecclesiasticus is more extensively used in the liturgy of the Roman Catholic Church than any other Old Testament work except the Psalter and was declared canonical Scripture by the Council of Trent.

The Peshitta Syriac version, made directly from the Hebrew about A.D. 200, is important for textual criticism.

An intriguing problem is raised by the existence of a recension of Ecclesiasticus in an expanded form found in the Hebrew manuscripts and in the versions. The expansions introduce a more advanced theology of the individual soul and its personal relationship to God and supplement the eschatology of ben Sira by insisting on retribution in "the future world." Correspondences of thought and expression between these expansions and certain portions of the Ethiopic Book of Enoch, the Book of Jubilees and the Testaments of the Twelve Patriarchs (*qq.v.*) suggest that they may be of Essenian origin. Moreover, there are similar coincidences between these glosses and the tenets of the Essenes and between them and the literature of the sectaries of Qumran, of whose library Ecclesiasticus formed a part. It is not impossible, then, that this expanded recension of Ecclesiasticus may be the work of the scribes of Qumran (*see* Dead Sea Scrolls). *See* also Apocrypha, Old Testament.

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ECHEGARAY Y EIZAGUIRRE, JOSÉ (1832–1916), Spanish dramatist, mathematician and statesman, who dominated the Madrid stage during the last quarter of the 19th century and shared with F. Mistral the Nobel prize for literature in 1904, was born in Madrid, April 19, 1832, and died there, Sept. 4, 1916.

He taught mathematics at the school of civil engineering, became an ardent exponent of free trade and held office in several governments during the revolutionary period (1868–74). It was

not until 1874 that he turned to the theatre with the play *El libro talonario,* but during the next 30 years he produced more than 60 plays.

With Echegaray came an extraordinary recrudescence of romanticism. Although not unsuccessful in comedy (*Un crítico incipiente,* 1891) he preferred tragedy: the "period" play (*La esposa del vengador,* 1874; *En el seno de la muerte,* 1879), generally in verse, and contemporary middle-class drama, generally in prose. Of this last, examples are *O locura o santidad* (1877; Eng. trans. *Madman or Saint,* 1907) in which society condemns as madness the overscrupulous conscience; *El gran Galeoto* (1881; Eng. trans. *The World and his Wife*), a study of how calumny corrupts its innocent victims; and *El hijo de don Juan* (1892), a travesty of Ibsen's *Ghosts.* In all his plays, his manner is melodramatic. The clash of violent passions is almost invariably resolved by bloodshed and probability is relentlessly sacrificed to skilfully contrived stage effects.

See A. Martinez Olmedilla, *José Echegaray* (1949). (H. B. HL.)

ECHIDNA, "snake," a monster of Greek mythology, half woman, half serpent. Her parents were either the sea deities Phorcys and Ceto, or Chrysaor, monstrous son of Medusa, and Calirrhoe, daughter of Oceanus. Among Echidna's progeny, by the hundred-headed Typhoeus, were the dragons of the Hesperides and of the Golden Fleece, the Hydra, the goatlike Chimaera and the infernal hounds Orthus and Cerberus. The Sphinx and the Nemean lion, both sired by Orthus, were also among her offspring. (D. E. W. W.)

ECHIDNA (SPINY ANTEATER), a common name applied to a group of egg-laying mammals, the Monotremata, the lowest order of the class Mammalia. Spiny anteaters are native to Australia, Tasmania and New Guinea. They are heavy-bodied animals with extremely short tails. The snout is characteristically elongate and very sensitive. Teeth are lacking and insect food is obtained by means of the long, slender, tubular tongue that is coated with a sticky secretion. The legs are short and stout, and the feet have long claws used in digging. The skin is covered with short, sharp spines, somewhat like those of porcupines and hedgehogs; hence the name "spiny anteater."

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ECHIDNA OR SPINY ANTEATER (TACHYGLOSSUS)

Echidnas often live in sandy, rocky places. When attacked they may roll into a ball, relying on their sharp quills for protection, or may burrow rapidly into sandy soil. They are nocturnal in habits, and have poor eyesight but well-developed senses of smell and hearing. The female lays a single egg that is incubated in an abdominal pouch in which the young remains for some time after hatching. The mammary glands open into the pouch.

The straight-beaked or five-toed spiny anteater (*Tachyglossus*) is found in eastern Australia, Tasmania and southern New Guinea. It varies from 15 to 20 in. in length, has a proportionately short, straight snout and coarse quills. The curve-beaked or three-toed spiny anteater (*Zaglossus*) occurs in New Guinea and adjacent Salawati Island. It attains a length of 30 in., has a relatively long, curved beak and fine quills.

See MONOTREME; MAMMAL. (R. T. O.)

ECHINODERMATA, a phylum of marine invertebrates which includes many prickly-skinned animals familiar to almost anyone who has visited the seashore in the temperate or tropical zones. The sea stars or starfishes (class Asteroidea), sea urchins (Echinoidea) and brittle stars (Ophiuroidea) are the dominant temperate-zone classes; in the tropics one is apt to encounter in addition the sea cucumbers (Holothuroidea) as well as the feather stars (Crinoidea).

These five classes into which the phylum is divided give an idea of how diversified the group is. Several aberrant classes existed in earlier periods of the earth's history but these died out before the end of the Paleozoic era (see *Fossil Echinoderms,* below).

INTRODUCTION

History.—The name Echinodermata, derived from Greek meaning "spiny skinned," was coined by J. T. Klein in 1734 and originally referred to the dry tests, or shells, of sea urchins. The name *Echinus,* still used for a genus of sea urchins, was originally applied by the Greeks to the European hedgehog as well as to the common Mediterranean sea urchins, the latter being about the same size and having spines of similar length and colour as those of their namesake on land. Klein's term, later extended to include all members of the phylum, is quite appropriate for the members of four extant classes but less suited for those of the Holothuroidea, which only rarely have large plates with spiny projections.

Importance.—In the ecology of the sea, echinoderms play an immense role. The crinoids deposit large amounts of lime through the decomposition of their skeleton, and in previous earth periods, when crinoids were dominant, they produced vast beds of limestone. Where they occur in great numbers the rock-boring sea urchins change the shore line. The sand- and mud-swallowing echinoderms remove large amounts of decaying matter that otherwise would accumulate on the sea bottom and thereby keep bacterial activities down. The sea stars are efficient scavengers and regulate the production of certain mollusks. The enormous swarms of microscopic larvae that the majority of echinoderms produce at certain times of the year constitute, with the larvae produced by other groups of invertebrates, an important food element for slightly larger plankton organisms.

For man the sea star also has a negative importance, as destroyer of commercially exploited beds of bivalves, and large sums are spent on finding methods that will curtail its activities. The simplest method has been to collect starfishes, usually by trawls, and destroy them. Recently chemicals have been used, and in some localities it has been contemplated to transfer oyster beds to water less saline than the sea stars can tolerate.

In the tropics sea cucumbers are dried and utilized as Bêche-de-Mer (*q.v.*) in a gelatinous soup, and the ripe ovaries and testes of some of the larger sea urchins are eaten raw or cooked in some parts of the world.

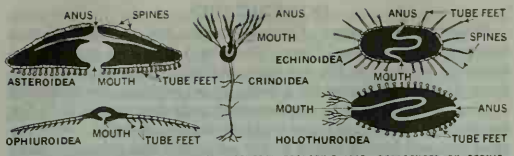
For the student of zoogeography the echinoderms have been most useful. As bottom forms they are restricted to the area where they have settled down, and they are usually sufficiently numerous so that material for study always can be procured. Where strong currents are present the planktonic larvae of echinoderms may be carried along and settle down within the area which is influenced by such currents, thus indicating the course of the current.

For modern experimental biology the eggs, sperm and larvae of many echinoderms have been the perfect material. The bibliography of the work performed on one single species of sea urchin fills an entire volume. Sea stars, brittle stars and sea cucumbers have been excellent subjects for experiments on regeneration (*q.v.*), and much has been learned about the reactions of invertebrates with a primitive nerve system through the numerous experiments performed on echinoderms.

STRUCTURE AND FUNCTION

Adult and Larval Characteristics.—The fundamental characteristics of the recent echinoderms are a free-swimming bilateral larva and an adult having (1) five-rayed symmetry; (2) an internal calcareous skeleton; and (3) a peculiar hydraulic apparatus, the water-vascular system, derived from parts of the coelomic cavities and having cylindrical projections, the podia, or tube feet, that extend to the surface. As always, there are exceptions. Thus many forms have acquired large eggs that develop directly without forming a larva; a secondary bilaterality is superimposed over the five-rayed symmetry in some sea urchins and in all holothurians; and in some sea cucumbers the calcareous skeleton appears to be lacking.

Adult Echinoderms.—Mature echinoderms are bottom dwellers, living on or in the surface of the sea bottom. Some holothurians are able to swim and a few species are even adapted to an entirely planktonic existence. Certain feather stars are able to swim by raising and lowering the "arms." Most of the recent echinoderms



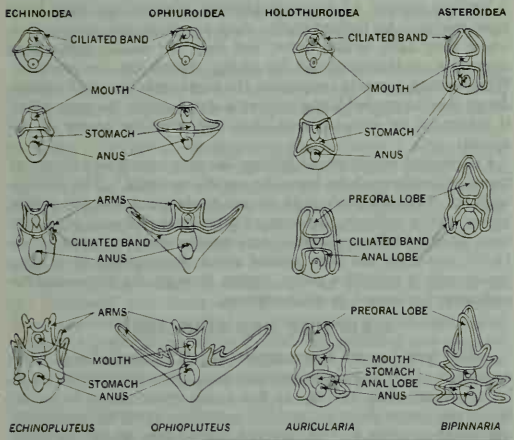
FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY," 1957; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 1.—DIAGRAMMATIC SECTIONS OF THE FIVE LIVING CLASSES OF ECHINODERMATA SHOWING THE RELATIONS OF MOUTH, ANUS, TUBE FEET AND SPINES. THE DIGESTIVE TRACT IS OUTLINED

are of moderate size. A few dwarfed forms have a body length of one to two centimetres, whereas some holothurians may reach a length of two feet or more. Some of the larger sea stars may have a diameter of about two feet, and the largest sea urchins may measure about 20 cm. in diameter. In earlier geological periods many forms reached a much greater size. Most spectacular were the ancient crinoids, some of which attained a stem length of up to 70 ft.; the few stalked forms that survive today rarely measure more than two feet in height.

The well-developed body cavity that all echinoderms possess marks them as three-layered (triploblastic) animals and thus places them high above the two-layered coelenterates with which earlier zoologists, not unnaturally, lumped them under the name Radiata. Echinoderms are nevertheless rather primitive in several respects. They possess no head and lack higher nerve centres, and their sensory organs are primitive. They have no heart and their blood vessels are lacunae. Their respiratory organs are of the simplest types, mostly thin-walled bladders, extensions from the body cavity or invaginations from the cloaca. They make extensive use of amoeboid cells for the transport of digested food and for the elimination of waste materials, and the sex products are simply shed into the water.

Larval Echinoderms.—Each class has developed a different larval form. Formerly these larvae were considered independent



FROM R. R. SHROCK AND W. H. TWENHOFEL, "PRINCIPLES OF INVERTEBRATE PALEONTOLOGY," 1953, AND FROM "MCGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY," VOL. 4. COPYRIGHT, 1960, MCGRAW-HILL BOOK COMPANY. USED BY PERMISSION

FIG. 2.—DEVELOPMENT OF ECHINODERMS FROM SIMILAR EARLY LARVAL STAGES TO DIVERSE FORMS OF YOUNG ADULTS (SHADED AREA). LEAST MODIFIED IS AURICULARIA OF HOLOTHUROIDEA; MORE ADVANCED IS BIPINNARIA OF ASTEROIDEA. MOST COMPLEX ARE THE PLUTEUS LARVAE OF ECHINOIDEA AND OPHIUROIDEA, THE MOST ADVANCED GROUPS OF THE PHYLUM

animals and each type was given a special name, but all represent modifications of a fundamental pattern. The fertilized egg divides and produces a typical gastrula—a hollow ball with an invagination, the intestine. In the echinoderms the original mouth becomes the anal opening while a new mouth is formed, a developmental pattern which is present in a number of other groups, among these the vertebrates, in contrast to worms, crustaceans and mollusks, where the original mouth remains as such in the adult while a new anus is formed. From the upper end of the intestine arises on each side a hollow pouch which extends downward and becomes subdivided into three pairs, from which develop the body cavity and the water-vascular system. In an effort to co-ordinate the echinoderm development with that of the vertebrates these divisions have often been called segments, but this interpretation is no longer accepted.

Externally the early stages of the different larvae are very similar. A ciliated band develops on the anterior side of the larva, forming a loop around the area where the mouth is forming. In the simplest larval type, that of the sea cucumber, the band becomes looped like a double-lined letter H (*see* fig. 2). Later the outer sides of the loops form several short lobes that give it a fancied resemblance to a human ear; hence the name *Auricularia* for the larva. In the sea star even more pronounced lobes appear, forming short arms; at the same time the ciliated band above the mouth forms an independent loop and the whole end of the larva above the mouth becomes greatly lengthened. This type of larva has been known as the *Bipinnaria*. In the crinoids, where only the comparatively recent stalkless forms have been studied, the larva, known as the *Doliolaria*, is barrel-shaped and has several ciliated bands arranged as hoops. (A similar stage occurs in the sea cucumbers before metamorphosis and is the only larval stage in those forms where the *Auricularia* stage has apparently been suppressed.) In the three larval types described so far no skeleton is present, except in the case of some of the holothurian larvae, in which a few wheel-shaped spiculae may be found.

In the two remaining groups, the sea urchins and the brittle stars, which represent the most advanced stages within the phylum, the larvae are more complex and surprisingly similar in type. Their similarity is hard to understand when one considers how unlike the adults of the two groups are. In these forms the lobes and arms, short in the larvae described earlier, have extended into enormous slender appendages supported by delicate, reticulated calcareous rods. The early students of these larvae, who fancied a similarity of the appendages to the long legs of a painter's easel turned upside down, called them *Pluteus*. In modern terminology the prefixes *Echino-* and *Ophio-* are added to distinguish between the larva belonging to sea urchins and brittle stars. In the sand dollars and cake urchins, which represent the latest evolutionary stage within the sea urchins, an unpaired rod extends downward from the mid-line of the larva, thereby making it possible to recognize the larvae of these forms at a glance.

Metamorphosis.—During metamorphosis the bilateral symmetry of the larva disappears, with the mouth and anus shifting into new positions (often temporarily disappearing and being reformed). At the same time part of the left coelomic cavity becomes the water-vascular system, forming a ring that sends out five radial canals. Other structures, such as nerve bands, blood lacunae, etc., simultaneously develop in a pattern co-ordinated with the water-vascular system.

Five-Rayed Symmetry.—The secondarily acquired five-rayed symmetry is evident in all echinoderms except some of the extinct groups; in some of the recent forms, the irregular sea urchins and the sea cucumbers, it is more or less overshadowed by a superimposed bilateral symmetry. Most of the organ systems, including the water-vascular system, blood lacunae, oral nerve system, radial muscles and skeleton, are centred around the mouth and radiate out; they are superimposed on each other, repeating the same essentially five-rayed pattern. The digestive system, though centrally placed, deviates from this pattern. The sex glands usually show a five-rayed distribution, placed interadially, with some deviations in some of the irregular sea urchins and in the sea cucumbers, in which only one pair of glands are present, presumably the

STARFISHES AND ECHINOIDS

Dried specimens of: (*lower left*) sea urchin (*Strongylocentrotus drobachiensis*, spines removed); (*centre*) cake urchin (*Clypeaster subdepressus*); (*lower right*) starfish (*Echinaster* species) ventral view; (*top, from left to right*) sea urchin (*Lytechinus variegatus*); keyhole urchin (*Mellita quinquiesperforata*); sand dollar, ventral view; three starfishes of the family Asteriidae; starfish (*Echinaster* species), dorsal view

Starfish *Pisaster ochraceous*, turned on its back (above), rights itself as shown in the series of photographs at the bottom of the page. This starfish is common on the American Pacific coast and specimens range from 6 to 14 in. across

The many-rayed sunflower star (*Pycnopodia helianthoides*), ranging from Alaska to southern California, has up to twenty-four arms and often measures two feet across

Starfish twists arms and uses its numerous suction-tipped feet to begin turn

The turn is half completed

Starfish completes the turn and is upright once more

PHOTOGRAPHS, (TOP) JOHN H. GERARD, (OTHERS) RALPH BUCHSBAUM

ECHINODERMATA

CRINOIDS, HOLOTHUROIDS, OPHIUROIDS AND ECHINOIDS

A white sea cucumber (*Eupentacta quinquesemita*) showing double rows of long tube feet. At left centre is the anterior end of a reddish sea cucumber

A common basket star (class Ophiuroidea), showing the star-shaped mouth and the five arms, from the underside

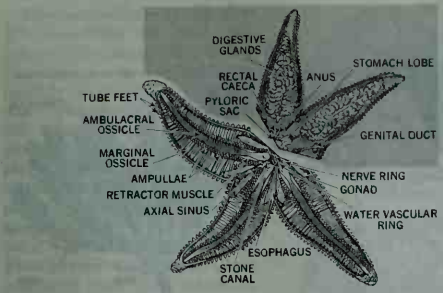
A giant red urchin (*Strongylocentrotus franciscanus*), more than 7 in. across. It is found from Alaska to Mexico in the deeper tide pools

A yellow feather star, one of the class Crinoidea, found mostly in shallow water. They live temporarily attached to bottom objects by short appendages (cirri)

Common European brittle star (*Ophiothrix fragilis*). Especially fragile, this species when handled may throw off all the arms in pieces

A close-up of the mouth of a sea urchin, with the five white teeth visible

PHOTOGRAPHS, RALPH BUCHSBAUM



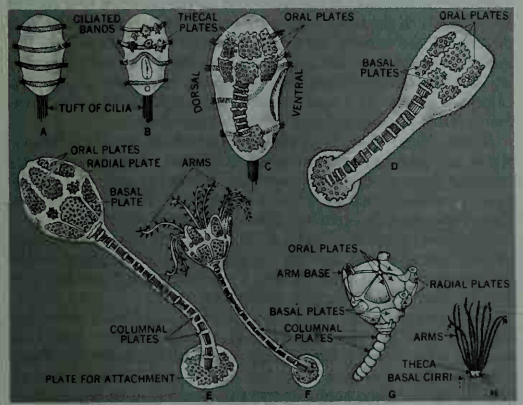
FROM "CAMBRIDGE NATURAL HISTORY," VOL. I, MACMILLAN & CO. LTD.

FIG. 3.—FIVE-RAYED SYMMETRY OF A STARFISH (ASTERIAS RUBENS), IN HORIZONTAL SECTION. ARMS IN SHADED AREA SHOW UPPER HALF; ARMS IN UNSHADED AREA SHOW UNDER HALF

primitive condition. In crinoids and certain brittle stars the number of arms is increased by forking, and in some sea stars new arms sprout out between the original five. There is rarely more than one madreporite, the porous plate through which water is taken into the water-vascular system. This plate, which is usually quite large and conspicuous, gives a certain irregularity to the otherwise perfect symmetry that most forms display. In sea stars and sea urchins the madreporite is usually large and easily seen on the animals' upper side, whereas in the brittle stars it has shifted to the underside, becoming one of the large plates around the mouth. In the crinoids the plate is lacking, and stone canals, of which there are several, hang free into the body cavity. In the sea cucumbers the madreporic plate lies in the mid-line of the upper side, between the mouth and the opening for the genital pore—a primitive condition—or it forms a round or oblong head that hangs free into the body cavity or is attached to the dorsal mesentery.

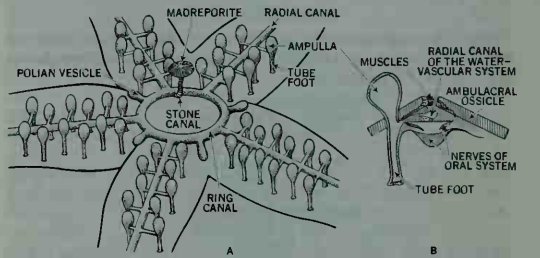
Skeleton.—The calcareous skeleton is formed by mesodermic cells in the deeper layer of the skin and is therefore a true endoskeleton. There is a certain similarity between echinoderms and vertebrates in the manner in which the skeleton is laid down and later, during growth, resorbed and reconstructed, but the chemical composition is different. In echinoderms the calcareous particles are laid down inside the cells, not outside them as in the vertebrates. The netlike structure of the echinoderm skeleton, the way the skeletal substance resembles a typical calcite crystal—in cleavage and in optic properties—makes it easy to recognize echinoderm skeletons and fragments of them in fossil strata. The ease with which the skeleton can be identified is one reason why echinoderm remains are so useful to paleontologists.

Except in the sea cucumbers, the young echinoderm begins by laying down a definite number of primary plates, or ossicles, characteristic of each group, and as the animal grows, more plates are added. The place where new ossicles are added lies, in the forms having arms, behind the terminal, unpaired plate of the arm; in the other forms, sea cucumbers and sea urchins, the growth area lies around the anus. In the groups in which regular plate systems exist, the older ossicles are rebuilt and enlarged so that they keep pace with the growth of the animal. In the sea cucumbers there is often considerable difference in the size of the spiculae of the older part of the animal (located near the mouth) and the newer part (located near the anus). As the animals grow older, new types of spiculae often appear in the deeper skin layer, while the older spiculae near the surface are frequently worn off.



FROM R. R. SHROCK AND W. H. TWENHOFEL, "PRINCIPLES OF INVERTEBRATE PALEONTOLOGY," 1953; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 4.—FORMATION OF SKELETON IN A MODERN CRINOID (ANTEDON BIFIDIA): (A) DORSAL AND (B) VENTRAL VIEWS OF EMBRYO AFTER EMERGENCE FROM MEMBRANOUS CAPSULE, WITH THECAL PLATES APPEARING; (C) EMBRYO SHORTLY BEFORE DISAPPEARANCE OF CILIATED BANDS, WITH THECAL AND STEM PLATES WELL DEVELOPED; (D) LARVA SOON AFTER ATTACHMENT; (E) PENTACRINOID LARVA AFTER COMPLETE SEPARATION OF ORAL PLATES WITH CUP CLOSED, AND (F) WITH CUP EXPANDED, SHOWING ARMS; (G) THECA OF PENTACRINOID LARVA SHOWING CALYX CLOSED BY FOLDING ORAL PLATES; (H) STEMLESS, FREE-SWIMMING ADULT WITH BASAL CIRRI



(A) FROM R. BUCHSBAUM, "ANIMALS WITHOUT BACKBONES," THE UNIVERSITY OF CHICAGO PRESS, © 1948 BY THE UNIVERSITY OF CHICAGO; (B) AFTER BATNER IN E. R. LANKESTER, "A TREATISE ON ZOOLOGY"; REPRODUCED BY PERMISSION OF MACMILLAN & CO., LTD.

FIG. 5.—WATER-VASCULAR SYSTEM OF A STARFISH: (A) CUT AWAY DIAGRAM FROM DORSAL SIDE; (B) CROSS SECTION OF AN ARM SHOWING RELATION OF WATER-VASCULAR SYSTEM TO MUSCLES, OSSICLES AND NERVES

Water-Vascular System.—The water-vascular system, which characterizes all recent echinoderms, was probably incipient even in those extinct forms that had not yet acquired a five-rayed symmetry. The middle part of the left coelomic sac forms the main part of the system. The anterior part of the sac supplies the madreporic plate, perforated by ciliated pores and connected to the ring canal by another canal, which, because in some forms its wall is stiffened by calcareous matter, is called the stone canal. The middle part of the left coelomic sac forms a ring around the esophagus and develops five blind-ending radial canals from which arise cylindrical outpocketings that push their way to the surface. These outpocketings, covered by skin, become the tube feet, or podia, of the adult echinoderm. In the more primitive forms—the crinoids and sea stars—the supporting skeleton lies beneath the water-vascular system. In the brittle stars the open groove with the radial canal has been roofed over by plates, the plates beneath the water-vascular system having developed into complex structures, reminiscent of vertebrae, with articulations and muscles. In the sea urchins the radial canals have somehow become placed internal to the close-fitting skeleton; the same is true of the sea cucumbers, in which the system lies well below the layer of spiculae. In the echinoderms in which the body is prolonged into arms, the podia are restricted to a band along the radial canals. In the more advanced types of sea stars the number of feet is increased by staggering the rows. In regular sea urchins the bandlike arrangement of the tube feet is retained, but also in these may occur an increase in the number of feet by pushing the plates that carry the pores for the feet into several short rows or arches. In forms like the sand dollars the number of feet on the underside is increased by their spreading over most of the surface. In many of the more advanced sea cucumbers, some forms, like *Thyone,* the species usu-

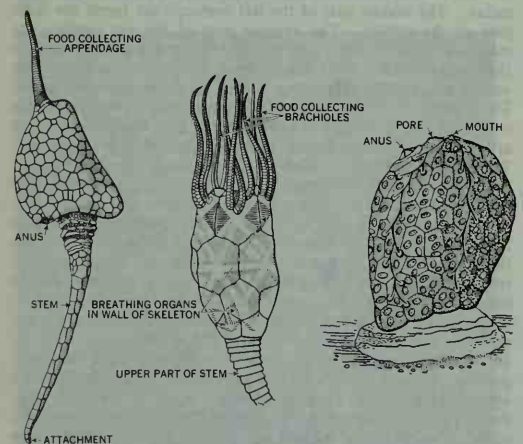
ally used for experimental work in the U.S., are covered by a veritable fur of tube feet. In cases in which they are actively used in locomotion the podia often have an inner bladder, the ampulla, extending into the body cavity: when a tube foot contracts, liquid pours into the ampulla; reversely, when a tube foot expands, liquid is poured into the foot from the reservoir of the ampulla. Similar bladders, called Polian vesicles, are often present on the circular canal. In forms in which the podia have no ambulatory function—in the crinoids and brittle stars—no ampullae are present. In irregular sea urchins podia on the central part of the upper side function as simple gills by being flattened into thin leaves. A special function is taken over by the podia around the mouth of the sea cucumbers; these podia are modified as tentacles that take in food, either by shoveling in sand and mud by means of broad, disc-shaped tentacles or by collecting food particles on branching tentacles as in a net. In the burrowing forms the tentacles are fingerlike and help partly in pushing the animal through the mud or sand and partly in stuffing the mud or sand with its organic debris into the mouth. In the highly modified heart urchins, in which the characteristic masticatory apparatus of the sea urchin is lost, long tube feet around the mouth help to gather up food particles lying on the surface of the mud.

CLASSIFICATION

The following taxonomic outline is the one generally accepted by the majority of invertebrate zoologists (wholly extinct classes are prefaced by an asterisk):

Phylum Echinodermata
- Subphylum Pelmatozoa
  - *Class Heterostelea
  - * " Cystoidea (Cystidea)
  - * " Blastoidea
  - " Crinoidea
  - * " Edrioasteroidea
- Subphylum Eleutherozoa
  - Class Holothuroidea
  - " Echinoidea
  - " Asteroidea
  - " Ophiuroidea
  - * " Ophiocistioidea

Fossil Echinoderms.—For the paleontologist the extinct classes of echinoderms from the Paleozoic strata (a period extending from 200,000,000 to 500,000,000 years ago) are of the greatest interest and an enormous amount of information dealing with these forms has accumulated. Unfortunately, as only the skeletons are preserved, much of what has been written about the soft parts, on the basis of our knowledge of present-day forms and their development, is hypothetical. At the present time five classes are accepted for the subphylum Pelmatozoa, the primitive, attached forms including the crinoids, and the only group which still has living representatives. Of the subphylum Eleutherozoa, the unattached forms, to which most present-day echinoderms belong, only one small extinct class is known exclusively from the Paleozoic period.



(A) FROM BATHER, "CARADOCIAN CYSTIDEA"; BY COURTESY OF THE ROYAL SOCIETY OF EDINBURGH; (B) AFTER JAEKEL IN "STAMMESGESCHICHTE DER PELMATOZOEN," JULIUS SPRINGER, BERLIN; (C) BY COURTESY OF THE BRITISH MUSEUM (NATURAL HISTORY)

FIG. 6.—FOSSIL ECHINODERMS: (A) HETEROSTEL DENDROCYSTIS; (B) RHOMBIFEROUS CYSTOID CHIROCRINUS; (C) DIPLORITE CYSTOID GLYPTOPHAERITES

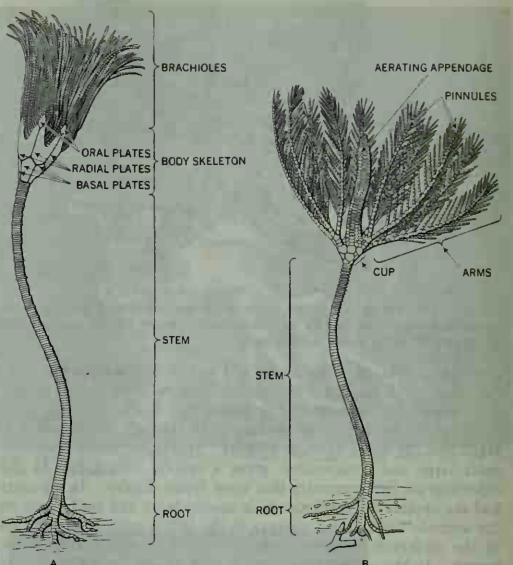


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FIG. 7.—FOSSIL ECHINODERMS: (A) BLASTOID OROPHOCRINUS FUSIFORMIS, (B) CRINOID BOTRYOCRINUS DECADACTYLUS

The pelmatozoans are characterized by the presence of a cup, or theca, in which the inner organs are placed, and are attached either directly to the substratum or by a shorter or longer stem. The mouth is directed upward and one or more food grooves run toward it. The animals may have arms, enclosing extensions of the body cavity, or shorter or longer articulated projections, the brachioles. Some forms may be without any such appendages.

Heterostelea.—Lowest rank the members of the class Heterostelea, in which no radial symmetry is evident; these had a mostly laterally flattened theca and a stem composed in part of a double row of ossicles, with or without brachioles. It is assumed that these forms had the stem and theca in a lateral position.

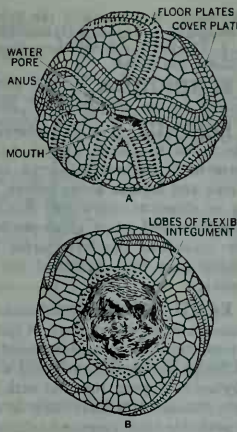
Cystoidea.—In the class Cystoidea the theca was upright, more or less spheroid, but not five rayed, and either attached to the bottom or provided with a stem. Two to five food grooves were present, bordered by simple brachioles.

Blastoidea.—In this class the theca had acquired a five-rayed structure and was directly attached or had a stem. Five food grooves were present, with brachioles along the sides; the latter were in many cases pinnulated like a feather with the grooves extending up along the pinnulae, thereby creating an enormous food-collecting surface. Many of these forms superficially resembled crinoids.

Crinoidea.—Both extinct and extant members of the class Crinoidea are characterized by genuine arms, with or without pinnulae, and usually with a stem—in the modern feather star, however, the stem disappears at an early stage—while the five-rayed pattern is pronounced. Three of the crinoid orders died out in the Paleozoic, but a fourth, which blossomed out in the Triassic period, is still extant, though chiefly represented by stalkless, unattached forms (see *Extant Echinoderms,* below).

Edrioasteroidea.—In the class Edrioasteroidea no stalk was present; the theca, more or less like a bag or a short cylinder, was possibly attached by a sucking disc. The mouth was placed on the upper side with five food grooves protected by marginal plates. The anus, likewise placed on the upper side, was covered by plates. The Edrioasteroidea is of special interest because possibly some if not all of the present-day Eleutherozoa (*see* below) have originated from forms related to this group.

Ophiocistioidea.—Of the extinct class Ophiocistioidea about ten species are known. They were free living, with the mouth directed downward, and had a shell, or test, reminiscent of that of a sea urchin but composed of fewer and irregular plates. The podia were few and large and formed five short double rows around the mouth. Many speculations have been made about their affinities to sea urchins and brittle stars, but probably the ophiocistioids represent merely a small branch that quickly became extinct.

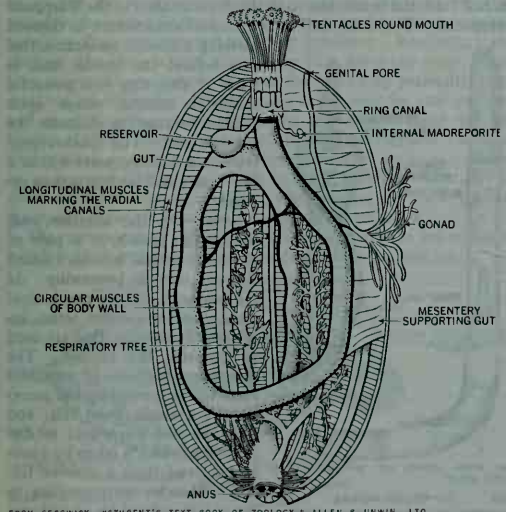


FROM E. R. LANKESTER, "TREATISE ON ZOOLOGY," A. & C. BLACK

FIG. 8.—FOSSIL SESSILE STAR (EDRIOASTER): (A) UPPER AND (B) UNDER SURFACES

Extant Echinoderms.—*Crinoidea* (*Sea Lilies and Feather Stars*).—Among the present-day echinoderms the surviving crinoids represent the most archaic type. They are attached, at least during the early stages, and have the mouth directed upward. They feed on microscopic plankton particles, which are carried to the mouth along ciliated grooves. The larva is of a simple type, and the radial canal of the water-vascular system lies in an open groove above the arm skeleton. The sex glands are pushed out in the arms or in certain pinnulae and the mature sex products are set free by rupturing of the skin. Most of the attached forms have a slender stem which justifies the common name sea lily. In the rare West Indian crinoid *Holopus* the stem is reduced to a short cylindrical base.

The arms divide synchronously usually once so that ten arms result; however, many forms repeat the bifurcation so that a larger number of arms are formed. Only in the most archaic species, as *Rhizocrinus*, from deep water off the coast of Norway, is the primitive five-armed condition retained. About 80 species of stalked forms are described from the deep water of present-day seas, although thousands of species populated the ocean bottom in earlier geological periods. In contrast there are now about 550 species of stalkless feather stars occurring in both shallow and deep water.



FROM SEDGWICK, "STUDENT'S TEXT BOOK OF ZOOLOGY," ALLEN & UNWIN, LTD.

FIG. 9.—A HOLOTHURIAN, OR SEA CUCUMBER, OPENED ALONG THE BACK

Holothuroidea (*Sea Cucumbers*).—Among the recent Eleutherozoa the sea cucumbers look least like echinoderms, with their strong development of muscles and with a skeleton usually reduced to microscopic spiculae or totally lacking. In a few forms larger plates are present, but not in a definite arrangement as in the other groups. Formerly sea cucumbers were considered an evolutionary offshoot from the sea urchins with which they share a lack of free arms; a meridianlike arrangement of the radial canals, which run from mouth to anus; closed ambulacral (podial) grooves; and skeletal elements placed external to the water-vascular system. But the extremely simple larva, the single pair of gonads and, in the more primitive forms, the position of the madreporic plate between the mouth and the genital pore all indicate a phylogenetic position far removed from the sea urchins. In contrast to all other echinoderms the sea cucumbers move with the oral end forward and the lengthened oral-anal axis parallel to the bottom. The underside, with three radial canals, is designated as the trivium and the upper side, with two canals, is called the bivium. The animals develop a bilateral symmetry, and there is usually a pronounced difference between the podia of the underside, which function as in sea urchins and sea stars, and those of the upper side, which often are nipplelike, with the sucking disc reduced. In two orders no tube feet are present, and in one of these orders even the radial canals are lacking. For catching their food the animals use the modified tube feet or tentacles around the mouth. A peculiar respiratory organ is present in three of the five orders: a pair of hollow, branching invaginations from the cloaca called the respiratory trees, or water lungs. Through these water lungs sea water is taken in and is expelled after an exchange of oxygen and carbon dioxide takes place. These organs are lacking in the most primitive order, the deep-water Elasipoda, and in the forms without tube feet and radial canals, the Apoda, a condition possibly indicating a close affinity between these two groups.

About 700 species of sea cucumbers are known. A large number are shallow-water forms; particularly important are the members of the genus *Holothuria*, with about 80 species, which inhabit the tropical reefs. The primitive Elasipoda, deep-water species, are the most extreme abyssal forms; they have been taken at more than 7,000 m. depth, as the Challenger and later the Galathea expeditions have amply demonstrated.

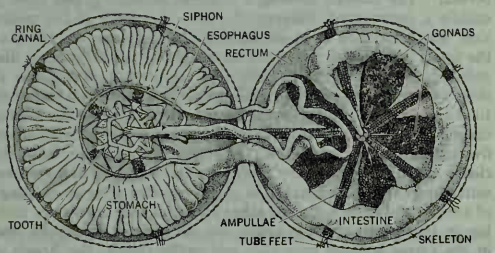
Asteroidea (*Sea Stars or Starfishes*).—Sea stars have the ambulacral grooves open and the larval type is simple. Except for the few species that sprout a larger number of arms between the original ones, the five-rayed condition is prevalent. The group is easily recognized by its star-shaped body though the arm length varies from virtually nonexistent in the pentagonal cushion stars to extremely long in other species. In the more primitive forms, like *Astropecten*, the arms are bordered by large marginal plates that give a certain rigidity to the arm; in these species the tube feet are relatively few. In evolutionarily higher starfish the marginal plates are insignificant and the tube feet, often numerous, are placed in three to four rows. Among these forms the stomach can be everted and wrapped around the prey, which is then digested outside the body.

ROBERT S. BAILEY

FIG. 10.—STARFISH (ASTERIAS FORBESI) WITH STOMACH EVERTED, PARTIALLY ENVELOPING A FISH

There are about 1,200 species of asteroids known from all parts of the oceans. Species from deeper water depend mostly on decaying matter for food and use ciliated paths for bringing the food particles to the mouth. In the colder parts of the world, where oysters and mussels abound in shallow water, one finds the more modern, aggressive forms of starfishes. They are particularly numerous in the North Pacific, an area where the lines between related species are not well defined, where great variability is displayed and where hybridization apparently often takes place.

Echinoidea (Sea Urchins, Sand Dollars, etc.).—The sea urchins have a highly developed larval form and the ambulacral grooves are closed, with the entire skeleton lying as a solid wall external to the grooves. The boxlike skeleton with its sharply defined plates, the highly developed articulating spines of all sizes and shapes, the efficient, three-pronged pincers and the complex dental apparatus in most forms all indicate the high developmental stage that the sea urchins have reached. From the regular forms, which live freely exposed on the sea bottom, two aberrant groups have arisen with members that live more or less concealed in sand or mud. In both groups the anus has moved out from the central position and the animals have become secondarily bilateral. In the sand dollars the dental apparatus is preserved, whereas in the heart urchins the mouth has become excentrically placed and the dental apparatus is lost; they live in mud and their food is collected by the large tube feet around the mouth. About 700 sea urchins exist at the present time, a fraction of what was found in earlier periods.



FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY," 1957; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 11.—AN ECHINOID, OR SEA URCHIN, SPLIT HORIZONTALLY WITH THE ORAL HALF TO THE LEFT

Ophiuroidea (Brittle Stars).—The brittle stars, with their slender arms sharply set off from their disc-shaped body, have a complex larva similar to that of the sea urchins, and the ambulacral groove on the arms is closed. They are more active than most other echinoderms because of the strong development of the muscles attached to the vertebralike plates in the arms. The podia, on the other hand, function merely as sensory organs but may also assist in bringing food particles to the mouth. Brittle stars have no intestine or anus and they feed chiefly on microscopic organic debris that is sifted by the numerous spines situated in front of the mouth. The size is moderate to small for the majority. A few species, however, have arms that are more than two feet in length; these giants are usually found clinging to the large six- to seven-foot-long sea pens (certain coelenterates) in deeper water. The smaller, shore forms are found in sand, mud, under rocks, in sponges and among algae. In deeper water, on muddy bottom, brittle stars occur in such quantities that the bottom is literally paved with them. About 1,700 species have been described, an indication that the class is definitely one of the most successful groups of echinoderms.

See also articles on various echinoderms; namely, BÊCHE-DE-MER; SAND DOLLAR; SEA CUCUMBER; SEA URCHIN; STARFISH; and references under "Echinodermata" in the Index volume.

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ECHINOIDEA, a class of the Echinodermata (*q.v.*), comprising the sea urchins (*q.v.*), heart urchins and sand dollars.

ECHINUS, in architecture, a convex molding, under the abacus of a column capital, so called from its resemblance in form to a sea urchin (Greek *echinos*). It is universal in both Greek and Roman Doric orders, in which it has a profile of circular or elliptical curvature; Roman examples have a *cyma recta,* double curved (*see* CYMA) profile. The convex molding between the volutes of the Ionic order is termed an echinus, as is any similar form in a capital of any style. *See* MOLDING; CAPITAL; ORDER.

ECHIURIDA (ECHIUROIDEA), a phylum of generally sausage-shaped marine worms that, in spite of an apparent lack of segmentation, must be considered nearly related to the Annelida (*q.v.*). Although formerly considered a class and placed in the obsolete phylum Gephyrea, together with Sipunculida (*q.v.*) and Priapulida (*q.v.*), echiuroids have little in common with the former, and it is probable that supposed relationships with the latter can be altogether discounted.

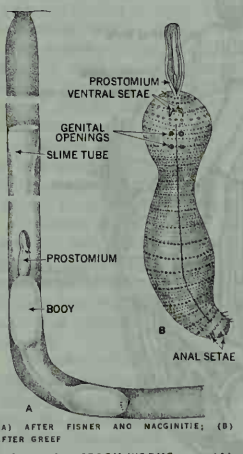
STRUCTURE AND FUNCTION

Typical representatives of the Echiurida are several species that, because of the extended scooplike proboscis (prostomium) overhanging the mouth, are called spoon-worms (fig. 1 and 2). Spoon-worms are moderately large, sac-shaped creatures that inhabit U-shaped tubes on sandy mud bottoms. The northern cold water species, *Echiurus echiurus,* is described below as an example.

External Features.—The body consists of a cylindrical trunk which reaches a length of 12 cm. or more, and a preoral lobe or prostomium, shaped like a hemispherical fan when fully extended, which is about half as long as the trunk. The prostomium is ciliated on its ventral surface and its margins are fused at the base, forming a funnel around the mouth. During feeding the prostomium is extended over the surface of the surrounding mud, and particles of detritus are swept along ciliary tracks toward the mouth.

The trunk is encircled by rings of mucous-secreting papillae, the slime being used to line the walls of the burrow. The anus is terminal.

Autotomy (Self-Amputation).—The prostomium is readily detached from the trunk, less so in the Alaskan than in the European subspecies. The body wall in the area of detachment is thinned forming a special autotomization ring behind the mouth, and in front of this ring is a powerful sphincter muscle, which upon sudden contraction discards the anterior end. The trunk regenerates the missing parts within a few weeks and feeding is then resumed.



(A) AFTER FISNER AND NAGGINITIE; (B) AFTER GREEF

FIG. 1.—SPOON-WORMS: (A) URECHIS CAUPO IN ITS BURROW; (B) ECHIURUS ECHIURUS

Setae.—At the anterior end, behind the mouth, is a pair of powerful ventral bristles (setae) that are used in burrowing. At the posterior end are two incomplete rings of smaller setae, interrupted ventrally, that are used in cleansing the burrow. The setae resemble those of annelids: each seta is formed by the secretion of a single basal cell; and when an old worn seta is discarded, its place is taken by a new one derived from a reserve follicle. Muscles corresponding to the protractors of an oligochaete annelid move the seta forward,

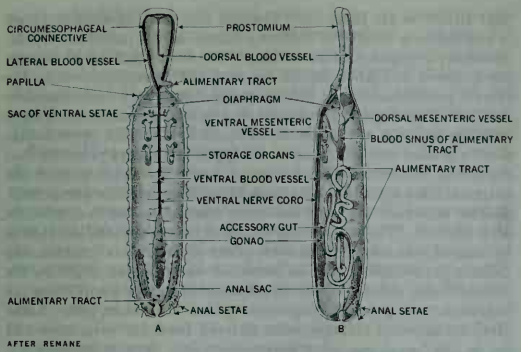


FIG. 2.—ANATOMY OF ECHIURUS: (A) VENTRAL VIEW; (B) SIDE VIEW

backward and sideways; other muscles, including an interbasal one, move the two ventral setae apart.

Body Wall.—The skin consists of a simple columnar epithelium that, except on the ciliated regions of the prostomium, secretes a thin cuticle. The subepidermal connective tissue layer contains yellow and red pigment cells. The muscular coat consists of three layers: the strongly developed longitudinal layer lies between the outer circular and inner oblique layers. A thin membrane, the peritoneum, separates the body wall from the spacious coelom or true body cavity (*see* below).

Internal Features.—*Body Cavities.*—The cavity of the prostomium is a system of canals and lacunae that are separated from the coelom by an incomplete partition, the diaphragm. These cavities are provided with an endothelial lining, and coelomic fluid moves freely between the two compartments. It has been shown that the prostomial cavity is derived from the embryonic blastocoele that develops a secondary connection with the coelom (fig. 3). Because of this unusual embryonic development F. Baltzer has likened the body of an echiurid to a chimera in which the anterior part is larval and the posterior part adult.

Coelomic Fluid.—The coelomic fluid contains two types of cells, spherical erythrocytes, which in the Californian species *Urechis caupo* contain a respiratory pigment similar to hemoglobin; and amoeboid leucocytes, often laden with red-brown pigment granules. In all but the youngest individuals, maturing sex cells are also found in the coelomic fluid. The coelomic fluid performs respiratory as well as nutritive and excretory functions. Respiratory exchanges take place in part through the skin, since the worm keeps up a constant flow of water through the burrow by peristaltic contractions of the body. Water is also taken into the anal vesicles and expelled periodically. According to A. C. Redfield and M. Florkin (1931), the properties of *Urechis* hemoglobin are such that it gives up oxygen at low tensions when the worm is confined to its burrow at low tide. This "oxygen reservoir function" is criticized by E. Eliassen (1954), who favours the "low tension transport" function (*see* also ANNELIDA: *Introduction*).

The coelomic fluid of *Echiurus* is isotonic with the sea water in which it lives and contains no plasma proteins in solution.

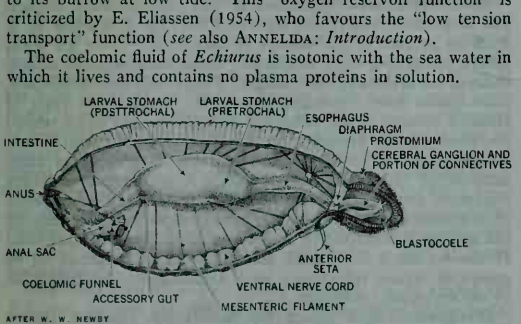


FIG. 3.—60-DAY LARVA OF URECHIS CAUPO; VIEW WITH PART OF BODY WALL CUT AWAY

Digestive System.—The mouth communicates with the pharynx, which makes a double loop in the region of the diaphragm; a thick-walled esophagus is dilated posteriorly to form a crop in which the food bolus is molded. These parts, constituting the fore-gut, are of ectodermal origin. The endodermal mid-gut, separated from the fore-gut by a sphincter, is divided into three regions, the pre-, mid- and postintestine. The midintestine is accompanied by a narrower accessory tube, which is continuous before and behind with an open ciliated groove. This accessory tube or siphon is of unknown function and, although similar structures occur in unrelated groups, as for example among polychaetes (Capitellidae) and in sea urchins, its presence is considered to be one of the more distinctive features of the Echiurida. The postintestine opens into a short anal tube, also of endodermal origin. Both mid- and postintestine are strongly coiled and convoluted. The intestinal juice is alkaline and contains a powerful protein-digesting enzyme. A fat-splitting enzyme is also present, but evidence for a starch-digesting one is inconclusive.

Excretory Organs.—The anal tube receives a pair of endodermal sacs; in the newly metamorphosed larva these sacs communicate with the coelom, each by a single funnel, the nephrostome; in the adult the number of nephrostomes is greatly increased. The anal vesicles are highly characteristic of the phylum. They subserve both excretory and respiratory functions and, since they are provided with typical nephrostomes, they probably represent a posterior pair of metanephridia.

Vascular System.—The vascular system is closed; a ventral vessel runs the whole length of the trunk above the nerve cord and forks anteriorly to form a ring around the margin of the prostomium. A short dorsal vessel, confined to the anterior part of the body, receives blood from the ventral vessel by way of a sinus surrounding the mid-gut. It pumps the blood forward into a median prostomial vessel that communicates anteriorly via the marginal loop with the ventral vessel. The blood is colourless and contains only phagocytic amoebocytes.

Nervous System.—There is a ventral nerve cord in which, in the adult, no separate ganglia can be recognized. It divides anteriorly, and the circumpharyngeal connectives form a long drawn-out loop that follows the margin of the prostomium. There are no special enlargements or cerebral ganglia. The ventral nerve cord arises embryonically by the union of two ectodermal thickenings and, in *Echiurus,* exhibits 16 transitory ganglionic masses. In *Urechis* the number of these supposedly primary trunk ganglia is only 12 (fig. 3).

Sense Organs.—Groups of sensory cells, which may be either tactile organs or chemoreceptors, underlie the epidermis and are especially abundant along the margins of the prostomium. Special sense organs are lacking in the adult, but eyespots are present in the larva.

REPRODUCTION AND DEVELOPMENT

Reproduction.—In *Echiurus* the sexes are separate but superficially alike. The gonad is suspended from the ventral vessel, and the maturing sex products are shed into the coelom. The naked eggs grow from 0.01 to 0.2 mm. in diameter, nourished by the coelomic fluid, and are then taken up by the ciliated funnels of the storage organs. In some genera, like *Bonellia,* the developing ovum is enclosed in a follicle and nutrition is mediated by a special cap of nurse cells. In males the sperm clusters also develop in the body cavity and the liberated spermatozoa are collected as they become mature and free-swimming.

There are two pairs of gonoducts that act as storage organs. They are regarded as modified metanephridia and although they perform no excretory function, are confusingly termed "nephridia" by some authors. Each of these ducts is provided with a bilobed ciliated funnel that gathers up the mature sex cells, and a large thin-walled sac that serves as a storage chamber. In *Echiurus* the funnel opens into the gonoduct close to its external end, but the presumably more primitive condition in which the funnel is at the internal end of the sac occurs in some other genera (*see* below).

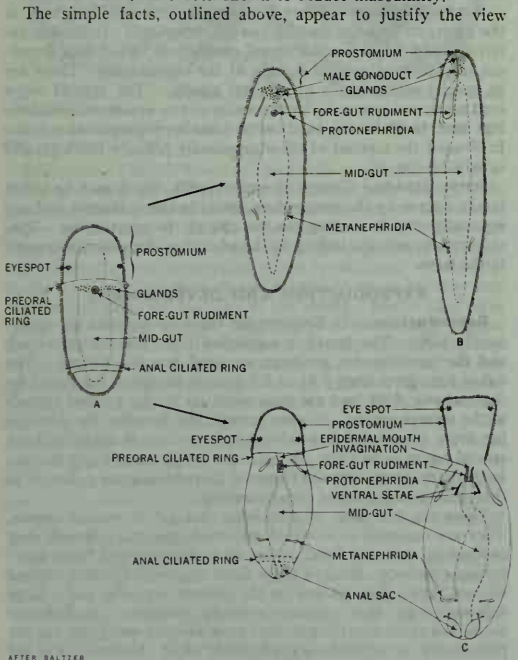
Development.—The most complete study of echiurid development is that of W. W. Newby on *Urechis.* Fertilization is ex-

ternal and the early stages show a spiral cleavage similar to that of Platyhelminthes, Mollusca and Annelida. A typical "annelidan cross" is formed from the first four cells, the first quartet, but the later stages show a predominance of supposedly molluscan features. Thus the blastopore, pushed forward ventrally by the expansion of the somatic plate, forms only the mouth. In typical annelids the somatic plate, as it grows downward on each side, unites ventrally to divide the blastopore into a mouth-forming and an anus-forming region. Mesoblastic teloblasts are absent in the better known European and North American species. Growth in length is achieved by expansion of the trunk region and not by the teloblastic addition of segments at the posterior end, as in the Annelida. However, C. N. Dawydoff described the appearance of two teloblasts and a transient metamerism in the giant larva of an unidentified echiurid from Annam. The body cavity is a schizocoele, that is, formed by splitting of the mesoblast into layers.

The embryo develops into a free-swimming trochophore of the annelidan type, provided with a pair of larval protonephridia.

Sex Determination in Bonellia.—Zoologists have long been interested in this problem and many outstanding contributions have been made, especially by Baltzer and C. Herbst. The trochophore becomes transformed into an indifferent larva (fig. 4). If it finds the prostomium of a female it becomes attached and remains for several days (*B. viridis*) during which period a gradual metamorphosis toward the male condition takes place. It then migrates to the fore-gut and thence to the antechamber of the female storage organ, where it remains for at least one breeding season. On the other hand, larvae that develop in sea water usually become females. However, the presence of female extracts, from the fore-gut or prostomium, will stimulate male transformation. The active principle, which resists boiling and is probably not a protein, has not been identified. Moreover, a diversity of foreign agents such as acids, potassium ions, heavy metals, glycerine and even shaking or transference from Mediterranean to North sea water, have been shown to induce masculinity.

The simple facts, outlined above, appear to justify the view that all larvae are potentially bisexual and that the male response is elicited by a variety of different stimuli and is therefore, fundamentally, a response to an irritant. The investigations of Baltzer have shown that when larvae are removed prematurely from the female prostomium they exhibit various stages of male transformation. The degree of intersexuality is approximately correlated with the duration of the attachment period, but, since extracts also elicit a graded series of transitional types, it appears probable that organs in the mouth region have a lower threshold toward the male-inducing substance than have those situated more posteriorly. Baltzer advanced the view that male transformation is essentially an inhibition. The stimulating action of potassium ions led Herbst to suggest, in view of the known effect of these ions in increasing cellular permeability, that an increased water uptake might be the masculinizing agent, and this hypothesis received support from the experimentally proved antagonistic action of calcium ions. Later Herbst suggested that glycerine derived from the metabolism of fat in the larval gut must play some role. R. Goldschmidt attempted to bring the facts in line with his famous theory of sex determination, and M. Hartmann pointed out similarities with the phenomenon of sex reversal in the polychaete Ophrytrocha. The theory that all eggs are potentially bisexual has been challenged by J. Z. Wilczynski (1960).



AFTER BALTZER

FIG. 4.—LARVAL DEVELOPMENT OF BONELLIA VIRIDIS: DEPENDING UPON ENVIRONMENTAL CONDITIONS, THE (A) INDIFFERENT LARVA TRANSFORMS INTO A (B) YOUNG MALE OR (C) YOUNG FEMALE

CLASSIFICATION AND RELATIONSHIPS

The Echiurida is a small phylum, with over 30 genera and about 80 species. Several systems of classification have been proposed; that adopted below is essentially identical with that of Dawydoff (1959):

Phylum Echiurida (Echiuroidea)
Family Echiuridae
" Urechidae
" Thalassematidae
" Ikedidae
" Bonellidae

Echiuridae.—As now restricted, this family comprises the single genus *Echiurus*, described above.

Urechidae.—W. K. Fisher placed the genus *Urechis* in a separate order, Xenopneusta, on account of the absence of a vascular system. There is only one ring of anal setae. The small prostomium is not used as a feeding organ; food is captured by means of a finely netted slime tube (fig. 1[A]), secreted periodically by a glandular girdle, that filters the water as it is swept through the burrow by peristaltic contractions of the body. The slime tube, together with its catch, is then eaten. It has been estimated that the net must have a mesh with pores of 36 to 40 Ångstrom (Å) units (Å = 1/10,000,000 mm.), since molecules of ovalbumin can pass through, whereas those of serum globulin are partly retained and those of hemocyanin completely retained. Another peculiar feature of Urechidae is the absence of a definitive gonad; the sex cells are found free in the coelomic fluid from their earliest identifiable stage. There are two or three pairs of gonoducts with external funnels in which the lips are drawn out into spirally twisted, whiplike processes.

Thalassematidae.—Members of this predominantly tropical and subtropical family were separated from the Echiuridae by S. Bock on account of the absence of anal setae. There are seven genera, comprising some 50 species. Some thalassematids inhabit shells of sea urchins or sand dollars. *Thalassema dendrorhynchus*, from Chilka lake, a brackish bay on the northeastern coast of India, is tolerant of low salinities; both this species and a related one have gill-like processes on the margins of the prostomium. *Anelassorhynchus abyssalis* has been taken at a depth of 1,083 fathoms off the coast of California. A presumably primitive metameric arrangement of the gonoducts is found in some species of *Ochetostoma*, with three to five pairs in sequence. More usually the number is restricted to one or two pairs. On the other hand *Ikedosoma* has 6 to 14 pairs, some of which are represented by groups of organs, reflecting a local, nonmetameric multiplication of the embryonic rudiment.

Ikedidae.—Fisher placed the remarkable Japanese species *Ikeda taenioides*, which attains a length of over one metre, in a separate order Heteromyota because, unlike the arrangement in

other echiurids, the longitudinal muscle layer is external to the circular layer.. The excessively long prostomium is readily discarded, and this part was formerly mistaken for a nemertean worm. The trend to multiplication of the gonoducts, noted above in the thalassematid *Ikedosoma*, has advanced so far in *Ikeda*, with 200 to 400 organs, that all traces of metameric paring are obliterated. The funnels are situated at the internal end—a primitive feature.

Bonellidae.—This interesting family, with over 20 genera, is characterized by a pronounced sexual dimorphism. Females are typical echiurids, distinguished primarily by the structure of the excretory organs: the nephrostomes are not sessile, but communicate with the anal vesicles, or rarely communicate directly with the cloaca by slender tubules. The prostomium is usually long and ribbonlike, but in *Nellobia* it is short and truncated; frequently it is deeply cleft or forked, as in *Bonellia* (fig. 5). In *Prometor* the margins of the prostomium unite to form a cuplike funnel at the base. There are usually two ventral setae, but they are lacking in some genera; anal setae are absent. *Acanthobonellia* has two clusters of small ventral setae on muscular pads. In *Acanthohamingia* minute ventral spinelets, without musculature, are situated in the genital groove (*see* below). There may be a single gonoduct, as in *Bonellia*, but more frequently the primitive paired condition prevails. The funnel may be apical or basal. *Archibonellia* retains a pair of supposedly larval metanephridia, and *Australobonellia* has a single such organ between the gonoducts. The siphon, rudimentary in *Achaetobonellia*, is said to be absent in *Shuiterina*. The majority of species are of an intense green colour; the pigment, known as bonelline, is a mesopyrrhochlorine, chemically a degradation product of chlorophyll. It is highly toxic to other organisms and may therefore have a protective function; the green tissues are usually rejected by predators. The lytic properties of bonelline solutions toward echinoderm larvae are enhanced by simultaneous exposure to light; it may be, for this reason, that *Bonellia*, which avoids light and is nocturnal, cannot tolerate appreciable illumination.

FIG. 5.—BONELLIA VIRIDIS IN ITS BURROW, WITH DIVIDED PROBOSCIS, OFTEN A YARD LONG, PROTRUDED

In the late 1950s specimens of four hitherto undescribed genera were recovered from Pacific deeps by a Soviet expedition; among these are *Vitjazema*, taken at 5,500–9,950 metres.

The males are usually minute, 1–3 mm. in length, and live as parasites upon or within the body of the female. Immature stages may be found developing in the fore-gut, on the prostomium or attached to the skin. Mature males of *Bonellia* migrate into the muscular antechamber of the gonoduct; in *Achaetobonellia* this region forms a thick-walled bulbous expansion. The androecium, or male tube, of *Pseudobonellia* is situated between the genital pores. Males of *Amalosoma* are found in an androecial groove in front of the genital openings; in *Acanthohamingia* this groove is set with setae. A relatively large male of *Acanthobonellia miyajimai*, 28.5 mm. in length, was found by I. Ikeda (1907) in the body cavity of the female. Except in the possession of functional reproductive organs, the dwarf males present a combination of degenerate and persistent larval characteristics. Setae may be present or absent. There is no prostomium and the mid-gut is closed at both ends (*Bonellia*) or degenerate (*Acanthobonellia*). The single collecting funnel of *Bonellia* opens into the blind fore-gut that functions as a sperm reservoir and spermatozoa are discharged through the mouth. The *vas deferens* of *Acanthobonellia* has four funnels. The excretory organs are a pair of larval metanephridia.

Doubtful Genera.—Two genera formerly placed among the Echiurida are now definitely excluded. *Sternaspis* is a polychaete, and "*Epithetosoma*" a nemertean of the genus *Micrura*. *Poeobius meseres* regarded by its discoverer, H. Heath, as a connecting link between Echiurida and Annelida, is clearly an aberrant polychaete. *Sactosoma* (= *Saccosoma*), placed by Fisher in the echiurid class Sactosomida, has not been seen since its original discovery and is of uncertain status. It is said to possess one pair of gonoducts but to lack prostomium, setae, anal vesicles and blood vessels.

Relationships.—The Echiurida have many features in common with the Annelida. Distinctive features of the group are the apparent lack of segmentation and the persistent "larval" anterior end that forms the proboscislike prostomium. It is by no means certain that the lack of segmentation is primary, although W. W. Newby favoured this view. Evidence of suppressed segmentation may be derived from the appearance of transitory ganglia in the ventral nerve cord, from the varying number of setal groups and from a metameric interpretation of the gonoducts and excretory organs. Molluscan features are evident in early development and for this reason it is difficult to regard the Echiurida as a degenerate class of the Annelida.

Molluscan affinities have also been suggested for the Sipunculida, another unsegmented phylum remotely related to the Annelida but widely different from the Echiurida. Echiurids are clearly more primitive, as shown by the half-larval character of their body, and more annelidian than the sipunculids, as shown by the possession of setae and by the terminal position of the anus.

Relationships with the Priapulida are extremely doubtful since the body cavity of the latter is probably a pseudocoele.

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(G. E. P.)

ECHMIADZIN, a monastery in the Armenian Soviet Socialist Republic of the U.S.S.R. is situated in the plain of the Aras (Araks) river, 860 m. (2,821 ft.) above sea level, 33 km. (21 mi.) W. of Yerevan and 64 km. (40 mi.) N. of Mt. Ararat. It is the seat of the Supreme *catholicos* (Katholikos) or primate of the Armenian Church. The name, which means "where the only begotten Son descended," was adopted because, traditionally, St. Gregory the Illuminator (*q.v.*), the founder of the Armenian Church, there beheld his vision and erected the first church in 309. The neighbouring small town of Vagharshapat, renamed Echmiadzin in 1945, dates from the 6th century B.C.; it took its name from King Vagharsh (Vologaeses III), who in the 2nd century A.D. chose it as his residence and walled it. In 344 it ceased to be the Armenian capital and in 453 the patriarchal seat was removed to Dvin, then to Ani and later to Hromkla and Sis in the medieval kingdom of Cilicia. In 1441 the primate George brought back the seat to the original see.

The monastery comprises a complex of buildings surrounded by brick walls 30 ft. high, looking, with their loopholes and towers, like a fortress. A modern college and seminary, a type foundry, a printing press and a bookbinding establishment are attached to the monastery.

The present cathedral, on the site of the original church, goes back to the 7th century; although considerably restored later, it retains the main elements of the structure—a cross inscribed in a square, with four salient apses and a dome resting on four piers. The recently excavated remains of two earlier churches show that the original church was a vaulted basilica and that it was replaced in the late 5th century by a domed church, which had projecting apses like the present one and free-standing piers supporting the dome. Large quantities of glass cubes found during the excavations proved that this older church had mosaic decorations.

The red porphyry porch and the belfry were added in the 17th century. The interior walls are decorated in Persian style, in part the work of Armenian painters of the early 18th century and in part modern imitations. In the cathedral treasury are numerous silver and gilt church vessels, medieval gilt bookbindings, vestments, hangings and other works of art, the sacred hand (relic) of St. Gregory, with which the primate confers the episcopal consecration, and the silver basin for the preparation of the holy oil. The rich collection of manuscripts, including some handsome illustrated copies going back to the 10th century, is housed at the

Matenadaran at Yerevan, but since their transfer a new collection has been started and is steadily growing.

Half a mile to the east of the monastery stands the church of St. Hripsime (618), a niche-buttressed square in which the dome rests on the projecting walls of the four axial and four diagonal niches; these, in the form of three-quarter cylinders, give access to subsidiary chambers at the four corners. The third church, that of St. Gayane, was built in 630; its plan is that of a cross inscribed in a square, with three apses and free-standing piers supporting the dome. The porches of both churches are later additions.

Echmiadzinski *rayon* (administrative division) of the Armenian S.S.R. has a mainly rural population of which Echmiadzin is the centre. The district suffers severely from drought, but an irrigation project was inaugurated which has greatly increased the production of the region. (S. D. N.)

ECHO, a sound reflected from an obstacle (*see* ACOUSTICS OF BUILDINGS), personified in later Greek mythology as a mountain nymph or oread (not before Euripides). In Ovid's *Metamorphoses* she offends Hera by keeping her talking and thus preventing her spying on an amour of Zeus; in punishment, she is deprived of speech, save the power to repeat the last words of another. A hopeless love for Narcissus (*q.v.*) makes her fade away to a voice only.

In Longus, Echo rejects Pan's advances; he thereupon drives the shepherds mad, and they tear her in pieces. Earth buries her limbs and allows them still Echo's power of song.

ECHO SOUNDER, a device that measures the depth of water by producing a sound just below the surface and detecting the return of the sound or echo from the bottom. The depth of the water is indicated by the time required for the sound to travel from the ship to the bottom and back to the ship.

One of the first practical echo sounders came into being in 1919. This was the Hayes sonic depth finder developed at the U.S. Naval Engineering Experiment station. It consisted of an electromagnetic device that sent sound waves to the ocean floor, received the reflection and indicated the depth by a timer calibrated at 4,800 ft. per second, the basic speed of sound in sea water. About 1927 the Submarine Signal company was producing a similar device that was given the trade name of Fathometer. Echo sounder design was later improved but the basic principles used in these earlier developments were not changed materially.

The echo sounder system consists basically of three parts: (1) the transducer, mounted on the underwater skin of the ship, which converts electrical to acoustic energy and vice versa; (2) the transmitter, which generates high-level electrical energy to feed the transducer; and (3) the receiver-indicator, which amplifies the very weak echo received by the transducer, displays it visually or aurally as an indication of depth, and controls the time at which the pulses are transmitted.

Operation of the echo sounder is comparatively simple. When the transmitter supplies a powerful pulse of electrical energy, the transducer converts this pulse into an acoustic pressure wave in the water directed downward. This wave strikes the ocean floor, is reflected back and received by the transducer. The echo is converted there from acoustic to electrical energy, then amplified in the receiver and applied to the indicator. The indicator is usually a neon light rotating at the proper speed (determined by the speed of sound in water) around a dial calibrated in feet or fathoms.

The echo sounder's operation is entirely automatic and indications are given on every revolution of the dial. This method of taking soundings has many advantages over the older methods (such as by lead line). For example, the soundings shown by the echo sounder indicate the depth directly beneath the vessel whether it is moving or stationary; ordinary speeds have no effect on the operation of the device. Older methods were much slower, and frequently depth information came after the ship had moved from the spot. Furthermore, the echo sounder can be left in operation for indefinite periods, resulting in thousands of soundings being indicated per hour. Most echo sounders are equipped with devices that automatically make a permanent record of such lines of soundings.

The chief use of the echo sounder is to insure that the ship is in safe water and not in danger of going aground. It may also be used in navigation by comparing a series of soundings obtained against those recorded on available charts. A good comparison fixes the ship's position and track with some degree of accuracy. Hydrographers use echo sounders in charting the oceans of the world and in survey work. The echo sounder is indispensable in charting the ocean's bottom and in discovering hitherto uncharted pinnacles and shoals. Echo sounders have even been used by fishermen to locate large schools of fish. Echo sounders are in operation on practically every important class of ship, naval and merchant, and are also found on small craft. (M. M. EL.)

ECHTERNACH, a town in Luxembourg, is situated on the Sûre river, 18 mi. N.E. of Luxembourg city. Pop. (1960) 3,389. In Roman times it was a resort of Trier merchants but the town itself grew around a Benedictine abbey, founded in the 7th century by the English St. Willibrord, who introduced Christianity from there. The surviving 18th-century buildings are partly used as a school, while the 11th-century church (basilica), where St. Willibrord was buried, was damaged in 1944 and later rebuilt. The town hall (Denzelt), originally a court of justice, is a beautiful example of 15th-century architecture.

Echternach is known for its religious dancing procession on Whit-Tuesday, in honour of St. Willibrord. The participants, headed by the bishop of Luxembourg and accompanied by the village bands, progress slowly from the Sûre to the basilica, dancing to a lively traditional tune. The town is an attractive tourist centre with excursions to the impressive natural scenery of the Müllerthal district, popularly though inappropriately known as Luxembourg's "Little Switzerland." (K. C. E.)

ÉCIJA, a city of southern Spain, in Seville province, is situated on a terrace overlooking the Genil river, 86 km. (53 mi.) E.N.E. of Seville by road. Pop. (1950) 41,621. It is the ancient Astigis and the Roman *colonia* Augusta Firma. Named Estedja by the Moors, it was recaptured from them by Ferdinand III in 1240. During the 16th century it enjoyed great prosperity stemming from trade with the West Indies, but it declined in the 19th century. Henry III granted it the status of a city. Écija is in an area of large estates and many of the inhabitants are farm labourers. The main crops are olives, cotton and cereals. There are sawmills and lime quarries, and textiles, soap and meat products are manufactured. (M. B. F.)

ECK, JOHANN (1486–1543), German theologian and principal Catholic opponent of Martin Luther (*q.v.*), was born of peasant stock on Nov. 13, 1486, in the Swabian village of Egg (Eck), a name he later utilized instead of or along with his family name Mai(e)r (Mayr or Mayer). He studied the humanities, philosophy and theology at Heidelberg (1498), Tübingen (1499), Cologne (1501) and Freiburg im Breisgau (1502), where he was ordained to the priesthood in 1508 and became doctor of theology (1510). In Nov. 1510 at the University of Ingolstadt Eck began a lifelong career as professor of theology, supplemented by several terms as dean, prorector and rector. During many of these years he also served conscientiously as local pastor. His active pen soon attracted attention. Worthy of mention among his early productions are the theological treatise *Chrysopassus* (1514), on predestination, free will and grace, and a series of philosophy textbooks. In public debate and writing he departed from medieval notions on usury by defending interest-taking up to 5% on productive capital.

Luther's break with the Catholic Church proved the turning point in Eck's life. Thereafter his numerous writings, sermons, public debates, speeches at diets and conferences, and diplomatic missions concentrated on religious controversy. Eck was friendly with Luther until the appearance of the latter's 95 Theses (1517), which Eck assailed as heretical in *Obelisks* (1518). Luther retorted with his *Asterisks*. His disciple Karlstadt joined the fray, which culminated in the celebrated public disputation at Leipzig (June 27–July 15, 1519) held in the presence of Duke George of Saxony, his court, the local university faculty and many others. To this popular form of intellectual tourney Eck brought a reputation as a matchless debater whose gigantic frame and stentorian voice

augmented the impression created by his vast knowledge, prodigious memory, quickness of mind and tongue. Karlstadt, with whom Eck contended for five days, cut a poor figure. Argument with Luther filled the remaining period. Chief topics were the divine institution of the papal primacy and the infallibility of ecumenical councils, both of which doctrines Luther denied. Here too the audience rated Eck victor. Neither conceded defeat; both proceeded to seek and gain sympathizers.

To speed proceedings Eck visited Rome (March–July 1520), where he played an important role in the deliberations prior to the solemn papal pronouncement *Exsurge Domine* (June 1520), censuring 41 of Luther's theses and threatening him with excommunication. Leo X created Eck an apostolic protonotary, and delegated him, along with Jerome Aleander, as special emissary to publish and enforce the bull in Germany. Eck's second journey to Rome (Oct.–Dec. 1521), coming at the time of the pope's death, was uneventful, but during a final trip (March–December 1523), at the request of the Bavarian dukes, Eck treated successfully with Adrian VI on several matters of ecclesiastical polity concerning Bavaria, informed the pope about German religious conditions and proposed reforms.

At the *Reichstag* at Nürnberg and Regensburg (Ratisbon) Eck was prominent in promoting a union of Catholic powers. At the diet of Augsburg (1530) he headed a theological committee which drafted a refutation of the Lutheran creed known as the Confession of Augsburg. When the Zwinglians also presented there a profession of faith, *Confessio Tetrapolitana,* Eck himself prepared the rebuttal. Previously he had gone to Switzerland as leading debater on the Catholic side at the Baden disputation (May 21–June 8, 1526), where he was judged winner against John Oecolampadius (*q.v.*) and other outstanding Zwinglians. Again Eck was the main Catholic orator at the indecisive religious colloquies at Haguenau (1540); at Worms (1541), where he faced Philipp Melanchthon (*q.v.*); and at the diet of Regensburg (1541). His labours carried him as far as England (1525), where he conferred with King Henry VIII, who had written a criticism of Luther. In the negotiations preliminary to the Council of Trent both Emperor Charles V and Pope Paul III consulted him. He died at Ingolstadt on Feb. 10, 1543.

As a writer Eck was prolific. His published titles exceed 100; many others remain in manuscript or have disappeared. Mostly composed in Latin, they are striking more as learned defenses of the traditional faith than for style or originality of thought. The most important tracts include: *On the Primacy of Peter* (1520); *On Penance* (1522); *On the Sacrifice of the Mass* (1526); *Enchiridion Against the Lutherans* (1525), a summary of contested Catholic beliefs, Protestant objections to them and answers to these difficulties. Counting translations into German, Flemish and French, this most popular of Eck's works saw 91 editions up to 1600, ranking it the best-used Catholic polemical handbook of the century. He was less proficient in his native language, and his German version of the entire Bible (1537) was so stiff that it merited only restricted acceptance.

Those intimately acquainted with the "Catholic Achilles" praised his tireless zeal and laboriousness, sincerity, frankness, blunt joviality, simplicity of life, disdain of ecclesiastical dignities and material gain. At the same time they found him impetuous, uncompromising, overcontentious and tending to arrogance. The tone of his polemics, bitter and coarse as it seems nowadays, was that customary in his time; his adversaries more than repaid him in kind. There was created a voluminous counterpolemical literature, in which the virulent lampoon *The Planed-down Eck (Eccius dedolatus,* 1520), probably by the famous humanist Willibald Pirckheimer, was but the best-known example. Its vilifications of his character, motives, virtues and manner of death were frequently repeated later, but these serious charges must be discounted as largely unfounded.

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ECKENER, HUGO (1868–1954), German aeronautical engineer and airship pioneer, commander of the first airship to fly around the world. Born at Flensburg on Aug. 10, 1868, he was educated at the universities of Munich, Berlin and Leipzig. He took a keen interest in airship construction, joined Count Zeppelin's firm, and was instrumental in developing the rigid airship in the early 1900s. During World War I, Eckener trained airship pilots and directed the construction of 88 Zeppelins for the German navy. Returning to commercial construction in Nov. 1918, after Zeppelin's death, he achieved great success in temporarily popularizing airship travel. He commanded the "ZR-3," built for the United States as a war reparations payment and later named "Los Angeles," in its flight across the Atlantic in 1924. He also commanded the "Graf Zeppelin" on its epic around-the-world flight in 1929 and on its polar exploration flight in 1931. In 1937 he was in command of the "Hindenburg" when it burned with heavy loss of life on May 6, at Lakehurst, N.J.—a tragedy that virtually ended international airship travel. Eckener spent the last years of his life as head of a machine plant in Germany and wrote several books. He died at Friedrichshafen, Ger., on Aug. 14, 1954. *See* AIRSHIP. (D. CR.)

ECKERMANN, JOHANN PETER (1792–1854), German writer, chiefly remembered for his association with Goethe, was born at Winsen, Hanover, Sept. 21, 1792. Brought up in great poverty, he served in the War of Liberation (1813–14), and became a clerk in the war department at Hanover, subsequently studying for a year at Göttingen. He published a book of poems in 1821, and in 1823 attracted Goethe's attention by sending him the manuscript of his *Beiträge zur Poesie mit besonderer Hinweisung auf Goethe.* Goethe invited him to Weimar and he there became Goethe's unpaid literary assistant, also acting as tutor to the grand duke's son, and, in 1838, acquiring an appointment at court and the position of librarian to the grand duchess. He died there, Dec. 3, 1854.

Eckermann's most valuable work was his *Gespräche mit Goethe in den letzten Jahren seines Lebens, 1823–32,* 3 vol. (1836–48), a source of information on Goethe's life and ideas. It was based on notes taken with Goethe's permission and is comparable in importance with Boswell's *Life of Johnson.* It has been translated into every European language: English translations (*Conversations with Goethe*) include those by S. M. Fuller (1839), J. Oxenford (1850) and R. O. Moon (1951). Eckermann also acted as Goethe's literary executor and published his posthumous works (1832–33), and, with F. W. Riemer, prepared the first complete edition of Goethe's works.

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ECKHART (ECKHART VON HOCHHEIM, called MEISTER ECKHART) (1260?–1328?), the greatest German speculative mystic, was born at Hochheim, near Gotha. He joined the Dominican order, probably entering the local friary of Erfurt. In 1293 he went to St. Jacques in Paris to complete his theological studies, but he did not graduate as master till 1302. In 1304 he was appointed provincial minister of his order in Saxony and proved a very successful administrator. Between 1314 and 1322 he was teaching and preaching in Strasbourg. After this he was lector at Cologne and the most popular preacher in Germany. But he was not without his critics. He was summoned to appear before the archbishop of Cologne on a charge of heresy in 1326. He vigorously defended his innocence and appealed to Pope John XXII. In 1327 proceedings were opened in Avignon, where Eckhart appeared in person. Eckhart recanted and soon afterward died. A papal bull of 1329 condemned 28 propositions from his works.

Modern scholarship tends to judge Eckhart charitably, to make allowances for his obscurity, his love of paradox and hyperbole, his tendency to startle his congregation. In philosophy he followed the Aristotelian tradition, including that of the Arabic commentators. His theology has close affinities with that of Thomas Aquinas, but there are differences of emphasis. His favourite writer was St. Augustine, from whom he borrowed his speculations about time and eternity. He was also influenced by Plotinus,

Pseudo-Dionysius and Moses Maimonides. Like Pseudo-Dionysius, Eckhart refers to God as "Nothing." This implies, not that God does not exist, but that he has a fuller existence than any created being. If we are to affirm anything positive about God, the most important statement we can make is that he is (Ex. iii, 14). With Aquinas, Eckhart adds that, whereas the creature *has* being, God *is* being. In a sense he is above being, since he created being.

When Eckhart asserts that all created beings are *unum purum nihil*, he does not deny the existence of the world, but means that in comparison with God the world is as nothing. His cardinal doctrine is that of the birth of the Son in the soul, which signifies the mystical union of the human and divine, the highest goal of man. This is attained by a process of purification. It is union of wills, not of essences. It is given by grace, not acquired by merit. The organ or faculty in, or through, which it takes place is the "spark of the soul." When dealing with mystical experiences Eckhart often used the language of Neoplatonism, hence the charges of pantheism. But his most daring observations can be interpreted in a Christian sense. He never taught that God can be reached without the aid of the sacraments and other religious observances. His attitude was that pilgrimages, fastings, physical austerities and external works in general are of no avail unless the soul is well disposed; which is perfectly orthodox.

Eckhart did not create medieval German prose: a tradition already existed, thanks to the great preachers of the 13th century and others. But he contributed in a marked degree to German vocabulary by the addition of many abstract terms. The standard edition (including the trial documents) is by J. Quint *et al., Meister Eckhart: die deutschen und lateinischen Werke* (1936–), with a modern German translation. There are English versions with bibliographies in J. M. Clark, *Meister Eckhart, an Introduction to the Study of His Works* (1957) and J. M. Clark and J. V. Skinner, *Meister Eckhart, Selected Treatises and Sermons* (1958), including extracts from the Latin works.

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ECKHEL, JOSEPH HILARIUS (1737–1798), founder of the science of classical numismatics, was born at Enzersfeld in lower Austria and educated at the Jesuit gymnasium in Vienna, where he had entered the order at the age of 14. He taught grammar at various collegiate schools, but because of ill-health gave up teaching to devote himself to his early interest in numismatics. In 1772 he was sent to Italy where he had access to important collections in Bologna, Rome and Florence, and in 1776, two years after his return, was appointed chief curator of the imperial cabinet of coins and professor of antiquities and numismatics at the University of Vienna. He died at Vienna on May 16, 1798.

Eckhel's great work is the *Doctrina numorum veterum* (8 vol., 1792–98), in which he established basic principles for the classification of coins by region, chronology and type that became the model and standard for later systems.

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ECKMÜHL (EGGMÜHL), **BATTLE OF,** an engagement of the Napoleonic Wars (*q.v.*), fought on April 22, 1809, at Eggmühl 13 mi. S.E. of Regensburg between the French and their allies under Napoleon and Davout and the Austrians under the archduke Charles. A week after his invasion of Bavaria, the archduke reached the Landshut area with 126,000 men on April 16. A further 49,000 Austrians, in two corps, had been sent 30 mi. N. of Regensburg on the Danube, where Davout's 60,000 lay exposed. On April 17, Napoleon arrived at Donauwörth and hastened to close up Davout's and Masséna's forces (still 75 mi. apart). He intended to hold the Austrians on Davout's front while to the south Masséna came up on their rear to cut them off from Landshut. On April 19, Davout marched from Regensburg across Charles's front, his rearguard successfully engaging at Teugen with one of Charles's three columns. Masséna now stood 30 mi. W. of Landshut, where J. Hiller commanded the two remaining Austrian columns that Napoleon had taken to be the bulk of Charles's army. On April 21 these were threatened by the French centre converging with Masséna, who arrived too late to take them in reverse. Hiller now retired, with considerable losses, to the Inn. Charles, however, reinforced by one of the corps previously north of the Danube, decided to attack the heavily outnumbered French left wing under Davout and Lefebvre next day. He began his outflanking movement against Davout's left at midday on April 22, but Napoleon's approach enabled Davout to launch his own attack on the Austrian left wing about 1 P.M., an hour before the French vanguard from the south debouched. Promptly suspending the right wing's advance in the face of Napoleon's threat to his rear, Charles withdrew over the Danube during the night. He had lost about 10,000 killed, wounded and captured, the French about 3,000 killed and wounded. (J. H. N.)

ECLAMPSIA, a disease condition of unknown cause, characterized by convulsions and coma and occurring chiefly in pregnant women. *See* OBSTETRICS; PREGNANCY: *Toxemias of Pregnancy.*

ECLECTICISM, in philosophy or in theology, is the practice of selecting doctrines from different systems of thought without adopting the whole system from which each doctrine was derived (Gr. *eklektikos*, "selective"). It is distinct from syncretism (*q.v.*) in that syncretism is the attempt to reconcile or to combine systems, whereas eclecticism leaves the contradictions between systems unresolved. In the sphere of abstract thought eclecticism is open to the objection that, insofar as each system is supposed to be a whole, of which its various doctrines are integral parts, the arbitrary juxtaposition of doctrines from different systems is likely to result in fundamental incoherence. In practical affairs, however, the eclectic spirit has much to commend it.

A philosopher, no less than a statesman, may be eclectic not on principle (though he can defend as a principle his right to be eclectic) but because he perceives the intrinsic merit or the utility of doctrines that happen to have been advanced by opposite parties. This tendency is naturally most apt to manifest itself when established systems are losing their novelty or having their defects revealed by changes of historical circumstance or by scientific discoveries. In antiquity, for instance, from the beginning of the 2nd century B.C. onward, a number of philosophers professedly attached to long-established schools—the Greek Academy, the Peripatetics, or the Stoics—were ready to adopt views from schools to which they did not belong; and Roman philosophers in particular, to whom all Greek philosophies were enlightening, often did not want to commit themselves to a rigid partisanship which Greeks themselves were abandoning (Cicero is eclectic par excellence). Very little purpose, however, is served by attempting to group the numerous ancient eclectics together as if they formed an "Eclectic school." In the 19th century, however, the name *éclectisme* was specifically adopted as the designation of his own system by the French philosopher Victor Cousin (*q.v.*).

ECLIPSE is the complete or partial reduction of visibility of a celestial body by the passage of a second celestial body (from Gr. *ekleipsis*, "forsaking"). The many eclipse phenomena known to astronomers are of two distinctly different types. In the first, the eclipsing body comes between the observer and the eclipsed object, and the latter appears to the observer partly or completely covered by the eclipsing body. Eclipses of the sun, occultations of stars by the moon, transits of Venus or Mercury across the sun's disk and eclipses of binary stars are of this kind. Eclipses of the second type affect only planets or satellites that are not self-luminous; here the eclipsing body intervenes between the sun and the eclipsed object. The latter remains in view of the observer, but its illumination by the sun is interrupted, and it becomes darkened by entering into the shadow of the eclipsing body. Examples of this case are eclipses of the moon and eclipses of the satellites of Jupiter.

To the general public, eclipses of the sun and of the moon are

of considerable interest since they are readily observable without a telescope and offer an impressive spectacle. Primitive people are struck with fear by the falling darkness during a total solar eclipse or by the weird sight of the eclipsed moon; even animals are disturbed or frightened. Accounts of such eclipses are found among the oldest records of history, battles have been decided by their unexpected advent and the successful prediction of eclipses constitutes one of the earliest triumphs of the scientific investigation of nature.

ECLIPSE PHENOMENA

Eclipses of the Sun.—An eclipse of the sun takes place when the moon, revolving in its orbit around the earth, comes between the earth and the sun so that the moon's shadow sweeps over the face of the earth (*see* fig. 1). This shadow consists of two parts: the umbra or total shadow, a cone into which no direct sunlight penetrates; and the penumbra or half shadow, which is reached by light from only a part of the sun's disk.

To an observer who is within the umbra the disk of the sun appears completely covered by the disk of the moon; such an eclipse is called total. To an observer within the penumbra, the moon's disk appears projected onto the sun's disk so as to overlap on it partly; the eclipse is then called partial.

As the umbra cone is narrow at its intersection with the earth, a total eclipse is observable only within the narrow strip of land or sea over which the umbra passes. A partial eclipse, on the other hand, is visible over the large area covered by the penumbra.

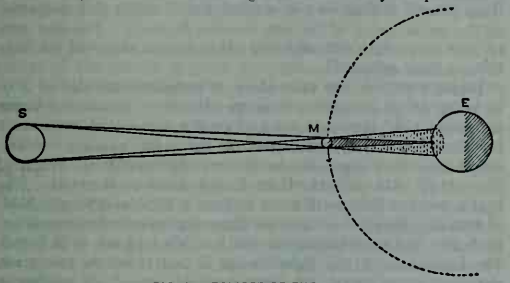


FIG. 1.—ECLIPSE OF THE SUN

The shadow of the moon M sweeps over the surface of the earth E. In the darkly shaded region (umbra) the eclipse is total, in the lightly shaded region (penumbra) the eclipse is partial

Sometimes the earth intercepts the penumbra of the moon but is missed by its umbra; only a partial eclipse of the sun is then observed anywhere on the earth.

By a remarkable coincidence, the sizes and distances of the sun and moon are such that they subtend very nearly the same angle (about $\frac{1}{2}°$) at the earth, but their apparent sizes are not constant. Since the earth revolves around the sun in an elliptical orbit, the distance of the sun varies slightly during the year, and this involves a small change in the angular diameter of the solar disk. In a similar way the apparent size of the moon's disk changes somewhat during the month because of the elliptical shape of the moon's orbit. Thus when the sun is nearest to the earth, and the moon is at its greatest distance, the apparent disk of the moon is smaller than that of the sun. If an eclipse occurs at this time the moon's disk passing over the sun's disk may enter completely inside the latter, leaving the rim of the sun visible all around it. Such an eclipse is called annular.

The various phases observable at a total solar eclipse are illustrated in fig. 2(A). "First contact" designates the moment when the invisible disk of the moon just touches the disk of the sun. The partial phase of the eclipse then begins as a small indentation in the western rim of the sun becomes noticeable. The dark disk of the moon now gradually moves into the sun's disk and the sun appears in the shape of a crescent. After about $1\frac{1}{4}$ hours the crescent grows very thin and daylight appears somewhat dusky. At the "second contact" the last trace of the sun's crescent disappears and the total phase begins. Within a few seconds all direct

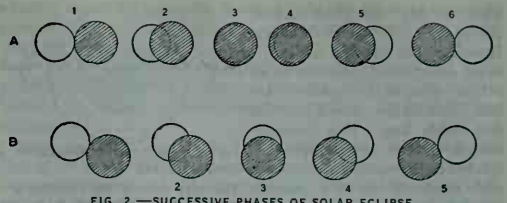


FIG. 2.—SUCCESSIVE PHASES OF SOLAR ECLIPSE

The dark disk of the moon gradually moves across the disk of the sun from west (right) to east (left). (A) Total eclipse: (1) first contact; (2) partial phase; (3) second contact, beginning of totality; (4) third contact, end of totality; (5) partial phase. (6) fourth contact. (B) partial eclipse: (1) first contact; (3) maximum phase; (5) last contact.

sunlight vanishes, it suddenly grows dark, the brightest stars become visible in the sky and the dark disk of the moon is seen projected onto the pale halo of the sun's corona—an unforgettable spectacle. The general landscape illumination during totality is considerably brighter than on a night of full moon, but the sudden transition from daylight is most impressive.

Totality never lasts very long, $7\frac{1}{2}$ minutes at the utmost. It ends at the "third contact" when the following limb of the moon begins to uncover the western rim of the sun. Daylight returns as suddenly as it vanished; the thin crescent of the sun gradually widens, and about $1\frac{1}{4}$ hours later the second partial phase of the eclipse ends at the "fourth contact," when the last encroachment made by the moon on the sun's rim disappears.

In a partial eclipse (*see* fig. 2[B]) the motion of the moon's disk is such that its centre does not pass across the centre of the sun. After the first contact the visible crescent of the sun decreases in width until the centres of the two disks reach their closest approach. This is the moment of maximum phase, and the latter is measured by the ratio between the smallest width of the crescent and the diameter of the sun. After maximum phase the crescent of the sun widens again until the moon passes out of the sun's disk at the last contact.

When observing a partial or annular eclipse it is necessary to protect the eyes against injury by the intense brilliance of the sun. The sun should be viewed only through a dark smoked glass (much darker than that of ordinary sunglasses) or a darkened photographic plate or film.

Eclipses of the Moon.—When the moon moves through the shadow of the earth (*see* fig. 3), it loses its bright direct illumination by the sun, although its disk still remains faintly visible. This phenomenon is called an eclipse of the moon. As the shadow of the earth is directed away from the sun, a lunar eclipse can occur only at the time of full moon, that is, when the position of the moon is opposite to that of the sun.

To describe the progress of a total eclipse of the moon a cross-cut of the earth's shadow cone, both umbra and penumbra, is drawn at the distance of the moon, as shown in fig. 4. The moon's path relative to the shadow is indicated by the dotted line, and successive positions of the moon are marked by $M_1, \ldots M_6$. At M_1 the full moon enters the penumbra, and while it moves from M_1 to M_2 a penumbra eclipse occurs. But the dimming of the moon's illumination by the penumbra is so slight as to be scarcely noticeable, and penumbra eclipses are rarely watched.

After the moon has reached the position M_2, a part of its surface is immersed in the umbra and is darkened; the moon is in partial eclipse. About an hour later the eclipse becomes total

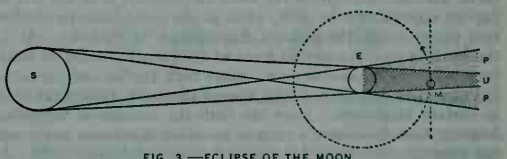


FIG. 3.—ECLIPSE OF THE MOON

The moon revolving in its orbit around the earth passes through the shadow of the earth. U (umbra) is the total shadow, P (penumbra) the partial shadow

when (at M_3) the whole disk of the moon is within the umbra. However, the moon's surface is never completely darkened by an eclipse; even at the middle of totality it is visible, with a peculiar dull ruddy hue. This illumination is caused by sunlight refracted in the earth's atmosphere and reddened by its passage through the air.

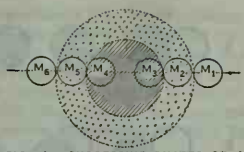


FIG. 4.—SUCCESSIVE PHASES OF A LUNAR ECLIPSE

The large circle of light shading is a crosscut of the penumbra at the distance of the moon, the smaller circle of dark shading a crosscut of the umbra. M_1 . . . M_6 are successive positions of the moon as it crosses the shadow

If the moon's path leads through the centre of the umbra the total eclipse lasts about $1\frac{3}{4}$ hours. At M_4 the moon emerges from the umbra; there follows a partial eclipse ending at M_5, then a penumbra eclipse ending at M_6.

An eclipse of the moon is visible and presents the same features at all places on the earth where the moon is above the horizon. Because of the earth's atmosphere the edge of the umbra is rather diffuse, and the times of contact between the moon and the umbra cannot be observed accurately. The progress of a lunar eclipse can be adequately followed with the naked eye, field glasses or a small telescope. It is an interesting experience for the layman but of little value for astronomical research.

Eclipses of the Satellites of Jupiter.—Eclipses of the four large satellites of Jupiter provide a frequently occurring and fascinating spectacle to the telescopic observer. The orbits of these satellites lie nearly in the same plane as Jupiter's orbit around the sun, and at practically every revolution of each satellite the following four eclipse phenomena take place: (1) eclipse of the satellite when it passes through Jupiter's shadow; (2) occultation of the satellite when it disappears behind the planet, as seen from the earth; (3) transit of the satellite across the disk of Jupiter; (4) transit of the shadow of the satellite across the planet's disk. Fig. 5 illustrates the occurrence of these phenomena; it shows Jupiter

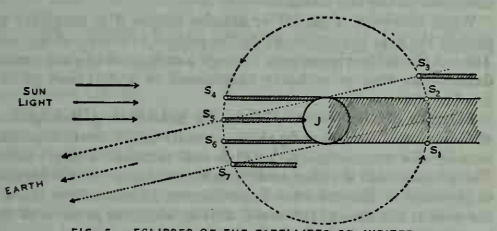


FIG. 5.—ECLIPSES OF THE SATELLITES OF JUPITER

J represents the planet Jupiter, S_1 . . . S_7 mark successive positions of one of its satellites as it revolves in its orbit around Jupiter. The system is illuminated by sunlight from the left but is observed from the direction of the earth

and the orbit of one of its satellites, the direction of the sunlight illuminating the system and the direction toward the earth from where the observation is made.

When the satellite in its revolution arrives at S_1, it enters into Jupiter's shadow (eclipse) and vanishes from lack of illumination. At S_2 it comes out of the shadow, but to the terrestrial observer it is now hidden behind the planet (occultation) until at S_3 it reappears at the limb. When the satellite reaches the position S_4, its shadow falls on Jupiter causing a small dark spot on its surface. Seen from the earth the satellite is to the left of Jupiter approaching its limb, while at the same time its shadow spot passes across the planet's disk (transit of shadow). At S_5 the satellite starts to pass in front of the planet (transit of satellite) following its shadow spot. Since both Jupiter and the satellite turn their illuminated sides toward the earth, they differ little in surface brightness. Near the limb the satellite is somewhat brighter than the planet's surface on which it appears projected, but near the middle of the disk it is hardly distinguishable. At S_6 the shadow leaves the planet, and at S_7 the satellite emerges at the limb.

Historically the eclipses of Jupiter's satellites are important for they provided one of the earliest proofs of the finite velocity of light. It is possible to calculate with considerable precision the times of disappearance and reappearance of a satellite undergoing eclipse. Ole Roemer (1675) noticed discrepancies between the observed and calculated times which he explained as being the result of changes in the travel time of light when the earth is nearest to Jupiter or farther away from it.

Other Eclipse Phenomena.—*Occultations of Stars or Planets by the Moon.*—From the earth the moon is seen projected onto a background of distant stars. As the moon moves eastward across the constellations it occasionally passes in front of one of the brighter stars or a planet, causing an occultation. At the moment when the eastern limb of the moon reaches a star, the latter suddenly disappears (immersion). In about an hour or less the moon will have passed over the star and the latter will reappear at the western limb (emersion). Between new moon and full moon the immersion takes place at the invisible (or faintly visible) dark limb; the emersion takes place at the bright limb.

The suddenness with which a star disappears and reappears without fading or flickering is conclusive proof that the moon has no appreciable atmosphere. Accurately timed observations of occultations are used to study the orbital motion of the moon.

Transits of Mercury and Venus.—The two planets Mercury and Venus, which are nearer to the sun than the earth is, do sometimes pass between the earth and the sun. With a telescope properly equipped to reduce the overpowering light of the sun, either of these planets is then seen as a small dark circular disk projected on the brilliant disk of the sun, crossing it slowly. The four contacts of the planet's disk with that of the sun are observed similarly as for a solar eclipse.

Transits of Mercury take place at irregular intervals of 3 to 20 years, on an average 14 times per century. Tranists of Venus are rather rare; they have been of great astronomical importance for the accurate determination of the solar parallax. Many expeditions were organized to observe the transits of Venus of 1761, 1769, 1874 and 1882 from distant places on the earth. The next transits of Venus will occur on June 8, 2004, and June 6, 2012.

Eclipsing Binaries.—These are stars that vary in brightness periodically, the most famous of which is Algol (*q.v.*), or β Persei. The explanation of the light change is that there are two stars, not resolvable with the telescope, revolving round one another in an orbit whose plane nearly passes through the solar system. Thus one star passes periodically in front of or behind the other as seen from the earth, and two eclipses take place during each revolution. From the way in which the light from the double system varies it is possible to calculate the orbit and relative sizes of the two components, and to obtain certain other information (*see* STAR).

Prediction and Calculation of Solar and Lunar Eclipses.—The problem may be divided into two parts. The first seeks to find out when an eclipse will occur, the other to determine its circumstances: whether or not it is visible at a given place on the earth, its type (total or partial), etc.

It is convenient to consider the earth as fixed and to suppose the observer situated at the centre of the earth. To this observer, O (fig. 6), the sun and moon appear projected on the celestial sphere, a large sphere which he imagines surrounding him. While this sphere appears to him to rotate daily around the line PP′ (the earth's axis of rotation), the sun's disk, S, appears to travel slowly along the great circle EE′ (the ecliptic), making a complete revolution in one year. At the same time the moon's disk, M, revolves along the circle LL′ once during a lunar month. The angular diameters of the two disks S and M are about $\frac{1}{2}°$, but vary slightly (see *Eclipses of the Sun*, above).

Every month the moon's disk revolving along LL′ will once overtake the more slowly moving sun; this moment of overtaking is called the new moon. In general the moon's disk will pass above or below the sun's disk. Overlapping of the two disks results in an eclipse of the sun; it will occur only when the new moon happens at a moment when the sun is near the points ☊ or ☋, where the circle LL′ intersects EE′. These points are called the ascending and descending nodes of the moon's orbit.

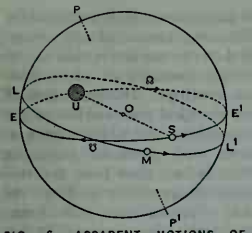


FIG. 6.—APPARENT MOTIONS OF SUN AND MOON ON THE CELESTIAL SPHERE

The observer O imagines himself at the centre of a large sphere. The sun S appears to move around the circle EE′ (the ecliptic) once a year, the moon M around the circle LL′, its orbit, once a month. The crosscut U of the earth's shadow is always opposite to the sun S. The intersections (nodes) ☊☋ of the moon's orbit and the ecliptic revolve along the ecliptic once in 19 years

The moon will suffer an eclipse when it enters into the shadow cone of the earth. The crosscut of the umbra at the distance of the moon (as shown in fig. 4) may be projected like a disk U onto the celestial sphere. It subtends an angle of about 1.4°; its centre will always be opposite to the sun's disk and travel along EE′. An eclipse of the moon takes place whenever the moon's disk overlaps the shadow disk; this happens only when the shadow disk is near one of the nodes, or the sun is near the opposite node. The passage of the sun through the lunar nodes is therefore the critical time for both solar and lunar eclipses. The moon's orbit plane, represented by the circle LL′, is not fixed, and its nodes move slowly along the ecliptic in the direction indicated by the arrow, making a complete revolution in about 19 years. The interval between two successive passages of the sun through one of the nodes is termed an "eclipse year," and since the moon's node moves so as to meet the advancing sun, this interval is about 18.6 days less than a tropical (or ordinary) year.

In fig. 7(A) the region of the ascending node as seen from the centre of the sphere is much enlarged. Here the node is kept fixed and the apparent motions of the sun and the moon are taken relative to the node. To the imaginary observer at the centre of the earth the sun's disk will travel along the circle EE′, the moon's disk along LL′. The sun is so distant compared with the size of the earth that from all places on the earth's surface the sun is seen nearly in the same position as from the centre. But the moon is relatively near and its projected position on the celestial sphere is different for various observing stations on the earth; it may be displaced as much as 1° from the position in which it is seen from the centre of the earth. If the radius of the moon's disk is enlarged by 1°, a circle C, is obtained which encloses all possible positions of the moon's disk seen from anywhere on the earth. Conversely, if any circle of the moon's size is drawn inside this "moon circle" C, there is a place on the earth from which the moon is seen in that position.

Accordingly, there will be an eclipse of the sun somewhere on the earth whenever the moon overtakes the sun in such a position that the moon circle passes over the sun's disk; when the latter is entirely covered by the moon circle, the eclipse will be central (total or annular). From fig. 7(A) it is evident that a solar eclipse will take place if a new moon occurs while the sun moves from S_1 to S_4. This period is called the eclipse season; it starts 19 days before the sun passes a node and ends 19 days after. Since there is a new moon every month, at least one solar eclipse, and sometimes two, occur during every eclipse season. When the new moon falls within 11 days of the node passage (between S_2 and S_3), the eclipse will be central.

Fig. 7(B) illustrates the condition for a lunar eclipse. If a full moon occurs within 13 days of a node passage of the sun (when the shadow disk passes the other node) the moon will be eclipsed. Most eclipse seasons, but not all, will thus also contain a lunar eclipse. Eclipses of the sun are evidently more frequent than those of the moon, but the former are visible only from a very limited region of the earth, the latter from a whole hemisphere. Any particular town or city would on the average experience about 40 lunar eclipses and 20 partial solar eclipses in 50 years, but only one total solar eclipse in 400 years.

The sun returns to the same node after each eclipse year; new moons (or full moons) recur at intervals of an ordinary month. Nineteen eclipse years (6585.7806 days) are nearly equal to 223 months (6585.3211 days). After this interval of 18 years 11 days, which is called the saros, the moon and the sun come nearly to the same relative positions again and eclipses will repeat themselves. Thus the solar eclipse of Oct. 2, 1959, was a repetition of that of Sept. 21, 1941, which was a repetition of that of Sept. 10, 1923, which was a repetition of that of Aug. 30, 1905, and so on (*see* Table). In ancient times the saros was used for the prediction of eclipses.

Since the coincidence of the two periods is not exact, the repetition of an eclipse after a saros will be of different circumstances. Suppose an eclipse of the sun takes place while the sun is at S_3 (fig. 7[A]) and the moon at M_3; it will be visible on the earth in high northern latitudes from where the moon's disk is projected into the lower part of the moon circle. After 223 months there will be another new moon with eclipse. As this period is shorter by 0.4595 days than 19 eclipse years, the moon will now overtake the sun before the latter has quite returned to S_3, while it is 28° farther to the right, nearer to the node. The sun will be closer to the centre of the moon circle, and on the earth the eclipse will be visible nearer to the equator or farther south than the previous eclipse. After every saros the meeting of the moon and the sun will be a little farther to the right, until it takes place near S_1 M_1, after which the eclipse returns no more. Solar eclipses may thus be ordered into series, each of which contains 68 to 75 eclipses (about 18 total), at intervals of a saros extending over 13 to 14 centuries.

The fraction of 0.3211 days in the period of the saros has the effect of making each successive eclipse of a series visible about 110° of longitude farther west on the earth, and after three saroses it returns nearly to the same longitude, but farther south if at the ascending node or farther north if at the descending node. Eclipses of the moon, of course, also occur in similar saros cycles.

During a solar eclipse the shadow cones (umbra and penumbra) of the moon sweep across the face of the earth (fig. 1), while at the same time the earth is rotating around its axis. The circumstances of a solar eclipse are best illustrated by a map which shows the intersections of the shadow cones with the earth's surface and their tracks across continents and oceans resulting from the combined effects of both motions. Fig. 8 illustrates the circumstances of the total solar eclipse of Nov. 1, 1948. The narrow double line marks the path along which the umbra travels in 3½ hours from central Africa across the Indian ocean toward New Zealand. Within the area of this lane, 50 mi. wide, the eclipse is total. The wide surrounding region bounded by the full line is that covered by the penumbra, where the eclipse is partial. Within the lune at its extreme left the sun is already in partial eclipse when it rises, within the lune at the right the sun sets during the partial eclipse. In the intermediate region the whole progress of the partial eclipse can be observed, and from the dotted lines the time of its beginning and end at any particular place can be read.

The astronomical ephemerides published for each year give such

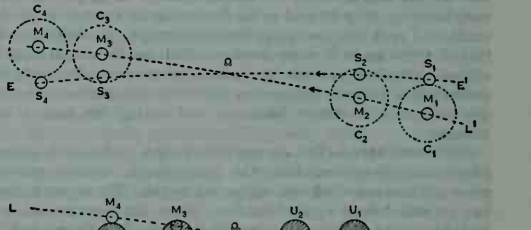
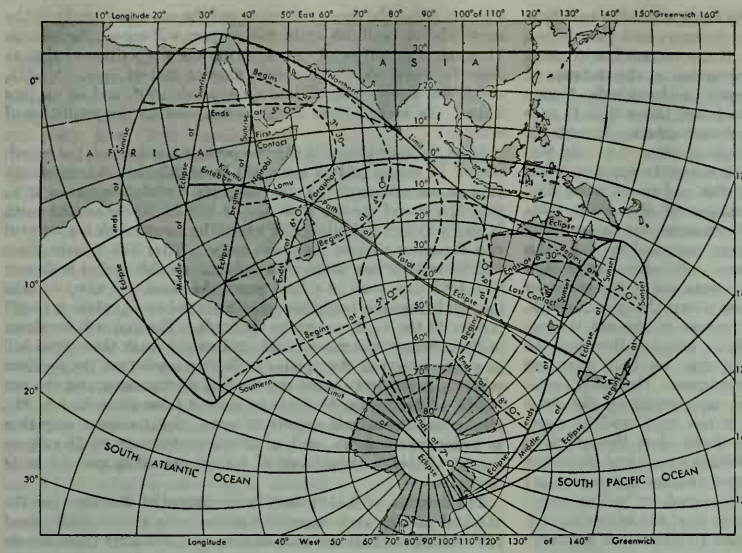


FIG. 7.—ASCENDING NODE OF THE MOON'S ORBIT AS SEEN FROM THE CENTRE OF THE SPHERE

(A) A solar eclipse occurs somewhere on the earth whenever the circle C overlaps the sun's disk S. The circle C encloses all positions of the moon seen from anywhere on the earth at a given moment

(B) A lunar eclipse occurs when the crosscut U of the earth's shadow overlaps the moon's disk M



NOTE: The hours of beginning and ending are expressed in Universal Time or Greenwich Civil Time

FIG. 8.—MAP SHOWING THE SOLAR ECLIPSE OF NOV. 1, 1948

Within the narrow double line a total eclipse is observed; in the large area outlined the eclipse is partial. Reproduced from the American Ephemeris and Nautical Almanac by permission of the Nautical Almanac Office, U.S. Naval Observatory

maps for the more important eclipses as well as data for accurate calculation of the times of contact at any observing station.

It is possible with the aid of modern tables to predict solar eclipses several years ahead with an accuracy of a few seconds. For predictions of longer range the main uncertainty is that of the moon's motion. Eclipses can, of course, be "predicted backward" as well as forward, and the calculation of ancient eclipses has been of value in historical research. (R. J. Tr.)

INFORMATION YIELDED BY SOLAR ECLIPSES

Partial solar eclipses give little information of astrophysical interest. Total eclipses, however, contribute much knowledge concerning the nature of the sun's external layers, regions that are usually lost in the brilliant sky glare from the sun's shining surface. At total eclipse, the disk of the moon acts as a screen outside the earth's atmosphere, cutting off the direct rays from the photosphere, as the bright solar surface is known. The brilliance of the sky is thus enormously decreased and the fainter appendages of the sun become visible. The astrophysical value of eclipse observation, however, may be said to be decreasing, as a result of the invention of such instruments as the coronagraph (*see* below), even though there are still some problems that can be solved only at eclipse. Observations can be secured every clear day with the coronagraph, whereas eclipses are relatively rare phenomena, usually occurring in distant locations and lasting for only a few minutes.

Chromosphere.—The chromosphere (*q.v.*), the sun's atmosphere, extends upward from the photospheric surface, growing more and more rarefied with increasing height. The chromosphere has no well-defined upper boundary, but it has been traced to a height of about 10,000 mi. above the surface. It is filamentary in structure, being composed of myriads of streamers of luminous gas projected from the solar surface. An individual small streamer, or spicule, is very short lived; from its beginning as a bright eruption on the surface until its fading out as a thin, faint, ribbonlike spurt is a period of only 10 or 15 minutes.

The sun's atmosphere thus in no way resembles that of the earth. Not only is the structure of the chromosphere nonuniform but the temperature is extremely high. Elements such as iron, calcium or aluminum, which are solids on the earth, are completely vaporized on the sun and appear as important constituents of its gaseous envelope. Determination of the chemical composition of the atmosphere and of the temperatures and pressures obtaining there is best done from spectroscopic observations made at the time of total eclipse. (*See* SPECTROSCOPY; SPECTROSCOPY, ASTRONOMICAL.) Each individual chemical substance—element or compound—when vaporized and heated to incandescence, sends out its own characteristic radiations. Thus, when the spectrum of some unknown substance is matched with the radiations from known substances, the chemical composition of the sample can be determined. The relative intensities of the lines of a given element give further information concerning temperatures and pressures in the luminous material.

The ordinary spectrum of the sun contains a brilliant background of all colours—a so-called continuous spectrum. This radiation emanates from the lower levels of the solar atmosphere, where the pressure of atoms and electrons is high enough to inhibit the previously mentioned characteristic radiations. The atoms in the upper levels, however, absorb these radiations, so that the solar spectrum consists of the bright rainbow background, with many fine gaps where the light has been absorbed. These gaps appear as dark lines—absorption lines—on the bright background.

At the moment of totality, when the moon obliterates the last trace of the bright photosphere, with its dark-line spectrum, the upper, rarer layers of the atmosphere flash into view with the characteristic bright-line spectrum of a luminous gas. This spectrum disappears within four or five seconds, as the moon moves over the sun, and a second flash occurs at the end of totality. Because of its evanescent character, it has been called the "flash spectrum."

Analysis of flash spectra has led to some surprising results. The spectrum matches the dark-line spectrum only roughly. The lines of the neutral metals are of comparable strength in the two spectra, but those of the ionized metals (*i.e.*, atoms that have lost one electron) are markedly enhanced in the flash spectrum. The difference is attributed, in part, to lower pressures in the upper layers, but elevated temperature appears to contribute to the increased excitation. Especially is this true for the flash lines of ionized helium, which do not appear at all in the ordinary dark-line spectrum. These require excitation temperatures of at least 25,000° K. for their production, whereas the temperature required to produce the observed quality and quantity of bright emission from the surface is only 6,000° K.

Prominences.—Extending upward from the chromosphere, and probably closely related to it, are the so-called prominences, one of the striking features of a total eclipse, which project outward into space, sometimes as far as several hundred thousand miles. They appear as rose-coloured patches of flame, projecting well beyond the limb of the moon. Despite their resemblance to fire, prominences cannot be referred to as flames. They consist of long interlacing filaments of incandescent gas. Their rosy colour arises from the predominant gaseous radiations, the red of hydrogen and the violet of ionized calcium. Prominences appear to have a temperature slightly in excess of that associated with the chromosphere.

The spectroheliograph (*q.v.*) enabled astronomers to record the prominences outside eclipse. Indeed, something of their form and structure is disclosed by an ordinary spectrograph, with the slit wide open. A special spectroheliograph, built at the McMath-Hulbert observatory, with motion-picture recording, was the first instrument to depict graphically the spectacular motions exhibited by some of the prominences. The objects often hang for days, suspended like clouds above the solar surface. Their internal motions are extremely complicated; a characteristic effect is the downward streaming of the filaments, which descend to the surface in long graceful arcs. Occasionally the great clouds erupt with violent explosions and rapid motions. Velocities in excess of 100 miles per second are not uncommon.

Corona.—During totality there appears one of the most beautiful of natural phenomena, the so-called solar corona, which shines like finely etched white frost against the deep blue of the eclipse-darkened sky (*see* CORONA). The form of the corona presented at different eclipses is almost infinitely variable. On occasion, usually near sunspot minimum, long streamers extend four or five solar diameters away from the sun. At other appearances, especially close to maximum, the corona is more nearly circular, but with jagged, flowerlike petals. The corona is faint, 500,000 times or so less brilliant than the sun itself. Consequently the ordinary sky glare surrounding the sun hides the faint coronal glare, and before the development of the coronagraph it was believed to be impossible to record the corona except at the time of eclipse. The coronagraph produces in effect an artificial eclipse of the sun inside the instrument, and under conditions of very clear sky, usually attainable only at high altitudes, makes it possible to record the corona with some degree of regularity.

The corona presents many interesting problems. The greatest mystery of all—the nature of its composition—was solved by B. Edlén. The spectroscope had revealed numerous lines, radiations that could not be matched with those from any known terrestrial element. For years astronomers theorized about "coronium," a supposedly new element existing on the sun. There was precedent for such a hypothesis. Helium had been discovered in the corona during the eclipse of 1868, and it was not isolated on earth until 27 years later. But as chemists filled in gap after gap in the periodic table of the elements, hope faded of finding coronium as a new substance.

A somewhat similar mystery, that of the bright emissions from gaseous nebulae, was meanwhile solved by I. S. Bowen, who showed that the lines were due to "forbidden" atomic transitions. In other words, they arose from changes within the atom that were contrary to rules for normal lines. Under laboratory conditions these forbidden lines are extremely faint. Under conditions of low density and special excitation, however, the normal radiations can be almost completely suppressed and the forbidden lines will then appear. Indeed, both nebular lines and coronal lines have been observed in the spectra of two variable stars of the recurrent nova class.

The coronal lines were also proved to result from forbidden transitions. But where the nebular atoms have lost but from two to four electrons, those responsible for the coronal radiations have had as many as 13 torn away. The substances identified are iron *X* (*i.e.*, iron with nine electrons missing), *XI*, *XIII* and *XIV*. Similar emissions from calcium and nickel also appear.

The import of this discovery is staggering. Reference has already been made to the high excitation of the chromosphere and prominences, which led to estimates of temperature as great as 25,000° K. This figure is in itself enormous compared with the 6,000° K. value usually ascribed to the solar surface. But 25,000°, in turn, is insignificant compared with the minimum figure of 500,000° required for the observed ionization of the coronal atoms. Some estimates have been higher than 1,000,000°.

These high temperatures are caused by the impact of gases explosively ejected from the sun, especially in the vicinity of active sunspot groups. The energy of the shock waves degrades into heat in the corona.

There is a further implication from this knowledge of the solar atmosphere. It can no longer be assumed that the solar radiation has a quality similar to that of a black body heated to 6,000° K. There must be in addition quantities of radiation in the far ultraviolet and even in the region of soft X-rays, far in excess of that from an incandescent globe at 6,000°. These short-wave radiations must enter the earth's upper atmosphere, where they produce the ionosphere, a high layer of electricity that makes possible long-distance radio transmissions. But the atmosphere so completely absorbs these wave lengths that none of the energy reaches the surface. Existence of the radiation is revealed only from study of flash and coronal spectra and from evaluation of the effects in the earth's atmosphere. Variability of the earth's magnetic field is an associated phenomenon. So, also, is the aurora, produced by streams of corpuscular radiation interacting with and penetrating the earth's magnetic field. The earth's upper atmosphere glows under the effect of an electric discharge. The continuity provided by coronagraphic observations shows that the corona is not uniform in brilliance around the sun and that it rotates with the solar surface. The corona shows many bizarre pulsating forms, clearly associated with the presence of magnetic fields and electric currents in its boundaries.

Deflection of Light by a Gravitational Field.—One of the most famous, and the first, of the tests of Einstein's theory of relativity was that of observing the bending of a ray of light passing close to the sun. During a total eclipse the brighter stars are visible to the naked eye, and many more can be photographed near the sun. Einstein's theory predicts that the stars near the sun should be found not in their true places but displaced away from the sun by a small but measurable amount varying inversely as the distance from the centre of the sun. This test was first carried out in 1919 and has been repeated since with results on the whole in favour of the theory.

Baily's Beads.—Totality does not begin or end quite suddenly, as it should if the sun and moon were of perfectly smooth outline. There exists for a moment or two a crescent of minute gleaming points of light, called Baily's Beads. These are due to the irregular outline of the moon (*i.e.*, its mountains and valleys), because of which the sun is left uncovered here and there for a moment after the disk representing the size of the moon, if smoothed out, would have covered it.

Shadow Bands.—When totality is nearly due and only a small crescent of the sun remains, there can often be seen on the ground or on the walls of buildings striations of light and shade, indefinite in outline but something like a sheet of corrugated iron, moving moderately rapidly perpendicular to their length. These, termed the shadow bands, are due to corrugations introduced into the nearly plane waves of light reaching the earth from the sun through irregularities in the refraction of the earth's atmosphere. They are of no great scientific import. (D. H. M.)

ECLIPSES IN HISTORY

In ancient times eclipses were regarded as portents; hence it is not surprising that many eclipses are mentioned in history and in literature, in addition to those which are recorded in astronomical treatises or on astronomical tablets.

The value of these records may be classified as follows: (1) literary and historical, depending on the interest which they aroused, the notice taken of them and their connection with events; (2) chronological, insofar as they make it possible by computing their dates to verify chronological systems resting on other evidence and to supply dates for events connected with the eclipses; (3) astronomical, including the determination by ancient astronomers of the periods and motions of the sun and moon, and by modern astronomers of the mean rate of change of those motions.

Literary and Historical References.—*Chinese.*—In the *Shu Ching* or *Book of History* it is stated that Hsi and Ho (semidivine figures sent by the legendary emperor Yao to the four corners of the earth to keep the sun on its course and to prevent eclipses) had neglected the duties of their office and were abandoned to drink in their private cities. The king, Chung K'ang, placed the marquis of Yin in command of an army with instructions to punish them. The marquis issued a florid address to his troops in which he referred to Hsi and Ho as having neither heard nor known anything

on a recent occasion when "the sun and moon did not meet harmoniously in Fang." This phrase is taken by all Chinese scholars, ancient and modern, to mean an eclipse. It would therefore appear that a military expedition was sent to punish Hsi and Ho for failing to observe, or to prevent, an eclipse. There are good reasons for believing that this part of the *Shu Ching* is a literary restoration dating from the 4th century A.D., but sufficient is found in a quotation in the *Tso Chuan* (*Tso Commentary* compiled between 430 and 250 B.C.) and in statements in the *Bamboo Annals* to prove that the reference to the eclipse is authentic, though its relation to the supposed offense of Hsi and Ho is doubtful. It is probably based on a comminatory ritual directed against these neglectful magicians. Attempts have been made to identify this eclipse, but the necessary data are wanting. The received Chinese chronology places the accession of Chung K'ang in 2159 B.C. The *Bamboo Annals*, whose chronology is probably nearer to the truth, place it in 1952 B.C. The *Shih Ching*, or *Book of Poetry*, contains a lamentation caused by an eclipse of the moon, followed by an eclipse of the sun. The dates are clearly defined and are found to agree with events in 734 B.C. The earliest eclipses that have been definitely identified are (for the moon) that of 1361 B.C. and (for the sun) that of 1217 B.C., both derived from inscriptions on ancient oracle bones. The eclipses recorded in the *Ch'un Ch'iu* or *Spring and Autumn Annals* possess chronological and astronomical rather than literary interest.

Assyrian.—The Assyrian eponym canon, which preserves the names of the annual magistrates who gave their names to the years, records under the year which corresponds to 763–762 B.C.: "Insurrection in the city of Assur. In the month Sivan the sun was eclipsed." The reference must be to the eclipse of the sun on June 15, 763 B.C. A reference to the same eclipse has been found in the Bible: " 'And on that day,' says the Lord God, 'I will make the sun go down at noon, and darken the earth in broad daylight' " (Amos viii, 9).

Greek.—Homer, in the *Odyssey*, twice makes the unrecognized Odysseus predict that Odysseus will return "as the old moon wanes, and the new appears," that is, at new moon, when alone an eclipse of the sun is possible. In one of these passages he predicts vengeance on his wife's suitors. On the day when Odysseus was to become known and slay the suitors, the seer Theoclymenus notes among other portents of gloom that "the sun has perished out of heaven, and an evil mist has spread over all." This was interpreted by Plutarch and Eustathius as a total eclipse of the sun. Some modern scholars have regarded it as merely a vision of the seer. An identification with the solar eclipse of April 16, 1178 B.C., which was total in or near Ithaca, has been suggested. But it is not improbable that this story belongs to legend rather than to history.

In a fragment of a lost poem by Archilochus occur the words: "Nothing there is beyond hope, nothing that can be sworn impossible, nothing wonderful, since Zeus, father of the Olympians, made night from mid-day, hiding the light of the shining sun, and sore fear came upon men." This phenomenon has been identified as the total eclipse of the sun on April 6, 648 B.C.

Small fragments survive of other poetic descriptions of eclipses, and the ninth paean of Pindar, addressed to the Thebans, takes an eclipse of the sun as its theme, as follows: "Beam of the sun! O thou that seest afar, what wilt thou be devising? O mother of mine eyes! O star supreme, reft from us in the daytime! Why has thou perplexed the power of man and the way of wisdom, by rushing forth on a darksome track?" Pindar then proceeds to speculate on the meaning of the eclipse as a portent. The poem probably refers to the solar eclipse of April 30, 463 B.C., which was nearly total at Thebes.

The most famous of ancient eclipses was a total eclipse of the sun which happened, according to Herodotus, during a battle between the Lydians and the Medes. The portent induced them to conclude peace. Herodotus further says that Thales of Miletus predicted this eclipse to the Ionians for the very year in which it happened. Babylonians were certainly predicting eclipses at about that time by means of the 18 years' cycle known as the saros (*see* below). But, as that cycle gives eclipses for every year, the statement about Thales must, if true, mean that he predicted that an eclipse of that particular year would attain a great magnitude. Such a prediction can be made by the 18 years' cycle without any mathematical computation. The eclipse was certainly that of May 28, 585 B.C., and must have been predicted by means of the eclipse of May 18, 603 B.C. Several ancient writers have preserved 585 B.C. or some neighbouring year as the date of the eclipse.

Thucydides comments on the frequency of eclipses during the Peloponnesian war. The most interesting of these were the solar eclipse of Aug. 3, 431 B.C., when "the sun assumed the shape of a crescent and became full again, and during the eclipse some stars became visible" (a statement that agrees well with modern computation) and the lunar eclipse of Aug. 27, 413 B.C. That date had been selected by the Athenian commanders Nicias and Demosthenes for the departure of their armament from Syracuse. All preparations were ready, but the signal had not been given when the moon was eclipsed. The soldiers and sailors clamoured against departure and Nicias in obedience to the soothsayers resolved to remain thrice nine days. This delay enabled the Syracusans to capture or destroy the whole of the Athenian fleet and army.

Aug. 15, 310 B.C., is the date of a total eclipse of the sun said to have been seen by Agathocles and his men the day after he had sailed from Syracuse on his way to Africa. Modern computations of the eclipse track render it probable that he sailed to the north of Sicily.

In Plutarch's dialogue *De facie in orbe lunae* ("the face on the moon's orb"), one of the characters, called Lucius, deduces from the phases of the moon and the phenomena of eclipses a similarity between the earth and the moon and illustrates his argument by means of a recent eclipse of the sun, "which, beginning just after noon, showed us plainly many stars in all parts of the heavens, and produced a chill in the temperature like that of twilight." A little further on Lucius refers to a certain brightness which appears round the moon's rim in total eclipses of the sun. The identification of this eclipse with that of March 20, A.D. 71, was confirmed by F. K. Ginzel after a very exhaustive discussion. There are numerous other references to eclipses in Greek literature.

Roman.—A large number of eclipses were recorded in Roman history. One which has attracted the attention of students of astronomy and of the Roman calendar alike is stated by Cicero to have occurred in what may have been the 350th year from the foundation of Rome. He also says that it was described by the poet Ennius: "On the Nones of June the sun was covered by the moon and night." This would appear to have been the solar eclipse of June 21, 400 B.C., which reached a total or almost total phase at Rome a few minutes after sunset. It seems to show that in that year the calendar month of June began 16 days later than it did after the Julian reform. The eclipse of the moon on June 21–22, 168 B.C., has attracted much attention. The Romans were at that time at war with Macedonia, and Polybius says that this eclipse was interpreted as an omen of the eclipse of a king and thus encouraged the Romans and discouraged the Macedonians.

Use of Eclipses for Chronological Purposes.—Although no continuous era has been used since ancient times, dates are frequently expressed in terms of regnal years, or are named after consuls or other officials of whom lists have been preserved. In these cases it is important to be able to equate certain specific years thus defined with years before the Christian era. This can be done whenever the date of an eclipse or other identifiable and calculable astronomical phenomenon is given in an ancient record.

The received Chinese chronology can be confirmed accurately by eclipses from the Shang dynasty (*c.* 1766–*c.* 1123 B.C.) onward. The chronology of Ptolemy's canon of kings, which gives the Babylonian series from 747 to 539 B.C., the Persian series from 538 to 324 B.C., the Alexandrian series from 323 to 30 B.C. and the Roman series from 30 B.C. onward, is confirmed throughout by eclipses. The eclipse of 763 B.C., recorded in the eponym canon, makes it possible to carry the chronology back with certainty through the period covered by that canon to 893 B.C. Assyrian, Babylonian and Persian chronology provide a stable chronology for the countries with which Assyria, Babylon and Persia came into contact, but there is no check from eclipses on Greek or Egyptian historical chronology before the Persian period. Identifiable eclipses re-

corded under named Roman consuls extend back to 217 B.C. The dated solar eclipse of Ennius, the lunar eclipse seen at Pydna in Macedonia on June 21–22, 168 B.C. and an eclipse of 190 B.C. can be used to determine the position of Roman calendar months in the natural year; and occasionally eclipses help to fix the precise dates of a series of events, such as those connected with the Athenian disaster at Syracuse.

Use of Eclipses for Astronomical Purposes.—*In Ancient Astronomy.*—It would appear that at least from the time of King Nabonassar (747 B.C.) a dated canon of astronomical observations was preserved at Babylon, including all eclipses. This rendered it possible to determine accurately the intervals between eclipses and must have facilitated the discovery of the 18 years' cycle (more exactly the cycle of 6,585⅓ days, which the 10th-century Greek lexicographer Suidas calls the saros) and its multiple, the 54 years' cycle of 19,756 days. These two cycles govern the recurrence of eclipses. It has been seen that Thales probably used such a cycle. In a Babylonian observation tablet of 568 B.C. mention is made of failure to observe a predicted eclipse of the moon, which is found by computation to have been real but invisible at Babylon. It was doubtless predicted by cycle. Tables based on the saros go back to the 4th century B.C. Eclipses of the moon give more accurately than any other kind of observation the actual time when sun and moon are in opposition. From an early date the Babylonian astronomers must have deduced from them not only the mean interval between two conjunctions but also the principal inequality in the motion of the moon and the similar inequality in the motion of the earth (or, as on their geocentric theory they conceived it, of the sun) and they were able to define the periods of these inequalities, which astronomers call the anomalistic month and year.

In the same way, since eclipses happen only when the two luminaries are stationed at intersections of their orbital planes called nodes, and since the path of the shadow in a lunar eclipse depends on the position of the centre of the sun in relation to the node, the Babylonians were also able to determine the position and motion of the nodes. By assuming, what is approximately true, that the saros of 6,585⅓ days contained an exact number (1) of synodic months, or revolutions of the moon measured from the sun, (2) of anomalistic months, or revolutions of the moon measured from its apogee or perigee (*i.e.*, from its farthest distance from and closest approach to the earth), and (3) of draconic months, or revolutions of the moon measured from its node, the early astronomers, perhaps in the 6th century B.C., computed the relative motions of the sun and moon, the lunar perigee and apogee and the nodes. About 500 B.C. Naburiannu, apparently from a more accurate study of eclipse observations, obtained improved values which for the motion of the moon from the sun were 10″ per annum too small, from the moon's perigee 20″ per annum too great and from its node 5″ too small. Still more accurate values were obtained by Kidinnu about 383 B.C., from whom they passed to the Greek astronomer Hipparchus. In the system of Naburiannu the distance of the moon from its node was used for the prediction of the magnitude of lunar eclipses.

In Modern Astronomy.—Ancient eclipses are of the highest value for the determination of "secular accelerations," *i.e.*, for the determination of the progressive, as distinct from the periodic, changes in celestial motions. Edmund Halley asserted in 1693 his belief that the moon's motion was subject to acceleration, but did not specify the amount of the acceleration. In 1749 Richard Dunthorne demonstrated from a comparison of the recorded with the computed times of eclipses distributed over 2,000 years that such an acceleration existed and assigned to it the value of 10″ a century. By this is meant that the effect of the acceleration is to produce an advance of 10″ in the moon's longitude in the course of a century. P. S. Laplace in 1787 showed that such an acceleration should be the gravitational effect of the secular diminution in the eccentricity of the earth's orbit; but according to J. C. Adams in 1853 the acceleration due to this cause amounted to 6″ only in a century. The residue must be explained by other causes.

This acceleration is mainly due to tidal friction, which has two consequences: (1) the earth's rotation is slowed down by the pull of the moon on the oceans at a rate that has averaged some 2″ per century per century since ancient times; *i.e.*, the total angle turned

*Solar Eclipses During the 20th Century**

Date of eclipse at noon point	Duration of totality (minutes)	Node and series	Regions crossed by belt of totality
1900 May 28	2.1	D 5	Mexico, S.E. United States, Portugal, Spain, N. Africa
1901 May 18	6.5	D 6	Sumatra, Borneo, New Guinea
1904 Sept. 9	6.4	A 7	S. Pacific ocean
1905 Aug. 30	3.8	A 8	Canada, Atlantic ocean, Spain, N. Africa, Arabia
1907 Jan. 14	2.3	D 9	S.E. Russia, central Asia, Mongolia
1908 Jan. 3	4.2	D 10	Pacific ocean
1911 April 28	5.0	A 1	Australia, Polynesia
1912 Oct. 10	1.8	D 2	Colombia, Ecuador, Brazil, S. Atlantic ocean
1914 Aug. 21	2.1	D 3	Greenland, Scandinavia, Russia, Asia Minor, Iran
1916 Feb. 3	2.5	A 4	Pacific ocean, Colombia, Venezuela, West Indies, Atlantic ocean
1918 June 8	2.4	D 5	N. Pacific ocean, British Columbia, United States (line from Washington state to Florida)
1919 May 29	6.9	D 6	Peru, Brazil, Atlantic ocean, central Africa, Mozambique
1922 Sept. 21	6.1	A 7	Somaliland, Indian ocean, Australia
1923 Sept. 10	3.6	A 8	California, Mexico
1925 Jan. 24	2.4	D 9	Great Lakes region, New York state, New England, N. Atlantic ocean
1926 Jan. 14	4.2	D 10	E. Africa, Sumatra, Philippine Islands
1927 June 29	0.7	A 11	England, Scotland, Scandinavia, Arctic, N.E. Siberia
1929 May 9	5.1	A 1	Sumatra, Malaya, Philippine Islands
1930 Oct. 21	1.9	D 2	Pacific ocean, Chile
1932 Aug. 31	1.5	D 3	Canada, New England
1934 Feb. 14	2.7	A 4	Borneo, Celebes, Caroline Islands
1936 June 19	2.5	D 5	Greece to central Asia and Japan
1937 June 8	7.1	D 6	Pacific ocean, Peru
1940 Oct. 1	5.7	A 7	Colombia, Brazil, S. Atlantic ocean, S. Africa
1941 Sept. 21	3.3	A 8	Central Asia, China, Pacific ocean
1943 Feb. 4	2.5	D 9	China, Pacific ocean, Alaska
1944 Jan. 25	4.1	D 10	Peru, Brazil, Atlantic ocean, Guinea, Sierra Leone, Upper Volta
1945 July 9	1.1	A 11	Idaho, Canada, Greenland, Scandinavia, N. Russia, S. Siberia
1947 May 20	5.2	A 1	Argentina, Paraguay, Brazil, Atlantic ocean, central Africa
1948 Nov. 1	1.9	D 2	Kenya, Indian ocean
1952 Feb. 25	3.0	A 4	Congo, Sudan, Arabia, Iran, Siberia
1954 June 30	2.5	D 5	United States (Great Lakes), Canada, Scandinavia, Baltic states, White Russia, Ukraine, Iran, Afghanistan
1955 June 20	7.2	D 6	Ceylon, Thailand, Philippine Islands
1958 Oct. 12	5.2	A 7	Pacific ocean, Chile, Argeotina
1959 Oct. 2	3.0	A 8	Canary Islands, Sahara, central Africa
1961 Feb. 15	2.6	D 9	France, Italy, Yugoslavia, Rumania, Bulgaria, Crimea, Siberia
1962 Feb. 5	4.1	D 10	New Guinea, Pacific ocean
1963 July 20	1.7	A 11	Japan, Alaska, Canada, Maine
1965 May 30	5.3	A 1	New Zealand, Pacific ocean, Peru
1966 Nov. 12	1.9	D 2	Pacific ocean, Peru, Bolivia, Argentina, Brazil, S. Atlantic ocean
1970 March 7	3.3	A 4	Mexico, Florida, Atlantic ocean
1972 July 10	2.7	D 5	N.E. Siberia, Alaska, Labrador, Atlantic ocean
1973 June 30	7.2	D 6	British Guiana, Atlantic ocean, Sahara, Sudan, Ethiopia, Somaliland
1974 June 20	5.3	D 12	Indian ocean, S.W. Australia
1976 Oct. 23	4.9	A 7	Tanganyika, Indian ocean, Australia, Pacific ocean
1977 Oct. 12	2.8	A 8	Pacific ocean, Venezuela
1979 Feb. 26	2.7	D 9	N.W. United States, Canada, Greenland
1980 Feb. 16	4.3	D 10	Atlantic ocean, equatorial Africa, Indian ocean, India
1981 July 31	2.2	A 11	Siberia, Sakhalin, Pacific ocean
1983 June 11	5.4	A 1	Java, New Guinea, Pacific ocean
1984 Nov. 22	2.1	D 2	New Guinea, Pacific ocean, Chile, Argentina
1987 March 29	0.3	A 13	Atlantic ocean, equatorial Africa
1988 March 18	4.0	A 4	Indian ocean, Sumatra, Philippine Islands, Pacific ocean
1990 July 22	2.6	D 5	Finland, E. Arctic, N. Pacific ocean
1991 July 11	7.1	D 6	Pacific ocean, Hawaii, Central America, Brazil
1992 June 30	5.4	D 12	S. Atlantic ocean
1994 Nov. 3	4.6	A 7	Pacific ocean, Chile, Argentina, Paraguay, Brazil
1995 Oct. 24	2.4	A 8	Iran, India, S.E. Asia, Pacific ocean
1997 March 9	2.8	D 9	N.E. Asia, Arctic
1998 Feb. 26	4.4	D 10	Pacific ocean, Central America, Atlantic ocean
1999 Aug. 11	2.6	A 11	Central and S.E. Europe, touching England; central Asia, India

*Those eclipses that are visible only in polar regions or are of exceedingly short duration are omitted.

through every century has decreased by an average of 2″ every century, so that the day increases in length; (2) the orbital angular momentum of the moon is increased, pushing the moon farther away from the earth and thus lengthening the lunar month. The first effect would by itself lead to an apparent acceleration in the moon's motion of about 26″ per century per century; the acceleration actually observed is only 5.2″ per century per century because the second effect counteracts the first.

See also references under "Eclipse" in the Index volume.

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ECLIPTIC, in astronomy, is the great circle on the celestial sphere which forms the apparent path of the sun in the course of the year. The twelve constellations or signs of the zodiac are arranged along the ecliptic. The plane of the ecliptic is the plane of the earth's orbit, or more strictly the plane in which the combined centre of gravity of the earth and moon revolves around the sun; it meets the celestial sphere in the great circle mentioned above.

ECLOGITE, a typical member of a small group of garnet rocks including both igneous and metamorphic representatives, and of special interest because of the variety of minerals they contain and their geological relationships. Under the name griquaite, eclogites are found as blocks or boulders in the kimberlite "pipes" of the diamond fields of South Africa (*see* DIAMOND). This eclogite is of special interest inasmuch as diamonds have been found as enclosures of the garnet of the rock, and according to one view eclogite is the parent rock of the diamonds of the South African fields, the diamonds of the "pipes" being derived from the explosive disruption of deep-seated masses of diamantiferous griquaite or eclogite.

The eclogites (from the Greek word *ekloge,* "a selection") are mostly coarse-grained and massive aggregates of green monoclinic pyroxene and red garnet, but some varieties possess green hornblende wholly or partly replacing the pyroxene, thus giving rise to the two important groups—the pyroxene and the hornblende eclogites. The minerals associated with these essential constituents include rutile, apatite and iron ores, and, less commonly, quartz, muscovite, zoisite, cyanite, albite, bronzite, olivine and chlorite. The eclogites correspond closely in bulk composition with gabbro and diabase (*qq.v.*), but are characteristically assemblages with high density (specific gravity 3.2 to 3.6 as compared with gabbro 2.9 to 3.0).

The pyroxene (*q.v.*) in eclogite shows considerable variation in composition, and includes both nonaluminous and aluminous varieties. The latter contain significant proportions of the jadeite and aegirine molecules and correspond to omphacite, a green variety of diopside. The red garnet (*q.v.*) is a pyrope-rich variety containing almandine and grossular, but is not so magnesia-rich as the garnet found in serpentines and peridotites. The hornblende (*see* AMPHIBOLE) is usually a green variety—smaragdite, or alkali-hornblende sometimes approaching glaucophane in composition.

Whether of metamorphic origin or considered as igneous rocks consolidating under excessive pressures, the almost complete absence of plagioclase feldspar makes these rocks of peculiar interest. The omphacite-garnet assemblages appear to have crystallized under high pressures, in place of augite, olivine and plagioclase. Magnesian garnet appears in place of olivine-anorthite, and a jadeite-chloromelanite-bearing pyroxene in place of the augite-plagioclase combination of the gabbros.

That some eclogites are of metamorphic origin is clearly revealed by their geological associations and microscopic structures. Such often appear as lenses intercalated among crystalline schists and show unmistakable crystalloblastic structures, that is, resulting from solid state crystallization.

Others, such as those of western Norway, occur as lenticular masses in granite gneiss or bands in olivine rocks (peridotites, dunites or their serpentine derivatives). These rocks possess no true crystalloblastic structure, and are believed to be unaltered igneous rocks. Probably some eclogites from other areas previously believed to be transmuted gabbros are of similar origin.

The amphiboles of the eclogites may represent either a direct crystallization from the magma, or arise by metamorphic processes from original pyroxene, and it is not improbable that many of the so-called "garnet-amphibolites" are transformed eclogites. The recognition of eclogites as primary magmatic consolidations under high pressures has led to the conception of an eclogite zone in the earth's crust immediately below the more acid silicate shell (*see* GEOCHEMISTRY: *Geochemical Structure of the Earth*). At considerable depth magma of basaltic or gabbroid composition may exist stable as solid eclogite, and it is possible that in this zone is to be discovered the source of the eclogite blocks of the kimberlite "pipes." The geological associations of some eclogites appear not to accord with the prevailing conception of the group as a high-pressure mineral facies. In a seemingly anomalous environment are certain eclogites and, indeed, the mineral jadeite itself, found in intimate association with low-grade metamorphic schists or serpentines, in France, California and the Celebes. Though some of these associations may be the result of tectonic transport, that is, movement of the earth's crust, there remain occurrences to which such an interpretation is inapplicable. The chief localities for eclogites are Pre-Cambrian and Paleozoic metamorphic-igneous complexes. They are known from Scotland, western Norway, Saxony, Bavaria, the Alps, Austria, Greece and California. (C. E. T.)

ECLOGUE, a pastoral poem usually in dialogue but perhaps originally signifying no more than a short poem (Gr. *ekloge,* selection). The term was originally applied specifically to pastoral dialogues and was equipped at the Renaissance with various fanciful etymologies, notably "goat-speech" (Gr. *aix,* goat; *logos,* speech), which accounts for the frequent English spellings "eglog" or "aeglogue" and the French *"églogue."* The form, widely used during the Renaissance by neo-Latin and vernacular poets, later became increasingly rarer. There are eclogues in English in Spenser's *Shepheardes Calendar* (1579) and Collins' *Persian Eclogues* (1742) and four in Louis MacNeice's *Collected Poems 1925–1948* (1949).

See BUCOLICS; PASTORAL. (J. F. KE.)

ECOLOGY, ANIMAL, is concerned with the interrelations between animals and their environments. It is a subdivision of the science of ecology, or that branch of biology that embraces the interrelations between plants and animals and their complete environments. Ecology is a basic approach to the conservation of natural resources and—together with several other biological sciences, such as biochemistry, genetics, cytology and general physiology—cuts across the sciences of zoology and botany, that is, ecology is concerned frequently with general principles that apply to both animals and plants.

This survey is divided into the following sections:

I. General
  1. Introduction
  2. History
II. Basic Requirements of Animals
  1. Food
  2. Shelter
  3. Habitats
  4. Reproduction
III. Principle of Community
  1. Major Community
  2. Stratification
  3. Community Metabolism
  4. Food Web
  5. Pyramid of Numbers
  6. Trophic Levels
  7. Biomass
  8. Productivity
  9. Periodicity

IV. Principle of Succession
1. Physiographic Succession
2. Biotic Succession
3. Sequence of Community Changes
V. Principle of Convergence
VI. Biomes
A. Terrestrial
1. Extension
2. General Characteristics
B. Marine
1. Aquatic Organisms
2. Layers of the Sea

I. GENERAL

1. Introduction.—The content of ecology may be divided in several ways. First, where attention is directed to the type of environment, ecology is divisible into terrestrial interrelations (terrecology), fresh-water interrelations (biological content of limnology) and marine interrelations (biological content of oceanography). Second, where emphasis is upon plants or animals, we speak of plant or animal ecology. Third, where the point of departure deals with the level of the complexity of interrelations, we have to do with autecology, or the interrelations of the individual plant or animal with its physical and biotic environments, or with synecology, which is the study of progressively complex interrelations of natural assemblages of organisms, such as populations and communities.

These groups of ecological categories are seldom wholly separable. They are united both by the application of common principles and by natural intergradations between any two. For example, fresh-water marshes merge with grassland or forest; areas may be covered with a temporary pond at a particular season of the year; river mouth and the sea meet at the estuary. A complete understanding of an animal is impossible without considering its relationships with plants. Similarly, such an understanding is not possible without considering its interrelations with others of the same kind and with animals of different kinds. Consequently, the study of the entire natural assemblage of plants and animals and their environment is desirable in any complete investigation.

The technique of ecology is both experimental and descriptive. The science has many important interrelations with other branches of basic and applied knowledge. Several examples are notable.

In basic biology one problem is that of the origin and establishment of species. When a new species arises, its particular adjustments of structure, function and behaviour must be such that the population may live in a particular environment or series of environments. It must adjust both to the physical influences that are in operation and to biological factors already established. Under such conditions the new population may do one of three things: It may adjust to the total environment; it may emigrate to another environment; it may die. If the organisms adjust, this implies that they can compete or co-operate with other species for food and shelter. Consequently, the establishment of a species is the result of ecological selection of a particular heredity.

Interrelations between ecology and sociology were summarized by J. W. Bews (1935).

There are many ecological aspects of man's industrial and agricultural production. These include the relations of economic plants to soil types, diets of farm and range animals, pollution, overlumbering, overgrazing, overcultivation, dust storms, floods, forest fires and game conservation. Often a man-made catastrophe has its origin in the unconscious application of ecologically unsound practices. For additional information the summaries of P. B. Sears (1935) and I. N. Gabrielson (1941) may be consulted.

The importance of general conservation, whether of oil and coal or of timber, soil, migratory birds or whales, cannot be emphasized too much with reference to the future well-being of mankind. Plants and animals are interrelated in highly complex natural communities and they must be manipulated or replaced with scientific care. Here the application of ecological principles ranges from those involved in the stocking of a small lake to a national program of reforestation. Basic research and the training of personnel should precede attempts at conservation since the solution may require answers to a number of inconspicuous yet important questions. For example, the bighorn or Rocky Mountain sheep formerly ranged over high mountains from Arizona into British Columbia and Alberta but is now absent or present only in reduced numbers in many parts of that territory. Herd reduction may be a consequence of many adverse influences, including (1) shooting of bighorn by hunters; (2) insufficient forage plants; (3) inadequate range; (4) scarcity of water; (5) disease; (6) parasites; (7) competition for food with domestic cattle; (8) competition for food with other game such as mule deer; (9) predation by such hunters as the bobcat and puma.

It will be seen that ecology has many interrelations with other branches of learning and that its applications are inextricably involved with man's destiny. As information accumulates in regard to the requirements of species populations and community relations, such data become available to animal husbandry, agriculture, conservation and public health. The danger is that the information will not be available in an integrated form soon enough to ensure broad conservation of natural resources.

Solution of many problems in public health and medicine involve ecology. Thus, the effective control of a variety of diseases is achieved by control of the vector rather than by control of the disease-producing agent or pathogen. Such vectors include malarial mosquitoes, mosquitoes carrying the virus of yellow fever and jungle yellow fever, rats and rat fleas infected with plague bacteria, ticks and mites carrying pathogens responsible for such diseases as certain relapsing fevers, forms of typhus, and many more. Control of the carrier is an ecological problem since the program involves the interrelations of the vector with its environment.

2. History.—In this brief survey of animal ecology only a small portion of the science can be dealt with. Historically, the subject is old in that some of its material is derived from natural history dating to Aristotle. In modern terms ecology is of recent origin as an organized science. It was established at about the time that the science of genetics was recognized.

In the 18th and early part of the 19th centuries there was considerable fact and fancy in natural history. In 1869 Ernst Haeckel stated that the individual was a product of co-operation between the environment and organismal heredity. This relationship he termed "oecology."

Haeckelian "oecology" was more or less forgotten in the activity that resulted from publication of Charles Darwin's theory of natural selection in 1859. This was a strange turn of events, since Darwin's theory was primarily an ecological theory of evolution, stressing the environment as a selection agent over long periods of time. Ecology was placed on a modern basis, more or less, by F. A. Forel in Switzerland in 1892, E. B. Warming in Denmark in 1896 and by the Americans E. A. Birge, H. C. Cowles and F. E. Clements between 1891 and 1905.

Thereafter, research in ecological subjects tended to stress population and community analysis. Quantitative and statistical methods increased the scope of the science, and more interrelations became apparent between ecology and taxonomy, physiology, biochemistry and geography. Study of microclimate and microhabitat became increasingly important. There was a growing emphasis among ecologists to evaluate their data in terms of evolution and of conservation.

II. BASIC REQUIREMENTS OF ANIMALS

Organisms have three basic physiological requirements to meet if they are to live as individuals and perpetuate the species. These drives are nourishment, recuperation and reproduction. Their ecological counterparts are food, shelter and certain problems involving territory. The particular ways in which species satisfy these drives involve modification of structure, functions and behaviour that are known as adaptations or adjustments. The better adjusted the organism, the better its chances of living with other members of its species population and with members of other species populations. Consequently, there are recognized three general categories of adjustments: feeding, sheltering and reproductive.

1. Food.—Organisms must obtain nourishment to live; and since food must be obtained from the environment, it becomes a

fundamental ecological factor. Certain basic aspects of plant nourishment are discussed in the treatment of communities.

As a rule, the food types that make up the bulk of a species' diet are associated with definite feeding adjustments. The first feeding category is that of plant eaters, or herbivores, only a few examples of which can be mentioned here. Numerous insects, such as aphids, feed upon plant sap; and their mouth parts are in the form of a tubular, sucking beak. Other insects, including certain ants, have thick crushing jaws for cracking seeds. Although lizards as a group are meat eaters some species eat vegetation and have rounded and broadened teeth. Among mammals the domestic cow and horse, as well as the deer, have some teeth flattened for grinding their plant food.

The second feeding category is that of the carnivores, or flesh eaters. Within this group are two subdivisions. The first are the predators. These stalk their food, kill it by direct assault and then feed upon the victim. Their feeding adjustments are for overtaking and holding prey. Here may be mentioned the long, highly modified mouth parts that enable cychroid ground beetles to feed on certain snails while the latter are withdrawn into their shells; the sharp claws of cats; the recurved teeth of the black snake; and the protrusible tongue of the toad. The second group of carnivores contains the parasites. These differ from predators in that they feed on the flesh of their prey, the host, while it is vigorous and at liberty, whereas predators feed after their prey has been subdued and is dead or dying. It is to the biological advantage of parasites that the host is not killed, so that the parasite may continue to feed upon it. Here are numerous types of feeding adjustments, including ectoparasites and endoparasites, living on or within the host's body, respectively. An entire branch of biology, parasitology (*q.v.*), is concerned with these animals. Many parasites are adjusted to feed on a special kind of food. The blood diet is such a particular case, and feeders on blood are known as sanguinivores. Such animals generally have specialized saliva that is anticoagulant and anesthetic in its action. Common sanguinivores are fleas, the majority of female mosquitoes, bedbugs, leeches and ticks. Common endoparasites include the tapeworms and flukes.

Then there are the omnivores, feeding on a variety of both plants and animals. Man is an omnivore; his dentition enables him both to cut and grind his food. There are many aquatic omnivores. The majority of these feed on minute organisms in the water and consequently must be collected by specialized conveying and straining mechanisms. Whalebone whales, rotifers, sponges, numerous marine worms, clams, oysters and barnacles collect and devour minute, usually floating, often microscopic plants and animals (collectively called plankton) in the water. Obviously, within and between these three major feeding categories there are many differentiations and intergradations.

2. Shelter.—Turning to the second of the three basic organismal drives, it is found that continuous physiological activity leads to exhaustion and finally death. Therefore, animals must undergo physiological recuperation or rest. Frequently this is accomplished during sleep or its physiological equivalent. Such resting periods, during which an animal is characterized by relative inactivity and relatively slower responses to external stimuli, are dangerous since the individual is more exposed to attack from its natural enemies. Consequently the majority of animals undergo periodic rest in some protected or sheltered spot, such as the mud on the bottom of a pond, a hollow tree, beneath a log, in a subterranean burrow, beneath a leaf or deep within a flower. These "homes" are known as habitat niches. They are restricted portions of larger areas known as habitats.

3. Habitats.—Habitats may be classified as follows:

I. Habitats occupied by free-living organisms
  A. Salt water or marine (polar, temperate, tropical)
    1. Littoral or shore
      a. Rocky
      b. Sandy
      c. Muddy
    2. Pelagic or surface waters of seas
    3. Abyssal or deep sea
  B. Brackish water, such as an estuary
  C. Salt lakes, such as the Dead sea of Palestine and Great Salt lake of Utah
  D. Fresh water
    1. Standing water
      a. Marsh
      b. Bog
      c. Ponds and lakes (polar, temperate, tropical)
        (1) Paralimnic, or fresh-water littoral
        (2) Limnetic, or fresh-water "pelagic"
        (3) Profundal, or deep-water, and pedonic, or lake-bottom
    2. Flowing water
      a. Springs
        (1) Cold-water
        (2) Thermal, or hot-water
        (3) Chemical, such as sulfur springs
      b. Streams (including small brooklets and large rivers)
        (1) Rapids or waterfalls
        (2) Relatively quiet pools
  E. Terrestrial
    1. Epigean, or aboveground
      a. Flood plains
        (1) Gravel
        (2) Sand
        (3) Silt
      b. Grasslands
        (1) Tall grass
        (2) Short grass
      c. Forests
        (1) Deciduous
        (2) Evergreen
          (*a*) Tropical
          (*b*) Coniferous
      d. Desert
        (1) Sandy
        (2) Rocky
      e. Ice desert
    2. Hypogean, or subterranean, such as caves
II. Habitats occupied by parasites
  A. Ectoparasitic
  B. Endoparasitic

This general classification can be expanded almost indefinitely. For example, the societies of ants, termites and certain wasps and bees, and the towns and cities of man are habitats of a great array of plants and animals. Again, each category in the above list is subject to considerable variation with respect to latitude and altitude and to the differential action of numerous environmental influences. Obviously there are many intergradations between habitats. For example, grassland and desert intergrade in semidesert; a shore may consist of sandy mud; or a pond may be present only during the spring months.

A habitat may be occupied continuously by the same animals, termed permanent residents, or occupied at a particular period by animals known as temporary residents. Within an American elm and oak deciduous forest, chipmunks are permanent residents, whereas the migratory black and white warblers are temporary residents.

Many permanent residents undergo special periodic sheltering adjustments associated with dormancy. One of the adjustments associated with winter is termed hibernation (*q.v.*). It is accompanied by a relatively low temperature and physiologically inaccessible water in the form of snow and ice, and the habitat niche is termed a hibernaculum. One of the adjustments associated with summer is termed estivation. It is accompanied by a relatively high temperature and physically inaccessible water or drought, and the habitat niche is termed an estivaculum.

Hibernation and estivation are broad seasonal adjustments. There are many sheltering adjustments of a more limited nature. A familiar example is the periodic occupation of habitat niches for a part of each 24-hour cycle of day and night. Often the same niche is occupied by different populations at different times. Many nocturnal animals inhabit the carpet of decomposing leaves of a forest by day and feed on the living foliage of the trees during parts of the night; their ecological counterpart, the diurnal animals, are active by day and inactive during the night, and many of these pass their period of rest in the same layer of leaf mold.

It must also be remembered that often the several stages in the life cycle of an animal occupy a series of different habitat

niches and often a series of different habitats. For example, the common fresh-water clams have minute young known as glochidia; these, when discharged by the parent, have a brief period in the water of the stream or lake during which time they must become attached to fishes to live. If they can attach to a fish, they become parasitic for a time and are dispersed in this manner. Eventually, however, the further developed glochidia leave the host and settle to the bottom, where they continue their development and become free-living clams. Again, the familiar May flies, stone flies and dragonflies hatch from eggs laid in fresh water, lead herbivorous or carnivorous aquatic lives as naiads and then transform into aerial adult insects.

Members of a particular kind or species of animal tend to have common structural, functional and behavioural adjustments; consequently the population occupies a series of similar habitat niches throughout the range of the species. These niches may be identical, or ecologically equivalent, if the range is great or the species is tolerant of a variety of conditions and habitats. This ability to tolerate environmental variations is known as vagility. The puma, with a range from sea level to high elevations in mountain ranges, from Alaska to Patagonia, has a high vagility; sloths, restricted to certain kinds of tropical American forests, have low vagility.

The environment is constantly selecting the inherited adjustments of animals, and animals are constantly modifying their environment through feeding, burrowing, respiration, depositing their feces and excreta and eventually their bodies. Consequently, through long periods of time, populations evolve with better adjustments to existing conditions through natural selection, and the habitats and habitat niches change through the influence of physical and biological factors.

In this almost constant process of change, the species that inhabit the same habitat compete for food and shelter and often cooperate for these necessities. Such competitions and co-operations among populations are both direct and indirect, and their proper study is a vast subject (*see* POPULATION ECOLOGY). The sheltering adjustments that allow a species to inhabit several habitat niches over its life history is such a large subject that only a few examples can be given here.

In the first place, there are the broadest levels of adjustment to media: for example, aerial, aquatic and terrestrial adjustments for locomotion as well as respiration in air or water; more specialized adaptations for life in the relatively fresh waters of inland lakes and streams in contrast with a life in the salt water of oceans. Within these broad adjustments are progressively more specialized features that allow a species to occupy a particular habitat and even a particular portion of its habitat.

Stream animals illustrate this process. They are adjusted to the whole stream in a general way, but some species (fishes, May fly naiads) obtain their oxygen through gills, whereas others (dytiscid beetles) carry a supply of fresh air with them when they dive and periodically replenish this supply by returning to the surface. Furthermore, certain types of animals tend to inhabit quiet pools, where the current is relatively slow and the amount of dissolved oxygen relatively small, whereas others tend to inhabit rapids, where the current is swift and the dissolved oxygen abundant. Consequently, there are pool mores and rapids mores, indicating that such animals have a collective type of adjustment to a special portion of the stream.

Then there are still more special adjustments to a part of such a habitat. For example, there are adjustments to the surface film of the water. Water striders (Gerridae) skate over the surface on the finely haired tarsal segments of their legs. Certain species of the staphylinid beetle of the genus *Stenus* have an anal secretion that lowers the surface tension of the water; because of the greater tension of the film on which the anterior parts of the beetle rest the insect is pulled rapidly forward. Still others, such as the larvae and pupae of mosquitoes, lie just beneath the water surface; the contact of the film with certain parts of their bodies supports them without expenditure of muscular energy.

Since most aquatic animals are heavier than water, those animals that inhabit the upper layers rather than move over the bottom must hold their spatial position against the pull of gravity. Such buoyancy or flotation adjustments are very diverse. The swim bladder of many fishes aids in this maintenance of position. Many minute single-celled animals or Protozoa achieve buoyancy by the presence of oil globules in their protoplasms. Certain marine snails have egg masses that are kept afloat by a mucous pad that is infiltrated with air bubbles. One marine group of protozoans, the Radiolaria, despite a dense skeleton of silicon, lives near the sea surface. In certain radiolarians this flotation is accomplished by the secretion of carbon dioxide that accumulates as gas bubbles in the protoplasm of the animals. Numerous surface dwellers, including some rotifers, many small crustaceans of the order Cladocera and protozoans of the genus *Ceratium* undergo a seasonal change in form in apparent correlation with the density and viscosity of the water. The warmer water of summer offers less resistance to sinking. The summer populations of these animals are characterized by individuals having the surface expanded in proportion to their mass, the winter populations by individuals having a relatively compact form with fewer or shorter projections.

Over long periods of time most organisms are chiefly responsible for the formation of a rich, organic soil. Activities of civilized man usually lead to strong modifications of habitats; for example, pollution of streams and lakes, soil erosion, destruction of watersheds, dense smoke clouds and increased radioactivity are but a few ways in which some habitats deteriorate.

4. Reproduction.—Another basic drive, reproduction, has many ecological implications. Climate and weather have both long-range effects and more immediate effects upon such diverse aspects as courtship behaviour, time of mating, laying of eggs and development of the larval or immature stages. Most higher plants are pollinated by an environmental agency. This agency may be a physical factor, as in the wind-pollinated trees, or it may be a biological agency, as in the transfer by insects of pollen for many fruits and vegetables. Growth of species populations through reproduction involves the problems of both food and shelter, attack by predator and parasite, disease, co-operation and numerous other aspects of general ecology. *See* also REPRODUCTION.

III. PRINCIPLE OF COMMUNITY

Even this brief survey of food, shelter and reproduction demonstrates that no organism can live wholly alone and be independent of other organisms. Herbivores must be associated with their food plants, and carnivores and parasites must be associated with their prey. Consequently, since no plant or animal can live in a foodless biological vacuum, species populations form natural gatherings with other populations. Such assemblages are of various sizes, composition and complexity. They have been called biocoenoses, if the interrelations are especially closely knit, but they are more generally known as communities. L. R. Dice (1952) distinguished between the nonliving environment and the community (living environment) and combined both as the ecosystem.

Since each species inherits a particular heredity that allows it to tolerate certain environmental conditions but not others, it follows that the populations of a community can tolerate the normal environment at that place. This environment is complex. It consists of two kinds of influences: (1) the physical factors, such as light intensity and quality, temperature, precipitation, evaporation, quality of the medium, substrate, salinity, air or water pressure and many others; and (2) the biological factors, including food, biotic aspects of shelter, population pressure, predation, parasitism, disease and many more.

1. Major Community.—When a community is relatively self-sustaining and self-regulating, it is at the level of survival for its component species populations. Such a community is called a major community. The major community is one of the fundamental concepts in biology. Normally single-celled organisms such as algae and protozoans cannot exist apart from their food supply. Similarly, the separate cells of many-celled organisms are unable to live apart from the tissues of which they are vital units. The tissue is similarly unable to exist apart from other tissues of the organismal whole. Finally, the complete organism cannot exist without food. Therefore the populations involved

must live together in a major community if they are to exist at all. This is the level at which survival is possible.

Given radiant energy from the sun, the major community is a self-maintaining, self-regulating, independent assemblage. There are few exceptions to this principle. A possible exception is found in certain kinds of caves, where the initial food supply is derived largely from external sources. A forest is a major community, as is an adjoining grassland, and each is independent of the other for survival. Similarly, a lake is a major community and the vast oceans are collectively a continuous, self-sustaining major community.

Within any of these major communities are almost innumerable smaller communities that are not self-sustaining; for example, tree holes and decaying logs in forests, cattle droppings in grasslands, the lake-bottom or profundal community and the coral-reef community in the sea.

Major communities have three basic features in common: (1) a fundamental structure, known as stratification; (2) systems of interchange and recombination of foodstuffs, known collectively as community metabolism; and (3) a common system of periodicities.

2. Stratification.—With respect to stratification, the species populations are in a vertical series of horizontal layers, termed strata, and usually also in a series of concentric layers, termed zones, from the periphery to the centre of the community. Major communities, then, are separable into both horizontal and concentric layers. Since a major community is always in contact with one or more major communities at its boundaries, there is always a marginal zone where the communities intergrade. This intergrading area is known as an ecotone. The seashore is a much-studied ecotone between the marine and terrestrial communities. Obviously the ecotone is not a major community since it is not self-sustaining; that is, it could not exist in its present form without being a part of, and dependent upon, the communities that it connects.

The principle of stratification will be examined again in the discussion of the marine biome, and forest stratification will be used as an illustration of community structure. A forest usually has the following strata: (1) subterranean; (2) floor; (3) herbaceous; (4) shrub and small tree; (5) canopy. Each stratum, dependent upon the other four, may be thought of as a community in the general sense but is not a major community. Each stratum has its own microclimate, its particularly adjusted stratal animal life and its peculiar organization. Stratal adjustments are abundant and suggest that the stratum places a positive selection value upon certain kinds of adjustments to maintain position or to procure food and shelter. Generally, stratal adjustments for a particular stratum are similar in widely separated forests over the world. Species occupying a given stratum in two such forests may be widely separated taxonomically but still have similar requirements. This phenomenon is termed the principle of ecological equivalence.

The subterranean stratum, at the bottom of the forest's vertical gradient, is most similar ecologically to the subaqueous stratum of aquatic gradients. Its matrix of soil particles is relatively continuous and homogeneous. Light is absent, and the soil temperature and soil moisture are relatively stable in contrast to higher forest strata. Living here are myriads of bacteria, fungi, soil protozoans, nematode worms, earthworms, almost countless mites, numerous insects, moles and the extensive root systems of trees, shrubs and herbs. Moles are good examples of animals adjusted for life in a certain stratum. They have large, horny forefeet for tunnelling, short tails, minute ears and vestigal eyes. These features are adjustments for a life of digging, and are shared more or less by numerous other ecologically equivalent mammals.

The floor is the second stratum. It is less homogeneous and less continuous than the preceding stratum but much more so than all higher strata. Similarly, it is intermediate between higher strata and the subterranean stratum in its physical and biological conditions. In contrast to the higher strata, the floor is slightly colder in winter, slightly warmer in summer, dimly lit during the day and more easily injured by forest fire and flood. The forest floor is an insulating layer, retarding erosion and accumulating diverse foodstuffs. Its matrix consists of leaf mold and log mold. In this layer are included fallen leaves in all stages of decay—providing a characteristic aspect to the stratum—rotting stumps and prostrate logs, twigs, nuts, fallen fruit and flowers, animal feces and the dead and decomposing bodies of animals. In evergreen forests the leaves tend to fall throughout the year, whether in tropical jungles and rain forests or in temperate coniferous forests. In deciduous forests the leaves tend to be deposited in the autumn season.

In addition to numerous animals that live their entire life cycle in the floor stratum, such as many mites and insects, there are others that spend a part of their life in the floor. For example, ladybird beetles (Coccinellidae) move from the herbaceous stratum of grassland communities, as well as from higher forest strata, to form large overwintering aggregations that hibernate in the leafy floor stratum; other animals nest or shelter there but feed by day or by night in higher strata; still others feed in the floor stratum but have their habitat niches elsewhere.

The three succeeding strata differ markedly from the floor. They are structurally discontinuous since the herbs, shrubs and trees rise separately from the soil. The essential matrix is made up largely of animate material in contrast to the largely inanimate matrix of the floor and soil. These higher strata provide large amounts of food for herbivorous insects, such as the leaf-feeding chrysomelid beetles, wood-boring buprestid and cerambycid beetles, sap-sucking aphids and the numerous scale insects (Coccidae); and for herbivorous birds and mammals, as well as for the predators that feed upon this multitude. Many animals shelter in the shrub and tree strata. Deer mice occasionally nest in shrubs and many predators visit shrubs and trees. In these strata tree frogs search for their insect food and the pilot black snake hunts for bird eggs and small mammals.

The leafy crowns of the topmost stratum, the canopy, interlock to form a forest roof that receives the full force of weather and that serves to modify such physical influences as light intensity, light quality, temperature, wind velocity, relative humidity and evaporation rate from the canopy progressively downward to the subterranean stratum. Along the ecotone the canopy often continues downward to within a few feet of the ground and is often secondarily interlocked by vines. In equatorial forests there may be several strata of trees, and true rain forests have three tree strata with correspondingly complex canopies.

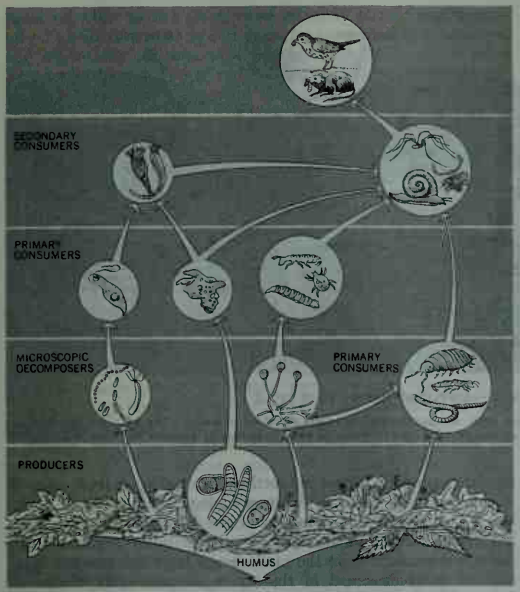
All the five basic forest strata briefly discussed above contribute to the well-being of the whole major community. During the seasonal growth period the forest climate is relatively cool, dark and moist, and the air is relatively still, in contrast to conditions external to the forest. These physical influences are only a few of those that operate from canopy to subterranean stratum and from the peripheral ecotonal zone to the centre.

3. Community Metabolism.—Such stratified major communities, whether forest, grassland, lake or sea have a basic system of food interrelations. This community metabolism is separable into two interlocking phases: (1) an anabolic phase, in which foods are formed; and (2) a catabolic phase, in which foods are broken down.

Community anabolism is divisible into two basic "key industries." These are: the microbiological industry, and the photosynthetic industry. Generally speaking, both of these anabolic phases are dominated by plants.

Dead plants and animals are broken down into organic compounds by many kinds of bacteria and fungi, known collectively as heterotrophs. Other bacteria, known as autotrophs, reduce these organic compounds further into inorganic salts. Essentially this is the microbiological key industry. It is fundamental to the life of a community and consequently fundamental to the constituent plants and animals. It is these inorganic salts that are finally absorbed by higher or "green" plants, through their root systems in the subterranean stratum of terrestrial communities, or by algae in the surface layers of aquatic communities.

The photosynthetic key industry is carried out chiefly by green plants and to a lesser degree by the poorly known photoauto-



FROM "NATURAL HISTORY," FEB. 1960

FIG. 1.—FOOD CHAIN OF THE FOREST FLOOR

The producers of the first trophic level include forest litter, diatoms and algae, and provide food for the microscopic decomposers, which are bacteria and fungi, and for some primary consumers. Primary consumers include single-celled animals and lower invertebrates, and are fed upon by secondary consumers, which include microscopic lower invertebrates and larger invertebrates. Secondary consumers are, in turn, fed upon by small vertebrates

trophic bacteria. Plant carbohydrates, manufactured in the photosynthetic process, are combined with inorganic salts, absorbed by the plants, to form plant proteins. These plant proteins in the form of plant tissues are available for the catabolism of the community.

The catabolic phase of a community is carried out chiefly by animals and fungi. The herbivores, which feed upon the plants, are in turn available as food to the predators, parasites and hyperparasites in several grades of carnivorism and scavengerism. Consequently all organisms are either directly or indirectly dependent upon the microbiological and the photosynthetic key industries; these two processes are entirely dependent upon each other and all of the intermediate stages in the food cycle of the entire community.

4. Food Web.—In any given community the circulation of foods is an interwoven system of feeding interrelations. The whole system is spoken of as the food web, and the separable strands of food and feeder are termed food chains, although it is apparent that a food chain, as such, is an arbitrary device for studying a few directly related portions of the food web.

Many examples of food chains are available but almost none are known completely. A simple example may be cited from a prairie community: the sap of grasses is eaten by aphids; the aphids are eaten by larvae and adults of ladybird beetles; the ladybird beetles are eaten by predaceous ground beetles, such as *Carabus* and *Calosoma;* the ground beetles are in turn devoured by such birds as dickcissels, horned larks and grasshopper sparrows; finally, the smaller birds may be eaten by marsh hawks. In this chain the several links are in relative balance. When the marsh hawk dies, its body is decomposed by bacteria, and eventually the resulting inorganic salts are available for absorption by the prairie grasses, completing the food cycle in a single food chain of the prairie food web.

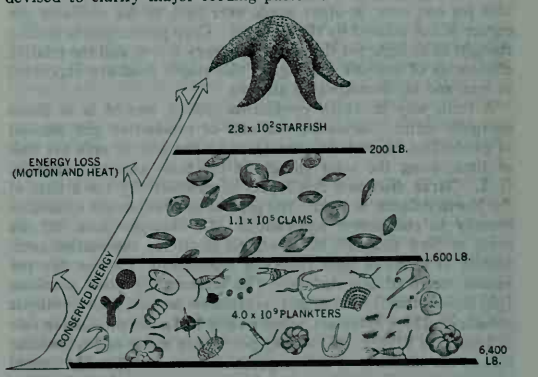
There are several other points to be noted concerning food chains. A species may eat different foods (1) in different parts of its geographic range, (2) in different stages of its life history and (3) at different times of the year.

5. Pyramid of Numbers.—When the food web is examined quantitatively, by counting or estimating the number of animals present per given area or volume of environmental medium, it is found that not only are there many more small animals than larger ones but that the size classes involved form a triangular figure when size is plotted against abundance (fig. 2). Charles Elton in 1927 called this relationship the "pyramid of numbers." Small animals have a higher reproductive potential than larger ones. Since the energy value of food eaten must eventually balance the physiological energy expended in obtaining and assimilating this food, predators generally eat animals in the next lowest size level or thereabout to conserve this energy expenditure. For example, in the prairie food chain cited above, the marsh hawk could probably assimilate the aphid protoplasm, but the energy expended in eating such minute prey would be greater than the potential energy of the food.

Pyramids of numbers have been investigated carefully for only a few communities. The pyramid has been figured for an Illinois deciduous forest by Orlando Park, W. C. Allee and V. E. Shelford (1939), for an equatorial forest in Panamá by E. C. Williams, Jr., (1941), for tree holes by Orlando Park, S. I. Auerbach and Glenna Corley (1950) and for certain Wisconsin lakes by Chancey Juday (1942). The food and feeder relationships in the pyramid were examined mathematically by R. L. Lindeman in 1942, and his formula was extended and modified by Allee, A. E. Emerson, Orlando Park, Thomas Park and K. P. Schmidt in 1949.

6. Trophic Levels.—The community pyramid of numbers may be considered to have four or five trophic levels (levels of feeding interrelations), each level containing a variable number of species and each species population containing a variable number of individuals.

Thus the first trophic level consists of the photosynthetic plants (either green plants or photoautotrophic bacteria or both). These organisms are the producers which manufacture carbohydrate material. The second trophic level comprises the herbivores, the primary consumers, which feed upon photosynthetic plants. The third trophic level includes the carnivores, that is, the secondary consumers, which feed upon herbivores and other carnivores. The fourth trophic level includes saprophagous organisms, such as heterotrophic bacteria and fungi; these are the tertiary consumers, drawing nourishment from the decaying organisms of the first three levels noted. Finally there is a fifth trophic level, consisting of the chemoautotrophic bacteria; these are the quaternary consumers, which further simplify organic compounds formed by the activities of the fourth level. This terminology is one of several devised to clarify major feeding patterns within the whole com-



FROM "NATURAL HISTORY," MAY 1951

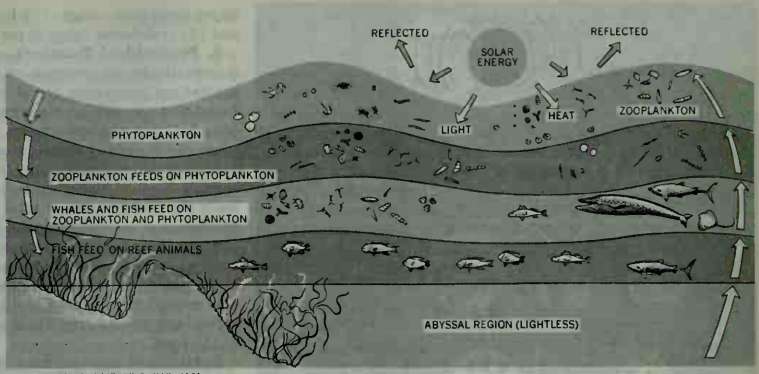
FIG. 2.—PYRAMID OF NUMBERS OF ONE PART OF A SEA COMMUNITY

Yearly food movement through plankton through clams (*Chama*) to starfish (*Pisaster*). Efficiency of production and energy transfer is indicated by the numbers of individuals and by the total weights or biomass that each level contributes to the next higher level

munity or ecosystem. Naturally, every organism consumes, transforms, produces and otherwise rearranges and reorganizes its protoplasm and its habitat.

Two items need amplification. First, omnivores encompass herbivores and carnivores in their food supply and alternatively feed upon the second and third trophic levels. Second, within the carnivore level are several grades of predation, that is, several size classes of predators. This tends to further complicate the secondary consumer category.

There are exceptions to the pyramid of numbers. These are generally found in animals that have special feeding adjustments that enable them to concentrate on small prey. The whalebone whales strain enormous numbers of minute organisms from the sea, and the paddlefish strains small crustaceans from the waters of the Mississippi valley.



FROM "NATURAL HISTORY," MAY 1961

FIG. 3.—SIMPLIFIED MARINE FOOD CYCLE

Phytoplankton is directly dependent upon solar energy and nutrient salts dissolved in water. The nutrient chemicals in dying phytoplankton sink to bottom (arrows at left) and are carried back to surface by currents for reuse in new cycle (arrows at right)

7. Biomass.—When a species population is weighed, in part or as a whole, the weight of the population can be examined in relation to other parts of the pyramid or food web. Walter Pickles in 1937 developed this concept in relation to ants and defined biomass as the total weight of a species population per unit of area. Obviously the biomass could be determined for each link of a food chain, for each stratum of a community or for the whole community.

8. Productivity.—When pyramids, or numbers of animals, and biomasses, or weights of animals, are discussed, the production potentials for a given area or volume of a given habitat become important. Productivity can be thought of in several ways. There is the annual crop production as well as the standing crop production, this latter meaning the amounts of protoplasm or protoplasmic products present at a given time and place. In these two concepts amounts are involved, as bushels of corn, board feet of lumber or pounds of beef or herring per acre of prairie, forest or sea surface.

A second way of thinking of productivity is in terms of the efficiency of production. For example, E. N. Transeau calculated that the photosynthetic efficiency of field corn (10,000 plants per acre) is only 1.6% in terms of the total solar energy that is available for one acre; in other words over 98% of the available sun energy is not utilized by these plants. Corn production is usually thought of as high, yet the actual efficiency is low, and the relative efficiencies of animals feeding on this staple food are important to man and his domesticated animals.

A third way in which production can be viewed is in direct energetic terms, calculating the rate of production and amount of production in gram calories (g. cal.) per unit of area per unit of time, using the solar energy as the total amount available. G. L. Clarke discussed this aspect of productivity for a part of the North Atlantic in 1946. His general conclusions are applicable broadly to community metabolism. On Georges bank, off the coast of New England, the energetic input for the marine community in terms of light energy is 3,000,000 g. cal. per day per square metre of sea surface. The diatoms are plant plankton (phytoplanktonic), important organisms in the photosynthetic industry. These abundant, minute algae had a net production rate of from 0 to 9,000 g. cal. per day per square metre of sea surface; that is, the efficiency of diatom production was 0.3%. The animal plankton (zooplankton) feeds primarily upon the phytoplankton. The net production rate of these minute, free-floating animals was from 0 to 440 g. cal. per day per square metre of sea surface; that is, the efficiency of zooplankton production was only 0.015%.

In turn, fishes feed directly on zooplankton, or on bottom-dwelling organisms, or are indirectly dependent upon these animals in the case of predaceous fishes at higher predator levels. Ultimately both zooplankton and fishes are dependent directly or indirectly upon the phytoplankton. These latter organisms are directly dependent upon the light energy from the sun and upon nutrient salts dissolved in the water, as previously discussed. Data concerning Georges bank were obtained on the weight of whole fishes of all species landed annually. Weight of the catch varied from 63,000,000 to 289,000,000 lb. per year over the 10,000,000 ac. of Georges bank. This represents a yield of from 7 to 33 lb. of fish per acre per year. Assuming an energy content of 740 g. cal. per pound for raw fresh fish, the yield of fish landed per acre per year is equivalent to a production rate of 1.6 to 7.7 g. cal. per day per square metre of sea surface. That is, the efficiency of production was from 0.00005% to 0.00025%.

Stated simply: on every trophic level, when one animal eats another animal or a plant, only a tiny fraction of the energy stored in the tissues of the organism eaten actually becomes available energy for the eater—by far the greater portion of the potential energy is lost to the environment as heat, as a result of the numerous metabolic activities of the eaten and the eater.

From this analysis it is clear that production efficiencies decline rapidly from lower to higher trophic levels in the pyramid of numbers of a major community. Naturally, the details will vary as between parts of the same community, between different communities of the same type and between different types of communities.

Ecological research is essential in productivity problems. Obviously, much more solar energy is available than is being utilized by plants and animals. Man himself uses more and more food as his population increases but returns relatively little available energy to the food cycle. When his global population cannot be supported by the available food supply, the problem of overpopulation will adversely affect the conservation of natural resources. Loss of natural resources will in turn adversely affect the food supply.

9. Periodicity.—Another basic feature in community organization is that of periodicity. The activities of animals, in their search for food, shelter and mates, fall into one of two categories. These are periodic activity and aperiodic activity.

Periodic Activities.—Most of the large activities of communities are periodic and are correlated with such physical recurrent influences as relative length of day and night, daylight intensity, air temperature and distribution of precipitation. In fact, correlation of community activity in the large with the periodic physical environment is essential for survival.

Periodic activities are of three general kinds at the level of the major community; they are seasonal, lunar and daily. Sea-

sonal activities involve the growing season of plants; mating periods of animals; several aspects of dormancy, including hibernation and estivation; correlations in photoperiodicity, or the relation between leafing, flowering and fruiting of many plants with the relative length of day and night throughout the year; and migration. The study of periodic, seasonal events is known as phenology. When a sequence of phenological changes is followed through the annual cycle and related to environmental factors, the general process is termed seasonal succession, or aspection. The year is often divided into a series of periods that are correlated with seasonal phenomena, such as the peaks of abundance of certain populations that are characteristic of a particular community or type of community. The seasonal population peak of typical species, which are frequently known as index species, or the appearance of some characteristic behaviour or structural change may serve as an index of the time of year as well as of the kind of community under examination.

Within this seasonal frame, certain animals exhibit reproductive phenomena that are correlated with tidal or lunar events. Such animals include the palolo worms, certain marine annelids that swarm and spawn at definite times of certain months. All such phenomena are embraced by the term lunar periodicity.

Finally, there are the changes in community activity that are correlated with the regular march of day and night. These changes, broadly termed diel activities, are divisible into diurnal (day) and nocturnal (night) events. Community activities characteristic of the twilight periods, dawn (auroral) and dusk (vesperal), are grouped broadly as crepuscular events. Probably the most important diel activity is the diurnal manufacture of carbohydrates by a photosynthetic plant. The complementary nocturnal process is the distribution of much of this carbohydrate material throughout a terrestrial plant. Another diel phenomenon is the vertical migration of many minute animals that inhabit the surface stratum of the sea. These animals, including many protozoans and copepod and cladoceran crustaceans, move to the surface during the night and move downward during the day. This migration is apparently brought about actively, by the animals' direct or indirect response to light intensity, as well as passively, by the animals' being carried by diel convection currents.

Communities commonly have a well-defined diurnal animal life and a well-defined nocturnal animal life. Numerous special adjustments allow animals to compete and co-operate within this diel periodism of the physical influences. The vertical pupil of the eye of many snakes, such as rattlesnakes, is an adjustment to their nocturnal habits. Some diurnal tree squirrels have slightly yellowish eye lenses, which adaptation reduces the intensity of bright daylight; whereas the lenses of the nocturnal American flying squirrels (*Glaucomys*) are perfectly translucent and allow all available light to filter upon the retina. Again, most nocturnal cats have a reflecting layer, or tapetum, back of the retina, and a similarly light-reflecting layer is found in the eyes of certain nocturnal moths and beetles. The tapetum is the structure that causes the eyes of such animals to glow when exposed to a light in the dark. The bioluminescent organs of the common fireflies or lightning bugs (lampyroid beetles) are adjustments that enable these nocturnal beetles to mate at night.

Almost all communities can be divided into two periodic animal groups, the diurnal and the nocturnal. As a consequence, the number of available habitat niches as well as the population is increased. This in turn increases the number and kinds of possible interrelations and renders the community more biologically complex. By this more complete utilization of the space-time lattice, the whole community considered as a unit approaches aperiodicity with respect to day and night in a physically periodic environment.

Aperiodic Activities.—In the second category of activity, the aperiodic type, there is no rhythmic correlation with the 24-hr. cycle of day and night. Instead, in aperiodic species populations some individuals are active and some inactive at any given time.

Aperiodic patterns are of two kinds. First, there are those species that inhabit relatively stable environments that are removed from direct periodic diel influences. These include the cave crayfish (*Cambarus pellucidus*) of Mammoth cave, Ky.; certain animals that inhabit the relatively constant subterranean stratum of terrestrial communities or the interior of decaying logs on forest floors, such as the subsocial beetle, *Popilius disjunctus;* the flour beetle (*Tribolium confusum*), which lives in the relatively stable habitat of stored food products. Second, some of the social animals are aperiodic, such as many kinds of ants and termites. Also, as man's social organization becomes more complex, his activities as a whole tend to become arrhythmic. Although other social species are not completely aperiodic, as for example many bees and wasps and some ants it is difficult to conceive of a wholly social species having its activity rigidly controlled by the periodic environment.

Whether animals such as man evolved sociality first and became aperiodic as an adjustment to social life, or were aperiodic first and became social later is an unanswered question. At least the aperiodic pattern is correlated with a relatively constant environment, whether this is the complex social medium or a habitat that is removed from direct control of diel factors.

IV. PRINCIPLE OF SUCCESSION

Turning from community organization, another important aspect is the growth and change of communities through time. This process, known as ecological succession, can be separated into two components: physiographic, influenced by all the physical features of the environment; and biotic, determined by the animals and plants comprising the community itself.

1. Physiographic Succession.—This form of succession was described by H. C. Cowles in 1901 with respect to the series of communities that gradually arose as postglacial Lake Chicago drained away leaving the smaller Lake Michigan and the Chicago plain in its place.

The effects of physiographic influences were summarized by H. C. Cowles in a classic statement ("The Plant Societies of Chicago and Vicinity," The Geographic Society of Chicago *Bulletin* No. 2 [The University of Chicago Press, 1901]):

> Having related the vegetation largely to topography, we must recognize that topography changes, not in a haphazard manner, but according to well-defined laws. The processes of erosion ultimately cause the wearing down of the hills and the filling up of the hollows. These two processes, denudation and deposition, working in harmony produce planation; the inequalities are brought down to a base level. The chief agent in all these activities is water, and no fact is better established than the gradual eating back of the rivers into the land and the wearing away of coast lines; the material thus gathered fills up lakes, forms the alluvium of flood plains, or is taken to the sea. Vegetation plays a part in all these processes, the peat deposits adding greatly to the rapidity with which lakes and swamps are filled, while the plant covering of the hills, on the contrary, greatly retards the erosive processes. Thus the hollows are filled more rapidly than the hills are worn away. As a consequence of all these changes, the slopes and soils must change; so, too, the plant societies, which are replaced in turn by others that are adapted to the new conditions.

Successional changes of this kind are widespread and basic. Erosion and deposition of soil by both wind and water profoundly modify the earth's crust within a given climatic period. These changes alter the structure of terrestrial and fresh-water communities to such an extent that established populations of plants and animals are unable to cope with the changed conditions, and their place is taken by other species that can adjust; hence, communities succeed each other through time.

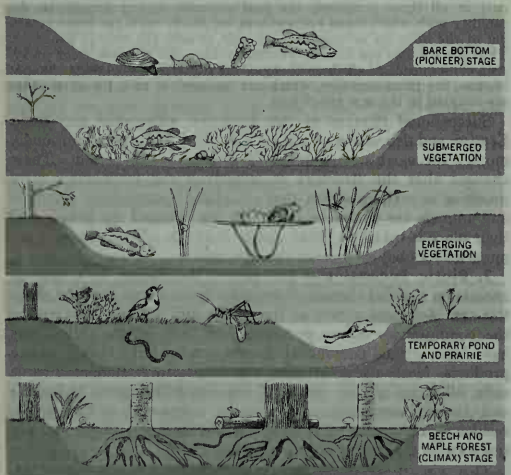
2. Biotic Succession.—The second component in ecological succession signifies changes in community structure brought about through biological action of the plants and animals constituting the community. These processes and their effects collectively have been termed community development. For example, waste products, feces, decay of dead organisms, formation of organic soils, filling up of lake and pond bottoms with organic sediments and other influences gradually change a community so that, again, residents are unable to tolerate the changed conditions and are replaced by different species populations.

This type of succession can be demonstrated in the laboratory. Thus, L. L. Woodruff in 1912 demonstrated the regular sequence of protozoan species that occurred in a flask of hay infusion chiefly as a consequence of food and waste product factors over a period of several weeks.

3. Sequence of Community Changes.—Together, physiographic and biotic factors induce and regulate the process of community change. Research showed that such changes may be described, are relatively continuous and to some extent are directional, hence predictable. Community changes continue until a stable end product is reached. A sequence or series of communities is termed a sere; the early stages are known as pioneer communities and the relatively stable end product is the climax community. This latter community is a climatic climax in that, for a given latitude, altitude and climatic period, the physiographic and biotic changes have become relatively stabilized and can be tolerated by resident populations. At high latitudes the substratum of the climax community may be very unstable.

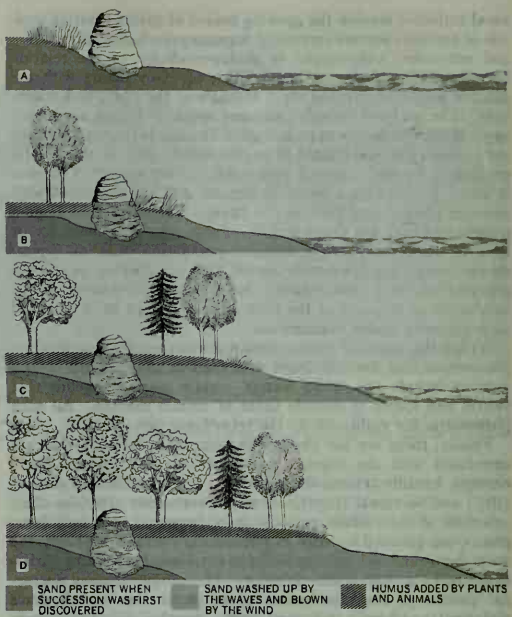
Normal community succession may be modified, deflected or arrested within any sere. The normal tendency of ponds to fill up to form marshes, and of marshes to form pioneer grasslands or forests, and these latter to form a climax high-grass prairie or a climax beech and maple forest in a certain area occurs over a long period of time. This has important practical significance for the formation of man's food supply, his fisheries, duck populations, corn and wheat yields or lumbering activities. Scientific management is clearly indicated rather than hasty action in attempting to alter natural processes. A community originated and maintained by human disturbance is an artificial community termed a disclimax. When succession and development take place relatively unmolested by man or his indirect influences, the sequence is a primary sere (prisere); when development and succession are controlled by man or his indirect influences, the sequence is a secondary sere (subsere).

Succession and development of a sere are also frequently controlled by local conditions primarily, rather than by the prevailing climatic conditions. Local effects are termed edaphic, and edaphic seres are common. Two powerful edaphic influences are soil and water. The edaphic aquatic sequences are of two general kinds: (1) the flowing water sere in which the change is from small, swift brooks with high velocity to the edaphic climax of an old, meandering river that has cut its bed to the base level and winds across a silted flood plain; and (2) the standing water sere in which the change is from bare-bottomed ponds and lakes to marshes or bogs and finally the pioneer stages in a terrestrial sere, either grassland or forest as a rule, depending on the seasonal distribution or rainfall and other climatic factors.



W. C. ALLEE, A. E. EMERSON, ET AL., "PRINCIPLES OF ANIMAL ECOLOGY," 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 4.—SUCCESSION AND DEVELOPMENT FROM A BARE-BOTTOMED POND (TOP) INTO EITHER A PRAIRIE (SECOND FROM BOTTOM) OR A FOREST CLIMAX (BOTTOM), DEPENDING UPON CLIMATE



W. C. ALLEE, A. E. EMERSON ET AL., "PRINCIPLES OF ANIMAL ECOLOGY," 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 5.—SUCCESSION AND DEVELOPMENT OF A SAND SERE IN THE DUNES OF NORTHERN INDIANA

(A) Grass takes hold on the beach; (B) as humus accumulates, cottonwoods appear; (C) these are replaced by pines and beeches, which in turn, (D) give way to maples. As one location reaches a climax away from the beach (to the left of the boulder), earlier stages are beginning on the newly developing beach, which is continuously being built up by wave and wind action

As the community as a whole undergoes succession intracommunity sequences take place. These latter are known as microseres and include changes that take place in cattle droppings in the prairie community, in the decaying bodies of animals, in decomposing fallen logs and stumps, in tree holes and in disintegrating fungi in the forest community. All these microseres follow a regular sequence of biochemical, structural and biotic changes, but are without a climax stage, since they are incorporated into the major community as it matures.

V. PRINCIPLE OF CONVERGENCE

An important principle emerges at the level of community maturation. This is the principle of convergence, which states that there is a general tendency for edaphic seres to run their course, for microseres to wax and wane and for climatic seres to mature from pioneer to climax. In the end, often over many centuries, an entire region tends to develop into the regional climatic climax.

Convergence was emphasized by H. C. Cowles in 1901. With Cowles' aid, V. E. Shelford applied the principle to the Chicago area in 1913. It was generally treated by F. E. Clements and V. E. Shelford in 1939.

The principle is illustrated well in northern Indiana, where four major seres are evident. These are sand, clay, flood plain and pond. The pond eventually fills, passing through a marshy cattail stage; the flood plain is exploited by a series of terrestrial communities; and the sand and clay seres accumulate humus. In the end, however, all four seres meet in the common development of a beech and maple forest. This latter is a climatic climax for this particular area. Even though the animal and plant life of the climax varies with latitude and altitude, the principles of convergence has many broad implications.

VI. BIOMES

A. Terrestrial

1. Extension.—Communities and major communities, whether edaphic or climatic, pioneer or climax, are distributed over the terrestrial parts of the world in a series of broad belts from the poles to the equator. In general, although edaphic influences alter the regularity of these belts, they are correlated with similarly broad climatic zones. The communities that occupy any one of these zones, including the extensions caused by the altitude factor, are known collectively as a biome. The biome is the largest ecological unit. It is seldom continuous, covers a large area of the earth and is subject to considerable intrabiomal variation. The biome consists of a single climax type, which usually varies in composition with latitude and altitude, and many subsidiary seres. It holds almost innumerable major communities, each self-sustaining and each consisting of many dependent communities and species populations. Convergence operates over any given biome through time.

2. General Characteristics.—The table gives the major details about the terrestrial biomes. This highly condensed summary does not stress the obvious fact that there are many intergradations between biomes. The study of biomes is an important aspect of ecological animal geography. Discussions of the latter are found in Animals, Distribution of and Zoogeography.

B. Marine

The terrestrial biomes, with their numerous alpine extensions and interbiomal intergrades, cover only about 30% of the world's surface. The remaining 70%, covered by ocean waters and their adjacent seas, has been called the marine biome.

This vast expanse, which contains numerous communities, is but a single, self-sustaining, independent, major community. Consequently, whereas terrestrial biomes each have many major communities, the marine biome and major community are synonymous. For example, given radiant energy from the sun, two oak forests 100 mi. apart are independent of each other and of adjacent meadows and lakes. Each forest is a major community. Two coral reefs 100 mi. apart are independent of each other but are dependent upon the minute organisms in the adjacent sea water for their initial food supply. The coral reefs are communities, but the whole sea is the major community.

The marine biome has the same basic structure as any other major community. It possesses both vertical and horizontal strata and zones; its metabolism is based upon the photosynthetic and microbiological key industries; its food cycle involves the same general principles; and finally, its activities in lighted regions are primarily periodic, involving seasonal, lunar and diel rhythms.

1. Aquatic Organisms.—Aquatic organisms are separable into three ecological categories. These are plankton, nekton and benthos.

Plankton.—Plankton comprises feebly swimming and free-floating organisms that cannot move against a current. On the basis of size, planktonic organisms are separable into: (1) macroplankton, organisms that are visible to the unaided human eye; (2) net plankton, organisms secured by a plankton net with meshes between 0.03 and 0.04 mm. wide and (3) nannoplankton or microplankton, minute planktonic components that pass through the meshes of a plankton net.

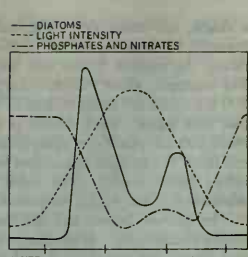
As noted earlier under *Productivity*, plankton is also commonly divided into phytoplankton and zooplankton. Phytoplankton consists of the minute, unicellular plants and animal-like plants. This important group forms the major part of the photosynthetic key

Terrestrial Biomes

Biome	Distribution	Climate	Typical animals and generalities
Equatorial forest (jungle; rain forest)	Range about 20° N.–20° S. About 6,000,000 sq. mi., mostly less than 1,000 ft. elevation. Indo-Malaysia, Congo basin, Amazon and Orinoco basins, much of Central America and Mexico on either side of Central plateau to Tropic of Cancer	Rainy low latitudes. Humid and warm, rainfall 50 in. to 150 in. per year, evenly distributed, but with some areas having one or more "wet" and "dry" seasons	Monkey, lemur, ape, sloth, tapir, elephant, army ant, driver ant, many termites, arboreal snail, *Peripatus* and allies, toucan, parrot and parakeet. Mammals typically thin haired; animals 40% diurnal and 60% nocturnal; 11% amphibious, 39% cursorial, 50% arboreal. Communities with many strata; e.g., true rain forest, at least 70 in. rain annually, with three tree strata and arboreal adjustment extensive
Temperate Grassland (steppe, plains, prairie, pampas, llanos)	Bordering deserts of Asia Minor and central Asia. North America from Texas northward into Canada and eastward to the 100th parallel	Great temperature extremes in winter and summer. Annual rainfall 20 in. to 40 in. for tall grass, and 12 in. to 20 in. for short grass	Asia: saiga antelope, Mongolian gazelle, wild ass, two-bumped camel. North America: bison (buffalo), pronghuck (prongborn antelope), prairie dog. Grasshopper typically abundant. Many adjustments to hibernation and estivation. Steppe mammals 47% subterranean and 53% floor residents; in general, gregarious, swift, migrate or hibernate, high fertility. Many running and digging animals
Tropical Grassland (savanna, pampas, llanos)	Tropical areas in Africa, Australia and South America	Generally warmer, with shrubby plants or trees scattered over grassy floor	Australia: kangaroo. South America: pampas deer; armadillo abundant. Africa: certain baboons, lion, hyena, certain buffalo, giraffe, zebra, square-lipped rhinoceros and many genera of antelope (eland, kudu, addax, wildebeest, bartebeest, blessbok, bontebok, etc.
Desert (vegetation, when present, usually thinly scattered)	Many areas over the world: Death valley in United States; parts of south South America; Sahara and Kalahari in Africa; Syrian, Arabian, Thar and Gobi in Asia; a part of Tasmania and interior of Australia	Annual rainfall less than 10 in. Death valley and Sahara have July means of 95° F., January means of 64° F., with usually cold nights and hot days	If semidesert and desert are combined, this biome would cover about one-fifth of terrestrial area, or 11,500,000 sq. mi. Estivation common, and nocturnalism typical. Characteristic desert forms include: Gila monster, sidewinding rattlesnake, desert fox and desert jack rabbit. Pronghuck; desert monitors (Australia); horned viper (North Africa and Arabia)
Temperate deciduous forest (variety of trees; well-developed herb and shrub layers)	North temperate zone of eastern North America, Europe, western and eastern Asia, Japan. Parts of northeast China; eastern coastal areas in Australia; New Zealand	Annual rainfall of 20 to 60 in., usually well distributed. Winter and summer well-defined, with at least four months with a mean temperature more than 50° F.	Wisent (European bison) and red deer. In the United States: Virginia deer, black bear, bobcat, flying squirrel, tree squirrel and chipmunk; numerous snails (*Polygyra*), carabid beetle (*Dicaelus purpuratus*), certain salamanders (*Plethodon cinereus*), common box turtle and the pilot black snake are typical. The biome has numerous types of climax forests, the chief trees being red oak, beech, sugar maple, tulip, chestnut, black cherry, magnolia, live oak and cypress
Taiga (coniferous forest; scant herb and shrub layers)	Circumpolar in the subarctic and north temperate zone of America, Europe and Asia	Annual precipitation between 20 and 40 in., much of which is snow. Winter season long and severe	This vast forest is notable for lumber and furs, and in many areas its fauna intergrades with the deciduous forest fauna (e.g., in North America tree squirrel, flying squirrel, chipmunk, Virginia deer, bobcat, black bear). Moose, caribou or reindeer, lynx, snowshoe hare, wolf, fox, marten, weasel or ermine are characteristic for both Eurasia and North America. The maral deer, wild dog and tiger are Siberian. Canada has the skunk and puma. There are numerous woodpeckers; crossbills and snowy owls are especially typical of coniferous woods
Tundra (snow and ice deserts; scant low vegetation, chiefly lichens)	Polar and alpine regions of the northern hemisphere, treeless and barren for most of the year. Generally from northern limit of taiga to Polar sea. Southern hemisphere: alpine zones of Andes, and certain mountains in Australia	Annual precipitation small, not more than 10 in., except for part of Greenland. Winter long, and summer short. Temperature of warmest month never exceeds 50° F.	Birds and mammals are either migratory, or depend on sea for food supply, with the exception of few birds including the redpoll and ptarmigan. Typical mammals include the reindeer (including the caribou), musk ox, ermine, arctic hare, arctic fox and lemmings

industry of the marine biome as a consequence of the diatoms, dinoflagellates and their allies; since this biome also includes many kinds of bacteria, it plays an important role in the bacterial key industry previously discussed.

Phytoplankton is so important to the food cycle and numerous related problems in productivity that some mention must be made of the seasonal abundance of diatoms. In arctic and temperate upper waters the diatom population is relatively low in winter, increases rapidly in the spring, falls off in summer, increases slightly in autumn and falls again to the winter low.



O. PARK, W. C. ALLEE AND V. E. SHELFORD, "A LABORATORY INTRODUCTION TO ANIMAL ECOLOGY AND TAXONOMY," THE UNIVERSITY OF CHICAGO PRESS.

(Adapted with permission after F. S. Russell and C. M. Yonge, "The Sea: Our Knowledge of Life in the Sea and How It Is Gained," Frederick Warne & Co.)

FIG. 6.—INTERRELATION OF THE SEASONAL CYCLES IN ABUNDANCE OF DIATOMS, LIGHT INTENSITY, PHOSPHATES AND NITRATES IN THE OPEN NORTH ATLANTIC

Many ecological influences are involved in this population cycle; for example, light intensity, water temperature, nitrate and phosphate salts and winds. Sea water is enriched constantly by inorganic salts that have been formed by bacterial action; these salts are utilized by phytoplankton in building their protoplasm. In the winter the concentration of these salts is high, but the light is insufficient for maximum photosynthesis, thus the diatom production is low. In the spring the production is rapid, since salts and light are ample; but meanwhile, the upper layer of water is warming rapidly and a discontinuity layer forms between the upper warmer and lower colder layers of water. This interposed layer, because of its electrical properties, prevents upwelling of nitrate and phosphate salts in sufficient amounts to be utilized by the rapidly growing diatom population. Consequently as summer approaches, the production begins to fall rapidly: the diatoms have exhausted the supply of these salts in the upper level, above the discontinuity layer. Summer, then, has a lowered population, even though light is ample for photosynthesis. (This, incidentally, is an illustration of J. von Liebig's "law of the minimum," which states that growth is limited by the factor that is operating in minimal quantity. As summer draws to a close, the falling temperature of the upper water approaches that of deeper waters, the discontinuity layer disappears and phosphate and nitrate salts are diffused upward by partial pressures, as well as by the mixing of waters that occurs during autumnal gales. Since the light intensity is still sufficient for photosynthesis, and since salts are again becoming available for metabolism, there is a second (autumnal) peak of diatoms. This latter does not equal the spring (vernal) peak since the approaching winter, with its lowered light intensity, interferes.

The production of vernal and autumnal peaks or pulses of phytoplankton in the temperate zones of the sea are paralleled by similar peaks in large lakes, but not necessarily in smaller bodies of fresh water.

Zooplankton consists of many groups of animals, most of which feed upon the phytoplankton. Zooplankton commonly is divided into several categories. There is the temporary plankton (meroplankton) consisting of planktonic eggs and larvae of nonplanktonic adults of both fishes and invertebrates. Permanent plankton (holoplankton), animals that live all their lives as planktonic individuals, makes up the rest of the zooplankton. Holoplankton includes protozoans, especially radiolarians and foraminiferans, many worms, jellyfishes and siphonophores, certain molluscs, such as the pteropods and heteropods, and especially crustaceans. These latter, being to the sea what the insects are to terrestrial habitats, include chiefly copepods, ostracods and amphipods. The copepod *Calanus finmarchicus* is an especially important member of the surface-water community since its numbers provide suitable food for many animals higher in the pyramid of numbers.

Nekton.—The nekton consists of animals that can move against currents. These are generally larger animals, including fishes and squids. Most commercially important fishes are nektonic; they feed upon plankton or prey upon other fishes, as the sharks. Marine mammals such as seals, porpoises and whales are nektonic.

Benthos.—This last division of marine animals includes those forms that inhabit the sea floor and subaqueous strata of the community. They consist of active benthos, such as many crabs and snails that move over the floor or burrow through the bottom substrate, and passive benthos, such as numerous colonial coelenterates and sponges that remain attached to the bottom as benthonic adults.

2. Layers of the Sea.—The sea is stratified both vertically and horizontally. The major divisions and some of the subdivisions will be characterized below.

Pelagic Division (The Water Mass of the Sea).—The water of the sea can be divided into two general zones on the basis of available light, the euphotic (lighted) and the aphotic (unlighted).

The euphotic zone, the upper 200 metres or so of water, is illuminated by daylight that is reduced gradually in intensity and spectral quality with increasing depth. The plankton inhabit this zone primarily: the phytoplankton must stay in the upper stratum of this zone to carry on photosynthesis and the zooplankton feed chiefly on these minute plants. Most nekton live here as well, since they too are directly or indirectly dependent upon the phytoplankton for food.

Below the euphotic layer is a deep aphotic zone, where light gradually fades out, the water pressure gradually increases and the temperature is relatively constant at a few degrees above freezing.

Benthic Division (The Entire Sea Floor).—This division consists of a series of more or less concentric zones that begins at the ecotone between terrestrial and marine, or fresh-water and marine, communities and extends seaward. The sea floor is divisible primarily into two subdivisions: the littoral system, extending from the shoreline to the edge of the continental shelf; and the deep-sea system, continuing from the continental shelf to the ocean deeps.

The littoral system is again subdivisible into two zones. The first of these is the eulittoral zone, from high-tide level on the shore seaward to a depth of about 40 to 60 m. This seaward limit coincides with the photosynthetic limit beyond which attached plants cannot grow. This photosynthetic limit naturally varies with latitude. Within the eulittoral zone is a relatively well-defined intertidal zone, which is bounded by high-water and low-water extremes of tide.

The eulittoral zone as a whole is rich in life, having an abundance of both floating and attached plants and animals. Its substrate is also highly variable; there are three chief types—sandy, rocky and muddy—as well as intergrades, such as sandy-mud.

The second littoral zone is known as the sublittoral. This extends from the seaward limit of attached plants to about the 200-m. line. The seaward limit of the sublittoral coincides more or less with the depth of the water at the outer edge of the continental shelf and also more or less with the depth that divides the aphotic and euphotic zones noted previously.

The deep-sea system is similarly divisible into two zones. The first of these is known as the archibenthic zone, and extends from the seaward limit of the sublittoral zone downward to about the 1,000-m. line. Its exact lower limit is variable. From about this latter depth to the sea bottom is the second deep-sea zone, the abyssal region.

The archibenthic zone is more or less physically uniform. Daylight is absent and the temperatures vary from about 5° to −1° C. Since there are no seasons, the seasonal rhythms so typical of the previously mentioned eulittoral zone are absent. Since there are no attached plants and no phytoplankton, the animal populations consist of parasites, carnivores and scavengers.

The abyssal zone is generally similar in physical conditions to the deep-sea zone, except for increasing water pressure. The abyssal populations are sparse, decreasing in numbers with increasing depth and with increasing distance from the shore. The animal life is thought to be endemic, that is, limited to the area, rather than impoverished ecological extensions from higher zones. Scar-

city of food appears to be the chief limiting factor. These grotesque animals that inhabit this zone are predators, scavengers or parasites. Since plants are absent, save possibly for bacteria, the abyssal forms are entirely dependent on the "rain" of food from the upper levels. However, this food is sparse, since the decomposing animals falling from the surface layers are broken down by heterotrophic bacteria in the upper and intermediate strata. Food input for the abyssal region, then, must be derived largely from the floating animals of intermediate depths. These latter animals are, in turn, dependent on the surface layers above them. The abyssal animals exhibit numerous structural adjustments to the great pressures of their habitat, and many deep-sea and abyssal fishes are provided with bioluminescent organs.

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(O. P.)

ECOLOGY, HUMAN. Human ecology is the study of the structure and development of human communities and societies in terms of the processes by which human populations adapt to their environments, taking account of the technological systems and patterns of social organization through which this adaptation is effected. As a discipline it represents an application of the perspectives of the biological sciences to the investigation of subjects included in the social sciences. The consistently naturalistic approach that this requires only became possible with the reappraisal of man's place in nature occasioned by the impact of Darwin's theory of evolution in the latter part of the 19th century. (*See* also ECOLOGY, ANIMAL; POPULATION ECOLOGY.)

Aspects of an ecological viewpoint are implicit in the observations of early thinkers like Plato and Aristotle on the relation of population size to the structure and stability of political institutions and, for example, in the contrasts between urban and rural modes of existence set forth by the medieval Arab scholar, Ibn Khaldun. Systematic work in human ecology, however, had to await the accumulation of geographic, ethnographic, and demographic data which got underway in the efforts of the 19th-century investigators. By the end of that century, it was possible to suggest theories dealing with such ecological problems as the determinants of population growth, the location of cities and the spatial pattern of economic activities, regional variations in disease and death rates and the evolution of the social division of labour. Although the idea of human ecology as a discipline gained currency only after 1920, the basis for its conceptual framework was laid by 1900 in such proposals as those of Friedrich Ratzel concerning "anthropogeography," Émile Durkheim concerning "social morphology" and C. H. Cooley concerning "territorial demography." The term "human ecology" was popularized in the 1920s in connection with the work in urban sociology of the so-called Chicago school—R. E. Park and his followers. It was perhaps a mere accident, however, that the first thorough elaboration of concepts and techniques in human ecology occurred in the context of studies of the contemporary metropolitan community. Specialists in disciplines related only remotely to urban sociology also found it fruitful to interpret differences among societies as reflections of varying environmental and demographic conditions and the modes of adaptation thereto. Ethnographic studies of tribal groups, for example, disclosed hitherto unsuspected connections among the sustenance technology, kinship structure, systems of social rank and the size and organization of settlement units.

Without reviewing the voluminous results of such specialized studies, it is possible to suggest in broad outline how the interrelations of population, environment, technology and social organization develop. As has been learned from research in prehistoric archaeology, the rudimentary technology of the Stone Age afforded a meagre return to efforts at gaining subsistence and provided a precarious protection against environmental hazards. Population groups were small and dispersed, with the consequence that only the most elementary division of labour based on age and sex differences could be effected. The transition to Neolithic agriculture in effect increased the carrying capacity of the land with a resulting augmentation of numbers. (*See* AGRICULTURE, PRIMITIVE: *Early Agricultural Communities.*) The sedentary mode of existence and the production of a small economic surplus beyond minimum subsistence needs provided opportunity for the perfection of craft techniques and a modest elaboration of specialized social roles.

Metallurgy, irrigation and other technological achievements of Neolithic villagers prepared the way for the urban revolution. Aggregations of population transcending the village in size and complexity of organization could be supported when the agricultural population of sizable regions was brought under the hegemony of centers of military power, and when caravan routes and sailing ships made possible extensive trade among cities. The early urban civilizations, however, like their imperial and feudal successors, remained low-energy societies.

Although the first phases of the Industrial Revolution may be said to have begun in the 18th century in England with mechanical inventions in the textile industries operated by water power, the effective multiplication of per capita energy supply awaited the application to machinery of steam power derived from fossil fuel; this innovation led to widespread industrialization and large-scale urbanization.

A salient feature of this sequence is that each stage represented a significant expansion over the preceding one in each component of the ecological complex. Populations increased, not only in the sense of increasing density within fixed areas but also in the territorial scope of the effective population unit. The environment was enlarged as the increasing capacity of technology created new resources and magnified the efficiency with which old resources were exploited. Organization underwent growth in numbers of units—specialized social roles, groups and strata—and in the ramifications of their interrelations.

The 20th century has witnessed no slackening of the rate of expansion. The population of the world, like that of most of its major regions, has grown at higher rates of increase than earlier history records. Technological innovation, ranging from the tapping of a new fundamental energy source, the atomic nucleus, to countless applications of new materials and processes, has proceeded at a seemingly accelerated pace. The scope and intensiveness with which the planetary environment is exploited have been without precedent. Organization on a world scale has become an economic reality, and world-wide international conflict has been followed by efforts toward a world polity. Meanwhile, within the nation-state new organizational forms and elaborations of old ones have co-ordinated ever more numerous and more diversified kinds of activities, whether the nominal locus of authority is government

bureaucracy or semipublic corporate enterprise. It is hardly surprising that such swift and radical changes should impinge unequally upon the areas and peoples of the world. The significant consequence, however, is that the several stages of the historical sequence are paralleled by contemporary differences among human communities, ranging from isolated groups in inaccessible regions still living under virtual Stone Age conditions, though increasingly brought within the orbit of development, to the pulsing metropolitan centres of the high-energy societies in which the leadership and impetus for change are concentrated.

Human ecology has its most significant contacts with plant and animal ecology at the point of common concern with the structure and dynamics of the total complex of community-habitat interactions, called the ecosystem. The diagnosis of a problem like soil erosion, for example, requires that patterns of human occupancy and exploitation of land be analyzed from the standpoint of their impact on the physical and nonhuman biotic components of the system. Changes in these necessarily alter—for better or worse—the conditions to which human activities must be adapted. The consequence of technological progress is man's growing capacity to make far-reaching modifications of the ecosystem, with a concomitantly increasing probability that these modifications will affect human welfare in complicated ways, difficult to anticipate. As the unique animal with the potential capacity to comprehend its own role in the ecosystem, however, man has the opportunity to develop ecological study so as to realize the advantage of foresight.

The holistic emphasis implied by the very idea of human ecology has been a continual threat to the unity of the discipline. Comprehensive treatises on the subject typically have represented expressions of social philosophy rather than empirically grounded statements of scientific theory. Indeed, numerous commentators have put forth the view that human ecology must remain primarily a philosophic viewpoint rather than aspire to the status of a systematic discipline. By the middle of the 20th century, however, promising attempts at scientific synthesis were beginning to appear, as in A. H. Hawley's *Human Ecology* (1950) and Julian Steward's ecologically based *Theory of Culture Change* (1955).

At the same time, researches in an increasing number of problem areas were manifesting the influence of ecological thinking, establishing human ecology as one of the most vigorous of the various intellectual movements cutting across traditional academic disciplines.

See also SOCIOLOGY: *Fields of Sociology: Human Ecology;* CIVILIZATION AND CULTURE; URBAN SOCIOLOGY.

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ECOLOGY, PLANT: *see* PLANTS AND PLANT SCIENCE.

ECOLOGY, POPULATION: *see* POPULATION ECOLOGY.

ECONOMETRICS, the empirical testing of economic theories and the expression of economic relationships in mathematical form. It was developed during the 1930s when, as a consequence of the economic crises in various countries, exact quantitative information was needed about the possible consequences of measures of economic policy. Though economic theory provides the government with ideas about the process which determines the economic magnitudes it does not quantify these ideas. Moreover, without empirical verification it is impossible to find out what economic laws are valid in a specific situation. It is the task of econometrics to carry out this empirical verification and to establish quantitatively the relationships which appear to be valid. If, for instance, economic theory points out that changes in the demand for certain consumer goods are determined by changes in income and prices, the econometrician tries to find out whether in fact this relationship exists. He also tries to describe it by calculating income and price elasticities, which are defined as the ratio between a percentage change in income and price respectively and the induced percentage change in demand. Only when all relevant relationships between economic variables have been quantified has knowledge been obtained which can be used as a guide for economic policy. In this way, J. Tinbergen (one of the first econometricians) carried out a statistical testing of the business cycle theories developed in economics and collected many coefficients describing the interdependencies among economic phenomena.

The statistical description of economic phenomena made great advances between 1920 and 1960. In several countries a complete picture of all economic activities could, by the early 1960s, be given every year. This is usually carried out by means of a system of national accounts on which the flow of goods and services between various sectors of the economy are recorded. As a rule the following sectors are distinguished: households, enterprises, government, foreign countries and capital formation. (*See* also NATIONAL INCOME ACCOUNTING.)

Economic quantities are as a rule measured in money units. If, however, the development of a certain quantity in several successive years must be shown, it is easier to make use of index numbers. The value of the item in one of the years, the basic year, is put equal to 100 and those of the other years are expressed as a percentage of it. These percentages are called index numbers (*q.v.*).

A well-known index number in many economic problems is that of retail prices. It is a weighted average of the price indices of various consumer goods. In the United Kingdom, for instance, it contains 10 main groups of goods; *viz.* food, alcoholic drink, tobacco, housing, fuel and light, durable household goods, clothing and footwear, transport and vehicles, miscellaneous goods, and services. Each group consists of a number of sections. There are 91 such sections. The weighting coefficients are the shares of each commodity in the total consumers expenditures derived from surveys of 11,638 households. (*See* COST OF LIVING.)

The main task of econometrics is to express in quantities the relationships which, according to economic theory, exist between economic phenomena. Attempts are made to express these relationships in mathematical equations, or, in other words, to "explain" the historical development of a certain economic variable by writing it as a function of other economic or noneconomic quantities, the explanatory variables. As all economic variables are mutually dependent, it is not sufficient to construct isolated equations. A complete system of these equations must be set up by means of which all important variables can be described simultaneously. Such equation systems are called econometric models. The greater part of the activity of econometricians had, until the early 1960s, been devoted to such "model building."

The first step in an econometric analysis is to specify the equation to be used for the description of a certain variable. This means that the economic and noneconomic quantities to be used as explanatory variables, and the mathematical form of the equation, must be determined by theoretical reasoning. As a rule, linear or logarithmic linear forms are chosen as a first approximation. So, for example, it can be deduced from the theory of consumer's behaviour that total national consumption in a certain year depends, among other things, on the national income and the price level.

A simple linear function to express this relationship can be written as:

$$C_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 p_t + u_t$$

If a logarithmic linear function looks more adequate the equation $\log C_t = \alpha_0 + \alpha_1 \log Y + \alpha_2 \log p_t + v_t$ can be used. In these equations the symbols have the following meaning: C_t = consumption in year t; Y_t = national income after taxes, in year t; p_t = average level of consumer's prices in year t; u_t and v_t = error terms. The parameter α_0 is a constant term and has, in general, no economic meaning; α_1 (in the first equation), the marginal consumption quota, shows what percentage of a given change in income will be consumed and α_2 measures the influence of price on consumption. In the second equation α_1 gives the ratio between the percentage changes of consumption and income. The variables u_t and v_t are introduced because the equations, given Y_t and p_t, do not determine exactly the quantity consumed, C_t. There are several reasons why the equations, used for practical purposes, are only approximations. In the first place they do not include all the variables which influence C, only the most important. So, for instance, income distribution is left out. Furthermore they are only linear approximations whereas in reality the relationships might well be curvilinear. Finally the equations may be disturbed because the variables C, Y and p may contain errors of measurement. The error term of an econometric equation is considered as a stochastic variable, which means that it can take on a number of different values each with a certain probability. When specifying the equation the properties of the probability distribution of the error term, which seem adequate in any special case, must also be given because they are needed in the next stage of the analysis, the estimation of the parameters. As a rule this distribution is supposed to be normal with zero mean and a certain finite standard deviation which is independent of the explanatory variables, and constant in time.

When the equation has been specified the parameters can be estimated. In practice this is done in most cases with the help of data on the recent development of the variables concerned. In that case such parameters are chosen that an equation is obtained which fits as well as possible the historical development of the variable to be explained. The concept "fits as well as possible" must be interpreted statistically. A criterion for the accuracy of fit which is very often used is that the estimates must be such as to minimize $\Sigma_t u_t^2$. This criterion is known as "the method of least squares."

When equations have been established in this way for all important variables of a certain economy, they form together an econometric model of that economy. Though, as already mentioned, all economic quantities are mutually dependent, the interdependency is not equally strong in all sectors. For a small economy, for instance, the economic development in other countries is very important; on the other hand the business situation in a small country will not have any influence on, say, world trade. The same phenomena can be found within a domestic economy. So, for instance, certain items of government expenditure will influence the economic process without being determined by economic variables. Therefore, in an econometric model two kinds of variables must be distinguished; *i.e.*, dependent or endogenous variables and independent or exogenous variables. The endogenous variables are determined by each other and by the exogenous variables, whereas the latter are fixed by noneconomic factors or by factors outside the economy.

A model is called complete when there are as many equations as there are endogenous variables. The endogenous variables can then, by solving the equation system, be expressed as functions of the exogenous variables. These functions are called reduced form equations. By means of these equations the impact of changes in the exogenous variables on the endogenous variables can be analyzed.

Among the exogenous variables there may be some which can be determined by the government. Government expenditure has already been mentioned; other examples are tax rates, interest rates and some kinds of investment expenditure. In certain situations these variables, as instruments of economic policy, can be used by the government to adjust undesirable economic developments to the targets of economic policy. The reduced form equations provide the quantitative information about the possible consequences of economic policy measures which is then needed.

In the description given much attention has been paid to macroeconomic phenomena. The examples given refer to quantities such as national consumption, national income and so on. Econometrics deals also with microeconomic analyses. So, for instance, much work has been done in the field of analysis of household surveys, which give insight into the structure of consumers' expenditure. The same is true with regard to investment behaviour of entrepreneurs.

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ECONOMIC ANTHROPOLOGY. Economic anthropology, a branch of social anthropology (*q.v.*), is the comparative study of the relations between the system of allocation and management of the resources of societies of various types and the structure and values of those societies. For a major part of its basic analysis economic anthropology relies upon the principles of economics. But the concrete generalizations of economics deal primarily with the institutions of western-type industrialized societies; *e.g.*, business firms, banks, wage-labour. Most of the economic systems which anthropologists first studied, in Oceania and Africa, were involved only peripherally with such institutions or lacked them entirely—some were completely ignorant of money—and hence the description of such systems had to be worked out largely without the help of economists. The earlier name of "primitive economics" often given to the study reflected the emphasis on its separate, exotic character. But as "primitive" communities all over the world have come more closely into contact with civilization, their economic life has taken over many western forms; and modern economic anthropology has developed correspondingly, in order to deal with these and also with the economics of a range of peasant communities with relatively complex institutions, such as those in Latin America and the orient.

The first task in economic anthropology was to demonstrate the existence of economic data and problems in primitive communities and their relevance for an understanding of the social life of the people. In the 19th century K. Bücher, an economist, and H. Schurtz, a sociologist, showed how primitive forms of labour, exchange and wealth were related in function to modern western forms, and in 1915 W. Koppers gave a synthesis of material and views over the whole field. But such work was necessarily based mostly on second-hand, fragmentary data; it often confused economic with technological problems; and it was couched in terms of the preconceived formal schemes of an evolutionary or quasi-historical character that were then current. The next task was to examine the economic institutions of primitive peoples by systematic investigation on the spot. Various fieldworkers, notably B. Malinowski and W. E. Armstrong, showed the economic effects of magical beliefs and practices, the social as well as the commercial significance of primitive systems of exchange and credit, and the general functional interdependence between systems of mobilization and control of wealth and systems of social status and social grouping. The more general significance of some of this work for the typology of societies was developed theoretically, as by R. Thurnwald and M. Mauss.

Later studies described the economic systems of particular communities or analyzed particular institutional forms comparatively. The major factors responsible for stimulating or inhibiting productivity in primitive and peasant economic systems have become fairly clear. Studies of incentives to labour, co-operation in work, and distribution of the product have brought out the delicate interplay between individual and social factors, such as personal ambition, community standards of industriousness, economic obligations attaching to kinship and household ties, and the sanctions of ceremonial and ritual performance (*see* LABOUR, PRIMITIVE). Studies of land tenure have shown the complex sets

of rights that may be held regarding particular parcels of land and the special significance in many societies of land rights attaching to membership of a descent group such as a clan or a lineage (*see* LAND TENURE, PRIMITIVE). They have also explained how, for ritual or symbolic reasons, land is frequently regarded as an asset which is not transferable by ordinary purchase and is therefore in a special economic category. Studies of capital formation have shown how even in the technologically simplest economic systems some types of capital goods occur and some principles of prudent management of assets are in operation. But the importance attributed to disbursement in primitive economic systems and the close relation between expenditure and social status has also been demonstrated. Saving for specific purposes is approved, but the object of saving is often to provide for a "feast of merit," a "potlatch" (*q.v.*), a wedding celebration or other ceremonial occasion for mass consumption of wealth. Participation and especially leadership in such a ceremony may represent the most significant avenue for achievement of status in the community, and productivity of the economic system may be geared in large degree to this socially defined aim.

Much attention has been paid in economic anthropology to examination of processes of exchange, which are often very complex and usually exemplify the intricate interrelationship between economic and social procedures and values. Primitive communities are hardly, if ever, self-sufficient and may engage in elaborate exchange of material goods, or of goods and services, including those associated with intermarriage. In this sense a purely "subsistence economy" is hardly ever found; even the most isolated community usually manages to have some trade in ornaments or raw materials, or exchange of women as wives, with its neighbours. But as Malinowski and Mauss showed, much exchange is for symbolic, not material, ends. The acts of transfer of goods and services, while affecting the concrete resources of the parties involved, also strengthen their social and political ties and represent, even in a mystical way, basic principles of social structure and social unity.

Analyses in economic anthropology are for the most part qualitative, but there has been an increasing tendency, illustrated, *e.g.*, by the work of R. Firth, S. Tax and C. S. Belshaw, to reinforce the analysis by quantitative data. The significance of such data is not simply to illustrate the theoretical propositions advanced but to show the magnitude of the economic system and the degree of possible variation in the factors involved. For instance, from a certain ascertained level of productivity, making allowance for maintenance of equipment and for a stated set of household and community wants to be met, the limits of capital accumulation can be estimated fairly closely. Quantitative data have also revealed the range of peasant household consumption and the relative importance of the management role of a wife in a domestic unit in which the husband is ostensibly the dominant partner.

The trend in later economic anthropology has been to study societies no longer "primitive" but using some institutions of western type. Studies have been made of peasantry growing cash crops such as cocoa or rubber for the international market or supplying labour to industrial concerns; or of peoples who have abandoned their traditional rural life for an urban market economy. Such studies can have an obvious practical interest. Moreover, growing interest in the economic development of communities that have been technologically backward has turned the attention of economists more closely to the social factors involved and hence to economic anthropology.

See also CURRENCY, PRIMITIVE.

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ECONOMIC DEVELOPMENT. Although economic development has been defined in various ways, two definitions vie for prominence: (1) the growth of aggregate output of a country; and (2) the growth in per capita output. At the outset it is worth observing that it is possible to have increases in aggregate output without at the same time enjoying any growth in per capita output. For example, if the rate of growth in aggregate output is 2% per year and the rate of population growth is also 2% per year, the economy is growing from the aggregate point of view but not from the point of view of output per person. For some problems a knowledge of changes in aggregate output might be the only factor that is significant while for others the per capita value might be the one that is of major importance. For example, if a country has limited foreign exchange, an increase in aggregate output may imply an equal increase in the demand for foreign exchange. With such a problem in mind, looking at development from the aggregate point of view would be the correct approach. On the other hand, if we are concerned with planning for development, and our aim is to raise the standard of living of the mass of the population, then a per capita index is clearly the more pertinent one. In this discussion we shall employ per capita output as our index of development.

Other indexes of development have been suggested from time to time. For example, the level of per capita consumption is considered significant since it is closely related to some notions of the welfare of the mass of the population. However, this does not take into account the extent of investment taking place currently. If we consider two countries that have the same level of per capita consumption but differ in their levels of per capita investment, then it would appear that the country with the higher per capita investment is developing more rapidly than the other because it is creating capacity for greater future output. From this point of view, per capita output would appear to be the more pertinent concept.

In discussions of development it is real output and not simply the money value of output that is of significance. Changes in real output reflect the changing capacity of the economy to produce goods and services, while a change in the money income may reflect nothing more than a fluctuation in the value of money. Thus, an index of development should be one in which money values have been deflated (or inflated, as the case may require) to account for changes in the price level. Also, normally it is net rather than gross output that is considered. That is, we must deduct from gross output for the year the amount necessary to replace the capital goods that have worn out during that period.

If we look at statistics of per capita output in different countries it becomes apparent that there are enormous gaps between the per capita output of advanced countries and of underdeveloped areas. For example, the United Nations' estimates of per capita output for various countries for the years 1952–54 revealed that the per capita output for the United States was $1,870, while that of Burma was only $50. Although it has been argued that in any real sense the level of income in the United States was not really 37 times higher than that of Burma, it is nevertheless true that the gap between these two countries was unquestionably large. The majority of non-European countries have a level of per capita income of less than $200 per year per person. In fact, such per capita estimates exaggerate the standard of living of the typical person in such countries, both because they include investment funds and because they do not take into account the fact that there is a skewed distribution of income so that the typical worker receives a wage below the average income level.

In a sense the problem of the underdeveloped countries is a problem of recent history. In all ages some countries have been richer than others but the great gaps that exist in the 20th century are larger than those of earlier centuries. It is likely that before the Industrial Revolution (*q.v.*) in the west very few countries had per capita outputs that were more than three or four

times that of any other country.

Among the reasons why some countries enjoy very high per capita incomes is the flood of inventions and technical knowledge that followed in the wake of the Industrial Revolution. The knowledge necessary to produce relatively large outputs per head is today available to all countries. Such was not the case two centuries ago. In other words, two centuries ago the maximum output achievable irrespective of the amount of capital available was very much lower than it is today. Hence, the problem of underdeveloped countries is not one of achieving increases in knowledge but rather one of accumulating capital and improving the quality of the work force to the degree necessary to employ the techniques required to attain high levels of output. Furthermore, we shall see below that it is possible, although unlikely in many cases, to bridge the gap between low and relatively high levels of output in less than half a century.

Characteristics of Backward Economies.—Backward economies usually exhibit a number of characteristics that are in part a reflection of the state of backwardness and in part help to explain why the state of backwardness may persist for long periods of time. The major characteristics may be summed up as follows:

In all backward economies a high proportion of the population, often above 70%, is employed in or dependent upon agriculture. This contrasts sharply with the less than 10% of the population dependent on agriculture in a country like the United States. It is usually believed that there is absolute overpopulation in the agricultural sector, so that one could reduce the number of workers in agriculture and still obtain approximately the same total output. There is normally very little capital per head and often only the crudest equipment is employed in the agricultural sector. The large mass of the people have practically no savings; there is among them a relatively high level of indebtedness in comparison to income. Savings are usually achieved by a landholding class whose personal values are often not conducive to investment in industry and commerce. Most consumption expenditures are on basic foods and necessities. Output in agriculture consists mostly of cereal grains and primary raw materials with exceedingly low amounts of protein foods. This is in part due to the fact that if one acre devoted to cereals produces a certain number of calories, it usually takes between five to seven acres of equally good land to be used as pasture in order to produce the same number of calories in meat products. The level of education in underdeveloped areas is, for the vast majority of the people, exceedingly elementary. Over half the adult population is usually illiterate. Such economies usually lack a strong and numerous middle class. The status of women is considerably inferior to that of men and their occupational opportunities are usually limited. For the bulk of the population, economic and social behaviour is determined by tradition.

Patterns of Development.—As might be expected, the process of economic development normally leads to a change in all of the characteristics we have mentioned. To begin with, development inevitably implies a shift of the labour force away from agriculture. For example, a highly developed European economy will normally have no more than 20% of its work force in agriculture, about 40% in industry, and the rest in various types of trade and service activities. This is true even for countries that continue to be exporters of foodstuffs after they industrialize, as in the cases of Denmark, the Netherlands and New Zealand. This simply reflects the fact that economic development is accompanied by the introduction of labour-saving machinery in the agricultural sector. The other side of this coin is the growth of the manufacturing segment of the economy, up to a point, as the per capita income of a country increases.

The changing pattern of tertiary industry in the course of development is not clear. Some authorities, such as Colin Clark and A. G. B. Fisher, have argued that the tertiary sector (trade, transport and services) increases indefinitely at the expense of agriculture in the course of economic growth. However, others, such as P. T. Bauer and B. S. Yamey, have claimed that there is usually a significant amount of minor trading activities carried on by the bulk of the population in backward economies, and that with the introduction of a factory system there may actually be a diminution of the proportion of the population engaged in such activities. Hence, the Clark-Fisher generalization is based on a statistical illusion, in part, due to the fact that such trading activities in backward economies are carried out by women whose husbands are engaged in agriculture, and who themselves live on the land and hence are usually classified as dependent on agriculture. But be that as it may, tertiary industry as a well organized and specialized activity does appear to increase in the course of development.

One of the main manifestations of development is capital accumulation. Indeed, both the quantity of capital and its quality will increase with increases in per capita output. In addition, the rate of savings of the majority of the population is also likely to increase as income increases. However, this aspect of the pattern of growth must not be exaggerated. Most nongovernmental savings in any capitalistic economy are not made by wage earners but rather by business firms in the form of undistributed profits, or by recipients of property income in the form of dividends, interest earned and rents.

Consumption patterns are also inevitably altered as a country's per capita income increases. The proportion spent on foodstuffs declines while that spent on manufactured products and services increases at a greater rate than the increase in the level of per capita income. Also, the nature of foodstuffs consumed shifts away from cereal grains toward high-protein foods.

The level of education and the quality of the population inevitably increases as a result of development. By the quality of population we have in mind only the acquired characteristics and not innate capacities.

In countries where development has taken place the status of women has usually risen considerably. Also, women have come to participate in a wider variety of occupations. This factor generally has had two definite influences. First, with a high proportion of women in the work force, output per capita has increased. Second, it has been claimed that this phenomenon has helped to induce the reduction in the birth rate that usually accompanies industrialization. It has also been argued that in advanced countries socio-economic behaviour is less tradition-bound than in underdeveloped economies. This in part may be due to the gradual movement of the population from rural to urban areas and to the simultaneous increase in the variety of occupational opportunities.

In addition, the scale of economic undertakings usually increases in the course of development. This is especially likely to be true in the nonagricultural sector. Not only is manufacturing shifted out of small cottage industries into factories, but the size of factories of various types generally increases with the expansion of the economy.

Capital Accumulation and Development.—By capital accumulation we mean the increase in the man-made equipment useful for economic production—machinery, tools and implements of various sorts, buildings and other structures, and inventories of goods. The process of development involves the accumulation of capital at a more rapid rate than the increase in the labour force so that there is an increase in the amount of capital per worker.

The analysis of development has been carried out with the aid of the concept of the incremental capital-output ratio. By the incremental capital-output ratio we mean the addition to capital required to obtain an additional unit of net output. For example, in the United States the capital-output ratio for many decades has averaged around 3:1. This means that a $3 addition in the capital stock will yield a $1 increase in net output. Thus, if an economy saves 9% of its income, and has a capital-output ratio of 3:1, it could expect a 3% increase in output per year.

Using this concept we can compute the rough relationship between required rates of savings (and investment) and the consequent rates of output that may occur. For example, a rate of net savings (out of net national income) of 21% per year, and a capital-output ratio of 3:1, would enable such an economy to grow in aggregate output by 7% per year. Such a rate of growth, when compounded, implies a doubling of an economy's output

about every decade. To make this example more striking, we might consider that an underdeveloped country would have a per capita income of roughly $100, while a developed European economy, such as Belgium, would have a per capita income of about $800. Now, if our underdeveloped economy grew at the rate of 7% per year, and if its population remained stationary, it could reach the level of income of an advanced European economy within three decades. Of course, rates of savings of 21% per year are exceedingly high and almost unknown, although not impossible.

In many underdeveloped economies, rates of net savings are less than 8% per year and rates of population growth are often above 2% per year. Given a rate of savings of 8%, a capital-output ratio of 4:1 and a rate of population growth of 2% per year, we would have an economy that had no growth at all in its per capita output. Hence, to find the reasons for a lack of economic development we must discover the reasons for low rates of savings, for relatively high capital-output ratios and for relatively high rates of population growth.

Various reasons have been suggested for the low rate of savings (and investment) in underdeveloped countries. First, it has been argued that the simple fact that per capita incomes are very low implies that the bulk of the population has to live close to the level of subsistence and that as a consequence there is little left for savings. Second, since underdeveloped countries lack a significant middle class, and it is in this class that we usually find the entrepreneurial groups in most advanced economies, there is a very limited amount of investment activity to induce adequate savings. Third, it has been argued that the landlord class, out of whose income savings could come, is not interested in improving the nature of its landholdings and hence saves little for that purpose. It has further been suggested that the landlord class is generally motivated toward conspicuous consumption in such areas. All of this is not to suggest that net savings do not take place in such economies, but that the savings are not sufficiently large to offset the rate of population growth.

Population Growth and Development.—Historically, high rates of population growth have always accompanied economic development. The reasons for this may be gleaned from our knowledge of the usual patterns of demographic change. In underdeveloped countries both birth rates and death rates are usually quite high. However, the improvement of sanitation and the growth in the general level of public health, which are a consequence of development, bring about a reduction in the death rate. However, these same phenomena do not initially affect the fertility rate, and the increasing gap between birth and death rates manifests itself in an increasing rate of population growth. Indeed, in many countries, *e.g.*, Mexico and Malaya, the rate of population growth is above 2.5% per year. However, any country that has developed successfully has experienced at some point in its history the onset of sustained fertility decline. It is this phenomenon that has reduced the population hurdle to growth and has facilitated further development in advanced countries.

The discovery of powerful insecticides and advances in public health techniques have led to the development of inexpensive means for the eradication of epidemic diseases. This has enabled some underdeveloped countries to reduce their death rates considerably, even in the absence of general economic improvements. The effect of such measures has been to increase actual and potential rates of population growth, and it has tended to magnify the population hurdle to development.

The importance of sustained fertility decline can be seen from two points of view. First, a reduction in the rate of population growth makes it easier to overcome the obstacles of fixed or not easily expandable factors of production, such as land. Second, a falling fertility rate alters the age composition of the population; it reduces the number of children per adult and hence decreases the burden of dependency. Indeed, it has been estimated that the reduced burden of dependency as a result of reasonably falling birth rates may enable such an economy to increase its investment and output to such an extent that the consequent per capita output would be higher by some 30% within three decades than would be the case in the absence of fertility decline.

The Strategy for Development.—There is no complete agreement among economists as to the best strategy to foster economic development in backward economies. Some have argued in favour of gradual development. This group views population growth as a factor that is dependent upon sociological considerations and that is independent, for the most part, of what happens in the economy. They argue that economies would naturally develop if left alone and recommend the introduction of institutional changes that would release the productive powers within it. Thus they advocate the removal of such restrictions on enterprise as tariffs, currency controls and export quotas, and restrictions on the mobility of either capital or labour. They believe that given such a restriction-free atmosphere, an economy would develop gradually of its own volition.

While not against such institutional changes, the opposing school argues that certain necessary types of economic activity must be engaged in on a fairly large scale if they are to be effective. For example, the introduction of a modern transportation system and the building of dams for the irrigation and reclamation of land are, by their very nature, large-scale projects which may often require much larger amounts of capital than would normally be obtained through voluntary savings. Furthermore, they maintain that since the rate of population growth is likely to increase as a consequence of development, the rate of capital accumulation must be sufficiently large to overcome the population hurdles in the earlier stages of economic growth. Therefore it has been argued that only with a fairly large initial effort can we hope to induce a rate of change sufficient to foster sustained growth.

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ECONOMIC FORECAST. An economic forecast, also known as a business forecast or trade forecast, is a statement predicting economic aspects of future events. Some forecasts cover the whole range of economic affairs and others are limited to specific industries or to the effects of certain economic policies. When an economic forecast deals with all branches of activity it may be described as an analysis of the business outlook. Such over-all forecasts are of value in answering broad questions of public policy and in serving as background for special forecasts of limited scope.

In making detailed analyses the forecaster may be concerned with any of the specific events or variables of interest to businessmen, individual investors or government officials. In business planning, forecasting enters into current operations, as in scheduling production for the months immediately ahead. It also helps to determine longer-range programs, such as deciding upon new products or new plant locations. Forecasts by government units are specialized in varying degrees; they may predict numbers of school-age children in future years, traffic burdens on designated highways or revenues from existing or proposed taxes.

Attempts to put economic forecasting on a scientific basis have met with only partial success. The most rigorous forecasters work with quantitative measures of activity or position, such as national income, business inventories and money supply, and they specify in terms of causal influences or relationships why the predicted result is to be expected. In a complex economy, however, many factors have to be considered; interrelations between them are often not fully understood; and disturbances originating outside the system frequently affect the outcome. Hence, the actuality never quite coincides with the forecast.

Development of Forecasting.—Through the centuries, personal judgment was the primary resort of the business executive. His decisions were based on his own forecasts, whether or not they were consciously worked out. Success was dependent upon his ability to sense the implications of the situation without explicit

definition or measurement of the forces making for change. Striking results were sometimes achieved, but extreme variations in accuracy occurred. Although still widely used, the process is subject to imaginative and emotional elements, and this kind of prediction commands little confidence today.

Not until the early years of the 20th century had statistical techniques or the theory of economic fluctuations developed sufficiently to make scientific forecasting possible. Then forecasters began to apply both statistical techniques and the theory of economic fluctuations with great enthusiasm. Unfortunately, the problem was oversimplified in various ways, and three decades of effort culminated in widespread disillusion. Although most of the elements of accepted business-cycle theory appeared in this early period of trial and error, the very multiplicity of theories led to confusion. Some were couched in terms of real production and consumption, others treated monetary and credit developments as decisive, and others focused on psychological phenomena, such as waves of optimism and pessimism.

Shortcomings of statistical analysis were also revealed. Using available time series, or indexes obtained by combining such series, statisticians attempted to segregate various components of past movements—such as trends and cycles—and then applied these components in projecting future movements. Long- and short cycles of great regularity were established; most widely accepted were a long cycle averaging 18 years and a short cycle averaging 3½ years in duration. (*See* BUSINESS CYCLE.) These cyclical patterns were used, alone or in combination with trend lines and other components of economic change, to predict the next movement. However, actual economic fluctuations did not display sufficient regularity to give these methods much value as forecasting devices. Moreover, both theory and practical analysis were hampered in this early period by lack of data on over-all economic activity and on such important segments as investment and consumption.

In the late 1930s two developments were largely responsible for a rebirth of forecasting: the formulation of an improved theoretical framework following the publication of J. M. Keynes, *General Theory of Employment, Interest and Money* (1936) and the compilation of national income and gross national product data. These new theories and data systems were brought into use as aids to planning and control by the United States and Great Britain during World War II. The importance of these tools in analysis and policy formation also gained official recognition in other countries, notably Sweden and the Netherlands, and advisory or planning agencies were set up by the governments concerned to ensure against any lack of preparedness for dealing with future recessions in their early stages.

Analysis of Economic Causes.—After World War II, forecasters focused their attention on patterns of economic causation. Each forecast was treated as a research problem in which the objective was to evaluate the importance of the causes that would be operating in the period ahead and from this analysis to formulate a hypothetical projection describing what was likely to happen. Among the "causes" commonly relied upon were: automatic economic processes, including both growth and cyclical movements or relationships; planned and controlled activities; and disturbances.

The older method of projecting growth by means of a fixed trend line has largely fallen into disfavour. Neither time itself nor the growth rates experienced in the past are causal factors. The causes of economic progress are of two kinds—the technical, including innovations, research and capital accumulation; and the demographic, including population and rates of participation in the labour force. By taking a certain number of workers, working a certain number of hours at a projected level of efficiency, an estimate of future output is derived. Since the underlying causes operate slowly, the method is of use only in making long-term forecasts. Like the trend line, it abstracts from short-term influences and requires an assumption that full employment will prevail at the target date.

Inflexible cyclical patterns have also been discarded. Modern business-cycle analysis in this tradition relies not on the periodicity of the cycle, but on observed sequences in the movements of specific variables related to it. Some variables consistently lead, so that their reversals may be judiciously interpreted as indicators of the approach of turning points. However, for an improved account of business cycles in causal terms, forecasters have turned toward the development and use of relationships between variables, particularly stock-flow relationships. The latter explain how cyclical movements develop from successive imbalances in the position of stocks and in the flows by which the stocks are created and used. In combination, these relationships can be used to project a pattern of changes in the variables considered. The most rigorous application of this approach utilizes equation systems called econometric models. The model expresses the interrelations between variables in such a way that, given current knowledge of some variables and future estimates of a limited number of others, called exogenous variables, a forecast can be obtained by simultaneous solution of the equations. The strong point of this method involves a weakness: rigorous mathematical treatment forces the exclusion of much that could readily be utilized by other procedures.

Among the variables often treated as exogenous in econometric models are business investment in new plant and equipment and government purchases of goods and services. Statistical methods are widely mistrusted in forecasting such variables because discretionary elements are considered more important than automatic responses. Forecasters therefore resort to analysis of plans and programs as a guide to future rates of expenditure. Quarterly surveys of a large number of business concerns are taken to determine their planned capital outlays in the quarter or year ahead. Detailed studies of the federal budget, of legislative enactments and of other current developments are made to obtain clues to future rates of government spending. However, plans are generally subject to change without notice, so the outcome can rarely be considered assured.

In addition, results may be seriously affected by disturbances not taken into account when the forecast was prepared; these include international military or political developments, labour disputes and unusual weather. Because neither these nor the autonomous elements in key variables can be handled in equations, many forecasters prefer a flexible form of quantitative analysis. As a rule, the forecaster proceeds by analyzing and projecting the expenditures of important groups, such as government, business and consumers. He then translates this preliminary forecast into income and employment and checks the various projections in terms of the known interrelationships between variables. Finally, successive approximations are taken to obtain a forecast that takes account of everything known about the specific variables and at the same time combines them into an internally consistent pattern of change.

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ECONOMIC MAN, a concept traceable back to the writings of the classical economists, especially to the works of Adam Smith and David Ricardo (*qq.v.*). It was assumed by most of the classical writers that political economy was a study of wealth and that mankind was occupied solely in acquiring wealth. While John Stuart Mill, one of the classical economists, did not use the term "economic man," he described the nature of the principal hypothesis which makes the abstraction of the "economic man" possible. It is generally recognized that Mill wrote the clearest statements of the body of doctrine identified as classical economics. "Political economy," he said, ". . . does not treat of the whole conduct of man in society. It is concerned with him solely as a being who desires to possess wealth, and who is capable of judging of the comparative efficiency of means for obtaining that end. It predicts only such of the phenomena of the social state as take place in consequence of the pursuit of wealth. . . . Political economy considers mankind as occupied solely in acquiring and consuming wealth." (*Essays on Some Unsettled Questions of Political Economy*, pp. 137–140).

It was assumed that, under the influence of these strictly eco-

nomic motives, man would express himself in economic decisions that would always maximize his returns; that he would prefer the greater to the lesser gain, pay the lowest price for all things purchased and exert every effort to lower costs and increase profits; sheer accumulation of wealth would know no limit. Ethical and moral considerations were negated to the one absorbing passion and motive, the desire for wealth. This concept created an unethical, unscrupulous, money-minded person who lacked the attributes necessary to live in a society made up of persons with other motivations. The behaviour of the "economic man" together with the gloomy forebodings that population would increase faster than food supply, helped create the impression that economics was indeed "the dismal science."

The concept has long since lost its appeal. There is no economic man any more than there is a social or a political or a religious "man." Economists of the 20th century, as Alfred Marshall remarked, are concerned "with man as he is; not with an abstract or 'economic' man, but a man with flesh and blood."

The values that determine human behaviour are vastly more complex and varied than they were when the concept was developed. The utilitarian emphasis on "good" and "happiness" helped to change the emphasis from the wealth or pecuniary motivation. It has been shown that man has many interests other than his interest in money; that his convictions, feelings and passions are determining factors; that he desires security, leisure, independence, justice and freedom in many forms. The virtually unlimited human wants and the efforts expended to satisfy them from limited resources is a much broader concept than conceived by the classical writers. In fact, economics is a science that studies human behaviour as a relationship between ends and scarce means, which have alternative uses. This is a far more comprehensive view than that which gave birth to the "economic man." (J. F. Be.)

ECONOMIC PRODUCTIVITY. Productivity has long been used by economists as a theoretical and interpretive concept, and its measurement has found varied applications. Economic productivity is the ratio of the output of a good or service, or collection of goods or services, to the input of one or more of the factors producing it. This ratio may be in the form of an average, expressing the total output of some category of goods divided by the total input of a factor or factors. Or it may be incremental, expressing the ratio of a change in output to the associated change in input. Most available productivity data are of the first type.

This article is organized according to the following outline:

I. Uses of Productivity Measurements
II. Factors That Determine Productivity Levels
III. Historical Trends
  1. Industrial Development
  2. Labour Productivity
  3. Productivity of Other Factors
  4. Trends in Productivity
  5. Relation Between Productivity and Output
  6. Rates of Growth
IV. Comparisons of Productivity Levels
V. Problems and Limitations of Productivity Measurement

In principle, any of the inputs associated with a given productive effort can be used in the denominator of the productivity ratio. Thus, one can speak of the productivity of land, labour, capital or subcategories of any of these factors of production (*q.v.*). One may also speak of the productivity of a certain type of fuel or raw material, or combine inputs to determine the productivity of labour and capital together, or the productivity of all factors combined.

Labour is by far the commonest of the factors used in measuring productivity. One reason is that, in terms of value, labour represents the largest input. Although great variation exists from product to product, labour absorbs, on the average, from two-thirds to three-fourths of the value added in economic activity. A second reason is that labour inputs are more easily measured than certain other factors, such as capital. This is especially true if by measurement one means simply counting heads and neglecting differences among workers in levels of skill and intensity of work. In addition, data relating to numbers of workers are often readily available, while information on other productive factors may be difficult to obtain. Not least important in explaining the emphasis on labour as an input is the fact that, historically, technological advance has made itself felt through the displacement of labour—that is, through increases in labour productivity—rather than through the displacement of other factors. Some kinds of labour productivity measures are thus valuable as indicators of this process and of the resulting improvements in man's material well-being.

The productivity of land, though it receives considerably less attention than the productivity of labour, also has been of historical interest. In ancient and preindustrial times the products of the soil comprised the bulk of total output, and hence the productivity of land constituted the major ingredient in a people's standard of living. Soil of low productivity could, and over much of the earth still does, mean poverty for a region's inhabitants. However, it is no longer generally believed, as it was in past centuries, that a country's economic well-being is inevitably tied to the fixed productive powers of the land. The productive potential of the land has proved not to be fixed but to be susceptible of great expansion through the use of modern agricultural methods. Moreover, industrialization, where it has taken place, has greatly reduced man's dependence on agriculture. These circumstances, together with expanding opportunities for trade, have enabled some countries to overcome in substantial degree the handicaps of a meagre agricultural endowment.

The productivity of capital—plant, equipment, tools and other physical aids—is a subject of long-standing interest to economists, though concern with its empirical aspects is of more recent origin. Improved statistical reporting and the availability of data in a few industrially advanced countries, notably since World War II, have encouraged systematic efforts to measure the productivity of this factor. Compared with achievements in measuring labour productivity, however, the progress realized has been quite limited. The theoretical and practical difficulties to be overcome are appreciable.

I. USES OF PRODUCTIVITY MEASUREMENTS

The most outstanding use of productivity measurement has been as an index of economic growth and of the level of technological development. A nation or an industry advances by economizing its inputs for a given output. Labour productivity is an especially sensitive indicator of this economizing process and is one of the major measures used to chart a nation's or an industry's economic advance. An over-all rise in a nation's labour productivity signifies the potential availability of a larger quantity of goods and services per worker than before and, accordingly, a potential for higher real income per worker. Countries with high real wages are usually also those with high labour productivity, while underdeveloped countries have low productivity and low wages. If, for the moment, other productive factors are neglected, it can readily be appreciated that the facts could hardly be otherwise, for the wage level will then be equal to the total national product divided by the number of workers; that is, it will be equal to the level of labour productivity.

The change during any interval in a nation's over-all labour productivity represents the sum of changes in the major economic sectors and industries. Some sectors and industries move ahead more rapidly than the over-all average while others gain more slowly or even decline. In the movement of a country from a level of low productivity and low income to one of high productivity and high income a strategic role is played by the industrial, rather than by agricultural and other sectors. In the late 18th and early 19th centuries the effect of the Industrial Revolution was felt first in the manufacture of woolen and cotton textiles, power generation, the metal trades and machine-making industries. Along with the development of new processes came the development of new products and services which formed the basis for new industries. An outstanding feature of these changes was increased labour productivity, which in turn laid the foundations for an enormous expansion of output. Technological change exerted and continues to exert its influence irregularly and unevenly.

In the compilation of over-all averages this diversity is concealed because high rates in some industries offset low rates in others.

Thus the rate for the economy as a whole varies within narrower limits than the spread among individual industries would suggest and, aside from erratic short-term movements, it may appear fairly stable over extended periods. A surge of labour-saving innovations would cause the over-all average to move higher, while a technological lull would depress it. History suggests that the surges tend to be associated with basic technological changes such as the steam engine, the gasoline engine, the electric motor and standardization of parts. Once introduced, such inventions or developments are used in many different industries. These surges tend also to be associated with such developments as employment of the open-hearth furnace in steel manufacture or the introduction of the steam railroad.

Besides its use as a means of measuring over-all growth and technological development, productivity is valuable also as an indicator of comparative rates of change among industries and products. Understanding of over-all growth is promoted by a knowledge of the contributions made to it by individual industries and of the circumstances underlying the pattern of movement of each of these industries.

Productivity has a third use, as a technical aid in measuring efficiency, planning and forecasting, and assessing resource allocation and its changes. While its validity as an efficiency measure is rarely definitive, a rough accuracy suffices to make it serviceable in various ways.

Related to the use of productivity as an efficiency indicator is its use as a performance standard or goal. Production quotas for men and machines set in terms of a specified volume of output per hour or per day may serve as yardsticks for evaluating the effectiveness of productive operations. They may also provide the basis for supplemental or premium payments to workers. Where compensation to workers is based on piecework alone, labour productivity becomes the sole determinant of labour income. Use of productivity as a standard may serve also as a basis for grading and evaluating any group of workers performing common tasks, distinguishing the more productive from the less productive. Applied to equipment, productivity standards can help to show when the performance of a machine or other mechanical aid is deteriorating and in need of special service or repair.

The role of productivity in forecasting stems from the fact that productivity is or can be made a variable in many forecasting problems. For example, a forecast of total output for some future year might be made by projecting both the size of the labour force and the level of labour productivity for that year and multiplying the two. A variant, common to planning in underdeveloped countries, arises from the desire to boost productivity, and with it per capita income, to higher target levels by a given future date. Information on the target level of labour productivity, together with expectations about growth in the labour force and some understanding of the relation between capital per worker and output per worker, facilitates preparation of an estimate of the capital investment needed to reach the target. Again, an estimate of the probable annual gain in labour productivity, together with an estimate of the probable annual increase in output, will permit an estimate to be made of the availability of future employment opportunities.

Output per unit of labour or other input has further value as a tool in analyzing resource allocation patterns and trends. The extent to which resources flow to various uses depends, among other things, on their productivity in each of those uses. Changes in productivity in the course of time alter the pattern of use and cause the quantities of resources required in particular uses to change. The resulting trends depend on several things. On the one hand, an increase in the productivity of, for instance, labour, since it means a decrease in labour requirements per unit of output, tends to reduce the demand for labour. But it also implies a cheapening of labour relative to the cost of other competing factors of production. Hence there will be a tendency to substitute labour for other factors. Where labour cost represents a large fraction of total cost, a productivity increase will contribute toward a reduction in the price of the product, thereby expanding sales and with them the demand for labour. The net result depends upon the sum total of all these separate effects. It is by no means uncommon to find that the expansionary effects predominate, and many economists consider this to be the normal outcome. In any event, the productivity concept and data on productivity trends can contribute importantly to an understanding of resource and output flows.

A final area in which productivity occupies a strategic place is covered by the term "prices, wages and productivity." Economists are far from a full understanding of the relations among these variables but there is substantial agreement on the following points:

1. The large increases in real wages that have come about over the long term in many countries are closely associated with large increases in labour productivity in these countries.
2. In the absence of increases in labour productivity, a stable price level is inconsistent with persistent increases in money wages.
3. An increase in labour productivity or in the productivity of other factors usually brings with it a reduction in costs and hence tends to result in price reductions, wage increases or both.
4. In industries where sales of products are comparatively insensitive to price changes, increases in labour productivity will tend to reduce employment and possibly also reduce wages.
5. Wage increases in individual plants and industries may induce productivity increases by encouraging the substitution of capital and other factors for labour.

This last statement forms the basis for an explanation sometimes offered of the apparently high rate of mechanization in the United States. Abundant economic opportunities for labour on the land and in the frontier west, it is said, resulted in a scarcity of labour in industry, and hence in high wages and intensive mechanization. The same logic, with a reverse twist, is sometimes used to account for low labour productivity in underdeveloped countries. Here the argument runs that very low wage rates make it economical to rely heavily on labour and to use little capital. While there is much that these explanations leave out of account, they are valid within limits.

II. FACTORS THAT DETERMINE PRODUCTIVITY LEVELS

The many factors that help to determine the level of productivity in a country, industry or enterprise can be classified in various ways. Virtually every listing would include, in one or another form, supplies of labour, land, raw materials, capital facilities and mechanical aids of various kinds. Included also would be the education and skills of the labour force, the level of technology, methods of organizing productivity activity, the energy and enterprise of managers and workers and a range of social, psychological and cultural factors that underlie and condition economic attitudes and behaviour. Some of these factors are physical in nature, like land or capital facilities, while others are nonphysical. Some are essentially man-made while others represent in one or another degree an endowment of nature. All possess qualitative and quantitative aspects, both of which are important for productivity.

These variables, however classified, interact and mutually condition one another in determining productivity levels and their changes. Thus, in any country one expects the level of technology, the skills of the work force, the quantity of capital and the capacity for rational economic organization to be positively correlated. A country with low productivity is likely to show deficiencies on all counts; a country with high productivity is likely to score high on all of them. To put it differently, the numerous productivity-determining factors behave as variables in a system of simultaneous equations, with all acting concurrently to shape the outcome. Within this system, there are no grounds for assigning causal priority to one or a few variables. All interact mutually to determine the outcome. Within certain problem frameworks, however, it may be entirely appropriate and indeed essential for explanatory purposes to emphasize certain variables over others.

Two broad problem frameworks may be distinguished, both of perennial concern to students of productivity and growth. One of these involves changes in production over time, the other involves differences in productivity levels among enterprises, industries and countries at a given time. Within these frameworks are countless problems and subproblems, each of which may lead to a somewhat different selection and emphasis of variables.

Explanations of long-term productivity changes in a country, region or industry usually stress technological change and, as an adjunct, changes in the quality and quantity of capital. Other variables are not ignored but are regarded as playing a passive role and are given a subordinate position. The justification for this is that change in technological knowledge and the capital embodying it is not only essential to substantial gains in productivity but is the factor most immediately associated with those gains. It ordinarily is perceived as the leading and moving force in the process. When technological change occurs, the quality of capital improves and the amount available to aid each worker usually increases. The kinds of raw materials used may change, better grades being required or the use of lower grades becoming possible. Changes occur in the way productive factors are organized and production is carried on. Although in some periods and in some circumstances work may have become harder and more tedious following technological advance, and while the transition from land to factory has often entailed special hardships, the dominant trend has been toward shorter hours and a diminution in the arduousness of labour.

Emphasis on technological change and capital accumulation as primary forces arises also from a recognition that they are essential, in ways that other factors are not, to large and systematic advances in productivity. Gains that can be obtained solely through a reorganization of work or use of better raw materials or the breakdown of restraining attitudes or practices are occasionally dramatic but always limited. By contrast, very substantial gains can follow from growing technological knowledge and increasing supplies of capital. If allowance is made simply for adaptive changes in other factors, the prospects for advance become almost unlimited. Only these two factors can fairly be singled out as constituting the engines of productivity growth.

There is a tendency in formal theories of economic growth to stress capital accumulation as a primary variable while treating technological change more as an implicit and omnipresent background force. There are several reasons for this tendency. One is that capital is the central transmission factor for technological change and the major medium through which advances in technological knowledge are given economic expression. It also is tangible and in certain respects measurable, while knowledge cannot be measured as easily. In addition, capital results from the investment process, which in turn is linked to the saving process, and both of these play a strategic role in most theories of growth. Hence, emphasis on capital rather than technological knowledge makes it easier to draw on an established body of economic thought in seeking to explain productivity gains.

It has been noted that both the quantity of capital and its quality change as productivity increases, and it is not possible adequately to separate the two in terms of their effects. Increases in capital per worker through the accumulation of more and more of the same kinds of equipment and tools would not lead continuously to proportionate or more than proportionate increases in output per worker. They would, after a point, lead to diminishing increases, and eventually even to a decline, in output per worker. The onset of a decline would be far distant in an industry or economy possessed of a high level of technical knowledge but starting near the bottom of the accumulation ladder and affected by an acute scarcity of capital instruments. But an ultimate decline would be expected on the basis of the principle of diminishing returns.

Qualitative changes in capital, reflecting advances in knowledge and skill and leading to the design and construction of improved capital instruments, offer an escape from this principle. If capital can be steadily improved over time, its expansion need not entail diminishing returns. In countries for which data are available for broad sectors and for many individual industries there is a rough correlation between growth in the quantity of capital per worker and growth in labour productivity.

III. HISTORICAL TRENDS

Man's use of capital as an aid in production is, strictly speaking, as old as his use of primitive tools of wood and stone. But the introduction of power-driven machinery, its systematic improvement and its progressive substitution for labour are a set of much more recent phenomena. (*See* INDUSTRIAL REVOLUTION.)

1. Industrial Development.—The influences of technological change and industrial development have touched virtually all regions of the world since the latter half of the 18th century, though in different ways and in widely differing degrees. Some areas were involved only through trade, receiving manufactured goods in exchange for raw material exports. Others developed industry to a limited extent that served principally as an adjunct to foreign trade and did not penetrate deeply into the domestic economy. Still other countries, like Great Britain and the United States, were more fundamentally affected as their economies underwent progressive advance and transformation. At the close of the 19th century, France, Italy, Germany, Russia, Japan and Canada, among others, also possessed substantial manufacturing capability. The transition was most evident in western and northern Europe and in North America, and least in the middle east, Africa, Asia and South America.

The countries that stood in the industrial forefront by the first decade of the 20th century remained there up to World War II, though their relative positions shifted. Most conspicuous was the forward surge of the Soviet Union, following the inauguration of the five-year plans in 1928. After World War II large strides were made in other countries of eastern and southern Europe. China and India also moved ahead, as did several South American countries.

TABLE I.—*Long-Term Trends in National Output per Worker*
(index numbers, 1890 = 100)

Year	Country			
	United States	Great Britain	Germany*	Japan
1890	100	100	100	100
1900	122	107	100	144
1910	138	110	107	166
1920	142	100	—	228
1929	172	116	90	366
1938	182	132	127	547
1948	223	132	—	314
1960	298	161	166	747

*For 1948 and later, German Federal Republic (West Germany) only.

Sources: Figures adapted and assembled by the author from data in numerous sources, including the following: Solomon Fabricant, *Basic Facts on Productivity Change*, National Bureau of Economic Research, Occasional Paper 63, Table A (1959); Joint Economic Committee, 85th congress, 1st session, *Productivity, Prices, and Incomes*, Tables 1 and 2; Colin Clark, *The Conditions of Economic Progress*, 3rd ed., ch. 3 (1957); Kazushi Ohkawa, *The Growth Rate of the Japanese Economy Since 1878*, Appendix Table 6 (1957); M. Frankel, "Some Implications of International Postwar Productivity Trends," *The 1958 Proceedings of the Business and Economic Statistics Section of the American Statistical Association*, Table 2 (1959).

The consequences for labour productivity of the changes under discussion—industrialization, mechanization and capital accumulation—are summarized in Table I for the United States, Great Britain, Germany and Japan. Because of the difficulties inhering in productivity measurement, the figures are rough approximations. They nonetheless suffice for distinguishing the rates of change among the four countries. It should be noted that in 1890 each of the countries occupied a different rung on the ladder of industrial development. By certain yardsticks, Britain already was a mature country. The United States and Germany were less advanced while Japan stood in a comparatively early stage of industrialization. Equally important, each country was differently endowed in terms of skills and resources, possessed different social and economic institutions, and was differently situated geographically. As a result, the potential for further growth differed among the four countries.

The figures show great unevenness in the rate of gain for each country from period to period. The differences among the countries are also marked, both for individual subperiods and for the entire 70-year span. These differences reflect the variety of forces that contribute to productivity change, their varying importance at different times and in different places and the complex ways in which they interact. Britain experienced no perceptible gain from 1890 to 1920, but moved ahead significantly during the next 18 years. The United States gained during the 1938–60 interval at a rate much above the rates prevailing over the preceding 50 years. Japan's rate during the 18 years following 1920 was about 80%

higher than its rate for the preceding 30 years. The very high rate in Japan between 1948 and 1960 was the result of recovery and restoration following World War II. A similar phenomenon is observable in a number of other countries, including Germany, though the figures in the table do not show it. Britain and Germany are noteworthy for their low average rates over the long term. Japan, in contrast, is unique for the high average rate attained over a very long period.

2. Labour Productivity.—An index of output per worker, like any single productivity index, provides only limited information on the process of productivity change. Some other features of that process deserve mention. Long-term increases in labour productivity have usually been accompanied by reductions in the number of hours worked per day and per week. In Britain or the United States, for example, a 60-hour week was not uncommon in 1850 but a century later 40 hours was a familiar figure. Hence, if the data in Table I were put on a man-hour basis, the rates of increase would, in general, be much higher.

A reduction in hours worked is simply one of the ways in which a people may benefit from productivity increases. Such reductions as have taken place probably have not entailed proportionate sacrifices in the quantities of goods and services that, with constant hours, might otherwise have been obtained. For when hours of work are very long, worker efficiency tends to be low. Within limits, as hours are reduced, efficiency rises. There is substantial evidence that the decline of the working day from very high levels has brought compensatory gains of this kind.

Systematic long-term increases in labour productivity have been accompanied also by changes in the quality of labour and changes in the quality and quantity of other inputs. Generalizations about these other changes are, however, difficult to make. In many fields of production, for many classes of work, introduction of machines has entailed a downgrading of skills. Loss of many traditional handicraft skills during the early stages of mechanization is a case in point. This type of loss has been repetitive throughout the history of mechanization. A machine replaces one class of skills and at the same time generates requirements for other skills of a lower order.

But the sequence is by no means one-directional. Machines are complex, and over the decades their complexity has increased. This growing complexity has created a need for skills of a high order for machine development and for the installation, servicing and operation of machines. Organizational requirements for the effective use of machines also have become more complex, thereby increasing the need for a large array of highly trained specialists. As a result, the downgrading and displacement of some skills have been accompanied by upgrading of others and the emergence of new ones. There is little doubt that the latter tendency has predominated over the long term. The general educational and technical qualifications of an industrial, highly productive labour force are very much higher than those of a low productivity labour force engaged largely in agricultural and handicraft pursuits.

3. Productivity of Other Factors.—Changes in the productivity of other factors have accompanied the more or less regular, long-term increases in labour productivity. Unfortunately the record is far less comprehensive and in some respects less clear as to the nature of these changes than in the case of labour productivity. By introducing constant improvements in farming methods, farm machinery and fertilizers, technological change has led to large increases in the productivity of land as measured by the output of foods and fibres per acre. But it should be noted that, unlike output per worker, output per acre does not correlate well with living standards because of the varying intensity with which cultivation is carried on in individual countries. This circumstance accounts, for example, for the fact that output per acre for a particular commodity sometimes is higher in a poor country than in a rich country. Technological change has also made it possible to economize in the use of some raw materials in production and thus raise output per unit of raw material consumed. But in practice higher productivity, while possible, may not result, since with a cheapening of this factor it often proves economical to use it more liberally than before. Sometimes, also, more mechanized methods of production are inherently more wasteful of raw materials than less mechanized ones.

In some countries, at least for some periods, the productivity of capital has risen. In the United States, from 1900 to 1960, output per unit of tangible capital increased about 80%, or at an average annual rate of just over 1%, with the bulk of the increase occurring after 1929. On the other hand, it barely changed between 1890 and 1920. As between the two factors, labour and capital, it is clear that over the long term the major savings have been in labour. Both theoretical considerations and statistical data suggest that continued technological change will bring further large gains in labour productivity but the probable trend with respect to capital is uncertain.

From the standpoint of the individual enterprise, all reductions per unit in factor inputs are important. The economic benefit is the same whether a given net reduction in cost results from the saving of labour, capital or raw material. But from a world-wide or economy-wide point of view, labour savings occupy a unique place. This is so because labour, interpreted in the broadest sense, is not only an input in the productivity process but also represents the goal of that process. Ultimately, goods and services are consumed by people. An increase in output per worker or per capita signals the availability, or potential availability, of increased quantities of goods and services for each individual. An increase in output per unit of capital or raw material does not necessarily carry this connotation. If the objective is to attain ever-rising living standards, then it is labour productivity that, over the long term, must be increased.

4. Trends in Productivity.—Trends in over-all productivity are composites of trends in the several sectors and subsectors of the economy and, in the last analysis, of trends in individual industries and enterprises. Trends at these subordinate levels often differ widely, both from one another and from the broader economy-wide averages. Some of this diversity may be seen by comparing the trend in output per man-hour in the total United States private economy with similar trends in the farm and nonfarm subsectors. For the entire period of 1909–56 production in both subsectors moved ahead about the same amount and roughly in line with the over-all movement. Between 1909 and 1929, however, the increase in the farm sector was far below that in the nonfarm sector, while for the period of 1938 to 1948 the reverse was true. The periods of 1929 to 1938 and 1948 to 1956 show a slightly higher trend in the farm sector than in the nonfarm sector.

The figures serve to qualify the popular impression that agriculture is a persistent laggard in the technological march. In the United States, during the 19th and early 20th centuries, the nonfarm sectors—including mining, manufacturing, communications and utilities—were certainly in the vanguard. But in later decades, productivity in agriculture rose. The farm surpluses of the 1950s and 1960s symbolized the results.

These productivity movements do not exhibit a close relation to movements in output. For all periods increases in farm output, though relatively low, averaged close to 1% per year. At the same time productivity increases varied widely, ranging from under .5% to over 3%. For the nonfarm sector an annual 2% productivity increase was registered between 1929 and 1938, a period when output declined by 1% a year. By contrast, much the same productivity increase occurred from 1938 to 1948 when output advanced at 6% per year. This outcome is perhaps not surprising in view of the fact that the sources of output and productivity increases are not identical. Productivity increases will result in output increases provided the quantity of resource inputs does not decline. But output increases may also result independently of productivity increases, from an expansion of resource inputs or from an increase in the intensity with which resources are used.

To gauge the contribution of any sector to the production total it is necessary to consider the size of the sector and its productivity level. Because agriculture in the United States contributes less than 5% of the national product and employs less than 9% of the labour force, even a large change in output per worker would have but a nominal effect on the total. The outcome may be very different if the sector is large and if its productivity level,

measured by value of output per worker, is high relative to other sectors. In that case, and depending on the method of measurement, a redistribution of labour in favour of the high productivity sector can produce large productivity changes in the total even though sector productivity changes little. This source of productivity gain, while important for all dynamic economies, is especially so for one that is in the early stages of industrialization. In such economies, low productivity agricultural pursuits absorb the bulk of the labour force, and hence the potential gain from their transfer to more productive occupations is very large. Traditionally, students of productivity have shown greater interest in the industrial sector than any other. The reasons for this, already touched on, have to do with the early and sustained influence of mechanization on this sector and the consequences for productivity that followed.

5. Relation Between Productivity and Output.—In comparing countries some association is observable between changes in productivity and output; countries showing large increases in one variable tend also to show large increases in the other. But the relationship is, at best, very loose. Coincident movement of the two variables would mean that gains in output had arisen exclusively because of labour savings. (Strictly speaking, this is true only if the productivity figures relate to output per man-hour.) By contrast, an increase in output accompanied by no change in productivity would indicate that the advance was attributable solely to the use of greater manpower or other resources. The data for the years following World War II show that both rising productivity and greater manpower contributed to the advances in output in all countries but that the influence of the former was generally greater. In Japan, Italy, France and Austria, for example, productivity was more important while in Poland, West Germany, the Soviet Union and Canada manpower increases played a larger role.

It is ordinarily preferable that increases in output be obtained through productivity growth rather than through a larger labour force, for this implies not only more product, but also more leisure, or at least a potential for more leisure. A tacit assumption here is that the leisure is voluntary. If it is not, then the problem of unemployment must be reckoned in the balance. Italy is a case in point. Between 1948 and 1957 industrial productivity in Italy rose at a rapid rate and in doing so accounted for almost the whole increase in output. But industrial employment expanded only slightly and contributed little to the relief of a serious unemployment problem.

6. Rates of Growth.—Performance during a span of over two decades, 1938–60, contrasted greatly for many countries with performance over the shorter postwar intervals. Indeed, one is left by the long-term data with a quite conservative impression of the progress made by the several countries, both individually and as a group. The amazingly high growth rates common in the postwar years are not in evidence and the order in which the countries are ranked from high to low is very different.

The contrast between growth rates over the long term and the short term reflects the impact of war and the efforts to recover from it. Japan and Austria are excellent illustrations. The high rates of increase in productivity realized in the postwar period by Japan and Austria did little more, by 1960, than restore those economies to their prewar levels. Much the same thing could be said of West Germany and of Britain, though in the latter case the gap between long-term and short-term growth rates is more modest. Other west European countries—France and Italy, for example—had by 1960 surpassed their 1938 levels by more substantial margins, though these economies also were obliged to devote a major fraction of their energies to overcoming wartime arrears. This applies also to the east European countries, the Soviet Union, Poland and Czechoslovakia. Within the intercountry structure of rates, and in contrast to its position in the postwar structure, the U.S. registered an average advance in excess of 2% from 1938 to 1960. A notable feature of the U.S. trend, in contrast with trends for most other countries, was its stability. Gains in the 1948–60 period were appreciably greater than for the longer interval but, comparatively speaking, the gap was small. The comparative closeness of long-term and short-term rates for the U.S. reflects its good fortune in escaping the physical destruction and economic disorganization of war suffered by other countries.

IV. COMPARISONS OF PRODUCTIVITY LEVELS

Besides knowing productivity trends over long periods of time, it is frequently useful to know productivity levels and differences in productivity levels at a given time. One problem in this category involves comparing output per worker, or worker-hour, among plants producing similar goods for the purpose of assessing the relative efficiency of each and explaining the differences among them. Another problem relates to determining differences in value productivity among subsectors and industries. Such knowledge is essential, for example, to an understanding of the effects on the national product of a change in the distribution of the labour force. The potential uses for data on productivity levels are manifold.

Comparisons of productivity levels of different countries, whether on an economy-wide or industry-wide basis, have attracted much interest because they serve, among other things, as a point of departure for appraising and understanding differences among countries in technology, resource utilization and living standards. Table II compares, on an economy-wide basis, output per worker and per capita for 16 countries. The fact that some of the figures are for 1950 rather than a more recent year is of minor importance because over-all data of the kind given tend to change only slowly. Neglecting small intercountry differences, the basic impressions conveyed by the table were doubtless still valid in the early 1960s. Yet it must be stressed that the figures are to be treated as only rough approximations.

TABLE II.—*Comparison of Levels of Output, About 1960*
(in both columns the figure of 100 represents U.S. output)

Country	Real output per worker	Real output per capita
Argentina	35*	27
Australia	62*	72
Brazil	21*	20
Canada	92*	74
Chile	29*	24
Denmark	62	62
France	52	52
Germany, West	46	51
Great Britain	50	58
Ireland	36	39
Italy	37	29
Japan	31	27
New Zealand	88*	90*
Soviet Union	25*	25*
Sweden	57*	65
United States	100	100

*About 1950 rather than 1960.

Note: A country's output per capita, relative to that in the U.S., exceeds its output per worker, relative to that in the U.S., if the fraction of its population in the employed labour force is greater than the corresponding fraction in the U.S.

Sources: Data developed from Colin Clark, *The Conditions of Economic Progress*, 3rd ed., ch. 3 and 4 (1957); *Statistical Yearbook* (United Nations); *Yearbook of Labour Statistics*, International Labour Organization: *Economic Survey of Denmark*, Secretariat of the Government of Denmark; *Survey of Current Business*, United States Department of Commerce; *United States Income and Output*, United States Department of Commerce.

The general level of productivity in the United States is the highest of those shown by a wide margin, and a more comprehensive listing of countries would not alter its position. New Zealand and Canada are not far behind the United States but the gap between them and the others is fairly wide. Australia, Sweden and Denmark bracket the high side of what might be called a middle productivity range, while Britain, France and—with allowance for incomplete postwar recovery—West Germany fall on the lower half of this range. The remaining countries, with productivity levels of between one-third and one-fifth that in the U.S., are located still lower on the scale. A large group of excluded countries, belonging in the underdeveloped class, would occupy still lower positions. This group would embrace the bulk of the peoples in Africa, Asia, the middle east and South America. It is well to keep in mind that these people comprise a majority of the world's total population and, accordingly, that the average productivity level for the world as a whole is, by western standards, very low.

Differences among countries in the relation between the output per worker and output per capita figures are attributable to differences among countries in the percentage of the total population at work. If the proportion of those seeking and finding gainful

employment was the same in all countries, the relation between each pair of figures in Table II would be the same. One might expect that with higher output and income levels there would be a tendency for the percentage of the population seeking work to decline. Entrance into the labour force would be delayed by longer schooling, and fewer family members would be obliged to work in order to maintain any given income level. The table suggests a relationship of this sort, though it is not a strong one. It may be that the tendency in this direction is stronger than appears but that it is offset by the more abundant and attractive occupational opportunities existing in countries with high incomes. In any case, the differences that exist between the two series are not large and do not alter the over-all intercountry pattern. The close correspondence between them affirms the overriding importance of productivity levels for living standards.

At least two broad approaches can be taken in seeking to explain such productivity differences as are found in Table II. One of these may be termed cross-sectional. It seeks to identify the chief factors associated with the observed differences and to ascertain their relative importance. Measurement and analysis of the degree of association between intercountry differences in output per worker and corresponding differences in, say, size of plant is an example of this approach. It does not of itself tell us the direction of cause and effect between two variables nor even that a causal relationship is present. Neither does it tell us anything about the time-trend of the relationship—whether it has always existed, whether its form has changed over the years or why it may have changed. Nonetheless, the approach is helpful in suggesting which factors may contribute significantly to productivity differences.

The other approach might be called developmental, since it involves an assessment of the process of economic change as it affects productivity levels. It goes beyond the cross-sectional approach in that it endeavours to explain how certain causal factors came to be important and how they have interacted with other factors to cause shifts in labour productivity over time. Necessarily in this approach the question arises of where and how to apportion responsibility for change. The answers supplied by economists have varied. T. R. Malthus (*q.v.*) selected population growth as his key variable. J. A. Schumpeter (*q.v.*) emphasized the role of entrepreneurship in a country's development. In much contemporary literature, whether concerned with industrialized or underdeveloped countries, the process of capital accumulation is regarded as of overriding importance. Despite their differences, all these treatments may be characterized as developmental since they give attention to the movement and influence of particular factors over time.

The two approaches are complementary. While useful hypotheses might be built wholly from one or the other, the value of each is enhanced by their joint use. The cross-sectional approach, in identifying factors of probable significance, facilitates the application of the developmental or historical approach. At the same time, the latter helps to amplify the meaning and significance of the factors found to be associated with productivity differences.

Needless to say, each country's current circumstances and its development, as these bear on productivity levels, possess unique characteristics. For this reason no single, simple hypothesis, whether rooted in one approach or in a combination of approaches, is likely to go very far in accounting for the wide range of differences in Table II. One probably valid generalization seems worth making, however. Differences in growth rates are essential to an understanding of most large productivity differences among countries. Almost without exception, the countries with high productivity are those that have succeeded in mastering improved technology; with the aid of capital accumulation they have diffused this mastery through the several sectors of the economy and have continuously improved it. Only by continued productivity advances over a fairly long period is it possible for a country to achieve such levels as prevail among the high-income countries.

V. PROBLEMS AND LIMITATIONS OF PRODUCTIVITY MEASUREMENT

Many difficulties, both theoretical and practical, attend the development in any area of an organized, consistent body of productivity data. Some of the difficulties are specialized and unique to a specific inquiry. Others are more general in character and affect many different kinds of productivity studies. The few remarks that follow treat difficulties of this latter type.

A basic difficulty arises from the heterogeneity of inputs and outputs that make up the productivity ratio. Ordinarily such ratios are computed not for a single, homogeneous type of output, but for product categories that embrace a host of subproducts. Thus the output of the steel industry consists of sheets, wire, rods, structural shapes of various kinds and a great many other items. Computation of satisfactory productivity data for an industry usually requires, therefore, that account be taken of the diversity of output and its changing composition. This can and often is done by weighting the subproducts in accord with their relative values and then adding them together. Unfortunately, however, relative values change over time, raising the question of what weights to use. Should they be initial year weights or terminal year weights or some combination of the two? The question is not academic, since different weights sometimes produce significantly different amounts of change between the initial and the terminal years.

There is a parallel problem on the input side. Strictly speaking, the labour force is not homogeneous. It is made up of a range of skills and specialties that embody varying amounts of education and training, and it is reasonable to suppose that their contributions to the production process vary accordingly. Weights may be used in aggregating, though in practice this is done less frequently than is the case with output. Where it is done, there is again the option of using different methods with different results. The weighting problem is not avoided by first computing productivity ratios for subproducts and then combining these ratios. For the individual ratios must be weighted before they can be aggregated, and in most suitable weighting systems the relative importance of the weights changes over time.

A second basic difficulty relates to the susceptibility to measurement of inputs and outputs. Labour inputs are relatively easy to measure, particularly if one is content simply to count heads. But if one wishes to take account of differences in the quality and intensity of labour inputs, the question of measurement immediately arises. At what rate should one type of labour be converted into another? Wage rates often are used for the purpose, not because of a belief that they are correct but because they are the most readily available yardstick.

Measurement problems are equally difficult in connection with capital inputs. Plant and equipment lose their value gradually over time, and in any one year contribute but a part of this value in production. There is no universally acceptable procedure for measuring this contribution. There exist a few recognized accounting practices but no one of them is recognized as superior to the others. It probably is true that no one procedure is best in all situations but that each has unique advantages for certain applications. Measurement is further complicated by the diverse composition of capital instruments, a fact that rules out any counterpart to headcounting for labour inputs.

Moreover, the composition of capital changes over time with the result that the kinds of machines and facilities used in one year may differ markedly from those employed a generation earlier. Any one of these circumstances would alone suffice to make measurement difficult.

For some inputs, such as organization or enterprise, an acceptable method of measurement is wholly lacking. The quality and very likely the quantity of each has changed greatly over the years and their importance relative to other inputs has changed. But no reasonably rigorous means for evaluating these changes is available.

On the output side, measurement difficulties are especially apparent with regard to services. In contrast to commodity outputs, which are tangible and divisible into identifiable units, some service outputs are very difficult to define and measure satisfactorily. In concrete terms, what is the output of an enterprise engaged in business consulting? Of an organization dispensing banking services? Of a government agency exercising regulatory functions? More is

involved here than the fact that each of these activities embraces a mixture of distinguishable services. The main trouble is lack of any acceptable standard by which to measure such outputs.

This problem is not unique to service outputs, but it shows itself most clearly in the service sphere. Lacking a suitable direct measure of service outputs the student will often use inputs as a substitute measure, the assumption being that inputs and outputs are equal or will move together over time. Whatever its merits for gauging output, this method is unsuited to measuring productivity. For the validity of a measure of productivity depends on a clear separation of outputs from inputs. Considering the nature of the problems, it is not surprising that the bulk of available productivity information relates to commodity production.

The availability of satisfactory sources and data constitutes a third major problem in developing productivity information. Censuses of production and population, national income series and their components, series regularly published on industrial and farm output, on wages, hours and the labour force, and data provided by regulatory and other government agencies are among the basic source materials that may be used. The scope and quality of these materials vary widely among countries, and tend to be more comprehensive and reliable in the more advanced, industrialized countries. With few exceptions, unfortunately, such data are not collected for the purpose of providing information on productivity. Special studies often must be undertaken either to supplement what information is available or, for certain input-output areas, to obtain any data at all. Even where information for recent periods of time is extensive the researcher may find it difficult to prepare productivity tables that extend back very many years. For no country can our knowledge of productivity trends in the 19th century be described as better than meagre. The situation for many underdeveloped countries is still less satisfactory.

A miscellany of other difficulties affect productivity measurement. One of these is the choice of a time period over which to measure changes in productivity. Another involves determination of the inputs of the productivity ratio. If the input is labour, should it cover all employees or only production workers? Should it be on a man-hour or a man-year basis? Yet another problem relates to determining a suitable output classification; that is, to determining the content of the output category and the breadth or narrowness with which it is defined. Decisions on these problems that are both theoretically sound and practical are often very hard to reach. *See* also ECONOMIC DEVELOPMENT; PRODUCTION, CENSUS OF.

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ECONOMICS (ARTICLES ON). The history of economic thought, which reflects the great transitions of social history, is summarized in the survey article ECONOMICS. This article outlines the views of the economic philosophers who were spokesmen for their eras, describes the emergence of economics as a scientific discipline and discusses the methods used by economists.

CAPITALISM discusses the evolution of private enterprise, the variations by which it has been adapted to changing societies, and the outlook for the future of the system as indicated by current tendencies. Historic forms of private enterprise are treated in GUILD; LAISSEZ FAIRE; MERCANTILE SYSTEM; and PHYSIOCRATIC SCHOOL. INDUSTRIAL REVOLUTION deals with the series of 18th- and 19th-century innovations that set much of the pattern of 20th-century enterprise.

SUPPLY AND DEMAND describes the factors that must be taken into account in gauging the interaction of these forces in specific situations. INFLATION AND DEFLATION discusses the causes of these phenomena and their bearing on the economic climate in which business is conducted. BUSINESS CYCLE analyzes dominant theories as to the nature of these broad upswings and downturns of business activity.

ECONOMIC FORECAST describes the methods that have been used, with varying degrees of success, to predict the occurrence and duration of business cycles.

COMPETITION, ECONOMIC deals with the advantages and disadvantages of this aspect of private enterprise. Attempts to eliminate competition are treated in CARTEL; CO-OPERATIVES; and MONOPOLY. The legal regulation of competition is discussed in FEDERAL TRADE COMMISSION and PUBLIC UTILITIES; self-regulatory measures are dealt with in TRADE ORGANIZATION.

Among the articles on individual phases of business activity are ACCOUNTING; ADVERTISING; BOOKKEEPING; BUDGET, BUSINESS; CREDIT; INSTALLMENT CREDIT; INSURANCE; MANAGEMENT SCIENCES; MARKETING; MASS PRODUCTION; OFFICE MACHINES AND APPLIANCES; OFFICE MANAGEMENT; PRODUCTION MANAGEMENT; PUBLIC RELATIONS; RESEARCH, INDUSTRIAL; and RETAILING. Related articles of importance are listed in FINANCE (ARTICLES ON).

Among the articles dealing with broad areas of economic theory are CONSUMPTION; DISTRIBUTION; LAND; MARKET: *Economic Theory;* PRICE; STANDARD OF LIVING; VALUE; WEALTH AND INCOME.

Articles concerned with statistical interpretations of economic conditions include BIRTH RATE; COST OF LIVING; ECONOMETRICS; NATIONAL INCOME ACCOUNTING; MARRIAGE RATE; POPULATION; PRICES, STATISTICS OF; ECONOMIC PRODUCTIVITY; etc.

Among the articles dealing with the relationship of government to business are FAIR TRADE LAWS; INTERSTATE COMMERCE; PUBLIC ENTERPRISE; SUBSIDY; TARIFF; and TAXATION.

Articles on various phases of the economics of labour include AMERICAN FEDERATION OF LABOR–CONGRESS OF INDUSTRIAL ORGANIZATIONS; APPRENTICESHIP; CASUAL LABOUR; CLOSED SHOP; EMPLOYMENT AGENCY (EXCHANGE); GENERAL STRIKE; HOURS OF LABOUR; INDUSTRIAL ACCIDENTS; INDUSTRIAL RELATIONS; LABOUR LAW; PENSION; STRIKES AND LOCKOUTS; TRADES UNION CONGRESS; LABOUR (TRADE) UNION; WAGES; WORKMEN'S COMPENSATION; UNEMPLOYMENT INSURANCE.

Among the articles involving problems of international economics are AGRICULTURE; COMMERCE, HISTORY OF; ECONOMIC DEVELOPMENT; ECONOMIC UNION; FOOD SUPPLY OF THE WORLD; FREE TRADE; NATURAL RESOURCES; STATISTICAL ORGANIZATIONS, INTERNATIONAL; TARIFF; TRADE, INTERNATIONAL. Also, sections on economics are included in the articles on the major nations of the world.

Articles dealing with the social and ethical implications of economic problems include HOUSING; LUXURY; PHILANTHROPY; POVERTY; SOCIAL SECURITY; UNEMPLOYMENT. Phases of economics are discussed within the framework of the other social sciences in PSYCHOLOGY, APPLIED; MATERIAL CULTURE; SOCIAL ANTHROPOLOGY; and SOCIOLOGY.

Articles on collectivist schools of thought include COLLECTIVISM; COMMUNISM; GUILD SOCIALISM; MARXISM; SOCIALISM: PRINCIPLES AND OUTLOOK; and SYNDICALISM.

Biographical articles set the background of the work of such

molders of economic thought as Adam Smith, Friedrich List, Thomas Robert Malthus, etc.

The lists given above should be taken merely as examples of the *Britannica's* coverage of economic topics. The Index cites articles and sections of articles on many additional phases of economic theory and practice.

In view of the key role of economics in the contemporary scene, the *Britannica's* articles on the subject have been planned with the general reader in mind as well as the student, and the style is essentially nontechnical, except for sections on mathematical procedures in such articles as ECONOMETRICS. The following articles are suggested as a minimal reading list for an introduction to the elementary principles of economics: CAPITALISM; ECONOMICS; INDUSTRIAL REVOLUTION; MARKET: *Economic Theory;* and SUPPLY AND DEMAND.

ECONOMICS. The term economics came into general use in the 20th century, replacing the older "political economy" as the name of a somewhat vaguely defined branch of social science. The change of name reflected changes in the discipline itself, which had become subdivided into a number of specialties. One separation had been made between economics as a pure science and economics as the study of public and private problems of policy; another separation was made between empirical economic facts—historical or statistical—and economic theory.

The word economy comes from two Greek roots referring to the management of a household or estate. But in the past two centuries or so the meaning has become generalized to cover all uses of means in such a way as to husband them, to make them go as far as possible. Political economy itself is a modern term. It was introduced about the beginning of the 17th century to describe the study of the problems of the princely states which at the close of the middle ages in Europe replaced the feudal-ecclesiastical political order. It referred to the economic affairs of the state or principality—the raising and use of revenue and increase of resources—treating the state as the estate of the ruler. But this study never was generally known by this name. After the nationalistic epoch gave way to individualism or liberalism, at the time of the enlightenment in the late 18th century, political economy was adopted as the name of a science based on the new moral and political world view, and the older state-oriented literature came to be designated as mercantilism.

Epochs in the Development of Economic Thought.—The sketch above suggests four main periods or epochs in the evolution of economics, corresponding to those usually recognized in European history. They are the Greek (or classical in the meaning of general history, but the Roman contribution was minor), the medieval, the early modern (16th to late 18th century) and the modern, roughly the 19th and 20th centuries. Each corresponds to a distinctive political order and to distinctive conceptions of man and society; and it is an important fact that books were written by and for different social classes in the different periods. The Greek literature was written by aristocratic philosophers and publicists, and related to the problems of the city-state, which was nominally democratic but was based on slave labour and excluded the merchant and financier from civic life. Such writers as Plato and Aristotle commented on many obvious facts and principles, such as the importance of division of labour and the use of money. But their interest centred in such moralistic and metaphysical notions as the condemnation of lending at interest as unnatural. Modern knowledge of the economic and industrial life of ancient Greece is derived mainly from other sources, incidental references in literature and archaeological remains. Many of the ideas were in fact survivals of primitive attitudes; they are found also in the older parts of the Bible, and survive as a strong influence even today.

Medieval economic thought is still more moralistic and alien to the modern outlook. The dominant social organization was the church, and recorded thought was more of the nature of preaching or theology and metaphysics than of science, as words are used now. For that world, the accepted ideal was a static or customary society and civilization, every man working out his lot in the situation to which he had been called. Trade was frowned upon, beyond limited routine exchange at "fair"—meaning customary—prices, corresponding with a customary standard of living for each social class, and interest-taking was condemned outright. In the later middle ages, however, numerous evasions of the prohibition against interest-taking, achieving the same result through other contractual arrangements, came into use and were recognized as legitimate. Men's interests were shifting to the concerns of earthly life, cultural, aesthetic and scientific, as well as material; *i.e.*, political and economic. The evolution of economics must be seen as integral with that of economic life and of European civilization as a whole.

The third period is best designated as that of economic nationalism, but the economic thought is usually called mercantilism. (*See* MERCANTILE SYSTEM.) It dealt with the economic policies of the national monarchic states which displaced the feudal order at the close of the middle ages. The distinctive writings on economic matters were produced by political pamphleteers. It was the age of the commercial revolution; the monarchical states saw wealth obtained through foreign trade as the basis of political power, and money as the embodiment of wealth. Europe was flooded with silver and gold, especially from the new world, chiefly by way of Spain; and the northern countries, which had no mines at home or in their colonies, centred attention on sharing in the treasure through a favourable balance of trade, an excess of exports over imports.

Mercantilism flourished from the 16th century to the 19th century, and was exemplified in innumerable writings and in the restrictive and regulative policies of such statesmen and rulers as Jean Baptiste Colbert, Lord Burghley, Oliver Cromwell and Frederick the Great. Besides attempting to secure a favourable balance of trade (an excess of exports, bringing in money or bullion), other aims were low interest rates, low wages, encouragement of population growth and colonies. It has been interpreted as nation building and as an advance toward free trade, which was promoted within the national domain, in contrast with the application of similar restrictive policies by smaller units in the medieval towns. Whether the measures advocated met the immediate needs of the times is still a disputed question. In economic terms, the fallacies have long since been exposed, but the general attitude survives today in protectionism.

Transition to Modern Political Economy or Economics.—Modern economics started out essentially as the theory of free enterprise. It is interesting to observe that the great mercantilist writers of the later 17th century in England (contemporaries of John Locke in political philosophy) were in substance free traders. Thomas Mun's famous booklet, *England's Treasure by Forraign Trade* (published posthumously in 1664 but in circulation much earlier), sophistically used the balance of trade argument in favour of freedom to export specie. Other writers, such as Charles Davenant, Nicholas Barbon, Sir Josiah Child and especially Sir Dudley North, worked out the theoretical argument for freedom in foreign trade about as explicitly and clearly as did Adam Smith nearly a century later. North argued that the wealth of a nation is that of its citizens and that the businessmen, traders and producers are the best judges of when trade involves a net gain. It remained for someone to apply the same reasoning to internal policy, against the surviving guild restrictions or national control of apprenticeship, of wages and interest, grants of monopolies and the like.

All through the later mercantilist period, economic relations were gradually becoming more free and controls were falling into disuse, particularly in England. In notable respects the statement of free-trade doctrine came earlier in France, where the movement itself was much slower. It was here, of course, that the phrase "laissez faire" originated in the first half of the 18th century. The kingdom of France was still subdivided into many districts with customs frontiers until after the Revolution. About the same time there appeared one of the most notable of the books anticipating the liberal point of view, the somewhat mysterious *Essai sur la nature du commerce en général,* by Richard Cantillon. It is apparently a translation, perhaps by the author himself, of an English manuscript which has disappeared. Cantillon showed

a fairly clear insight into the mechanism by which a free market will direct resources into the production of the goods most in demand. Similar insights were conspicuous in the nearly contemporary essays of David Hume, though he wrote no systematic treatise. Early in the second half of the 18th century much attention was attracted by the writings of a French school, the members of which called themselves *les économistes* but who are now referred to as the physiocrats. The word is practically equivalent to law (or rule) of nature. The leader was the court physician François Quesnay. Like many of the mercantilists, these writers used rather absurd if ingenious arguments; and it has been pointed out that their position was connected with the self-interest of certain groups that had achieved wealth and power in the disturbed conditions in France after the death of Louis XIV, especially in consequence of the ambitious schemes of John Law and the famous "Mississippi Bubble." But the physiocrats are to be credited with an attempt to see and analyze a national economy as a whole. Their most characteristic doctrine was the view that only agriculture yields a surplus beyond what is required for the support of the workers; hence land rent alone is available for the support of the state and higher culture or the increase of wealth, and is the only proper subject for taxation. These ideas survived in part in the work of Adam Smith and the British classical economists. The pre-Revolutionary statesman, Anne Robert Jacques Turgot, renowned for his courageous but abortive economic and fiscal reforms, was to some extent a disciple; his work, *Réflexions sur la formation et la distribution des richesses* (1766–70), is an exceedingly able treatise.

The Classical Political Economy.—In 1776 Adam Smith published *An Inquiry into the Nature and Causes of the Wealth of Nations*, a work in which wisdom, learning and the power of analysis are joined to an extraordinary degree. As already noted, Smith shared many of the popular prejudices that were evident in the writings of the physiocrats. He held that "in agriculture nature works with man,"—as though this were not true of all other pursuits—and that only labour is productive. He also held that the interests of businessmen, as a class, are more often opposed to the interests of the community than are those of landowners. Nevertheless, Smith gave the world a new view of the advantages of trade as a mechanism for working out the division of labour, and a new philosophy of commerce. But he saw in commerce, as well as internal trade, a means to welfare, not merely to the aggrandizement of the state. His book was, in one leading aspect, a formidable tract directed against mercantilism. Money, from the communal point of view, he held to be merely an instrument, a wheel of trade. The real source of a country's wealth, he said, is its annual labour, and its wealth or well-being could be increased only by making its labour more effective, particularly by extending specialization and accumulating product in the form of capital. (For "labour" we should now say "productive resources.") "The division of labour is limited by the extent of the market" is one of his most famous sayings.

These were Adam Smith's fundamental principles. He elaborated them with great skill in relation to concrete problems, showing unusual powers of fresh observation in his selection and use of illustrative material, and passing large sections of economic history and the whole range of the contemporary commercial and fiscal problems of Britain under survey. Although his book is the most influential brief ever formulated for unimpeded trade, neither hampered nor coddled by governments, its greatest importance lies not in that circumstance but in the general picture, at once simple and comprehensive, which it gives of the economic life of a nation. It shows how the apparent chaos of competition, the welter of buying and selling, is resolved or transmuted into an orderly system of economic co-operation by means of which, under individual freedom in contrast with central direction, the community's wants are supplied and its wealth increased. This general picture has been in the minds of economists ever since, whatever their opinions with respect to the efficiency or morality of the competitive system, and its general outline is admitted even by collectivists to be valid for their systems. Despite some sweeping phrases which invite another interpretation, Smith was no doctrinaire advocate of a hands-off policy by governments in respect of economic matters. His treatment must be understood against the background of conditions of his day, in which so much was a holdover from the period of mercantilism and even the middle ages. He was opposed to monopoly, exclusive combinations and special privileges of all kinds, quite as much as he was opposed to the type of legislation which aims at fostering a country's prosperity by restricting its trade. He is often styled the "apostle of self-interest," but he took no pains to conceal his dislike for some of the forms in which self-interest manifests itself in trade and industry, and had no aversion to legal measures wherever they actually promised to be beneficial. What his attitude would have been under the later conditions of the 19th and 20th centuries toward the factory acts, social insurance, and particular measures intended to foster equality of opportunity, we cannot tell. But there is nothing in the aims of these newer types of legislation which runs counter to his principal contentions or is inconsistent with his general economic philosophy.

Adam Smith's work had a profound influence not in Great Britain alone but in almost every part of the western world. It was partly responsible for some radical changes in the commercial policies of governments, though its influence cannot be measured, because the current of the times was moving in the direction of his contentions. Its effect upon scientific thought and upon the character and quality of public discussions of economic questions cannot be questioned. Men like Jean Baptiste Say in France and Karl Heinrich Rau in Germany based their work very largely on Smith's and helped to diffuse his influence. Say, however, was more than a mere popularizer. He had some clear-cut views of his own and developed Smith's work in directions other than those it took in the hands of Smith's British successors. In the United States, Say's work came to be about as widely read as Smith's.

The particular trend which the development of economics took in Great Britain after Smith was largely determined by the character of the economic problems which confronted the nation, partly by reason of rapid changes in its own industrial structure (the industrial revolution) and partly in consequence of the French Revolutionary and Napoleonic wars. Population increased rapidly and foreign trade expanded. The changes were accentuated by the wars and by governmental effort to maintain self-sufficiency in food (or to benefit the landed interest, which controlled the government); land rents rose with the increase in agricultural prices; the currency was depreciated (a practically universal accompaniment of any major war); rates of interest and of profits were disturbed; and, after the peace, both industry and agriculture experienced depression conditions. Some of these conspicuous and important phenomena engaged the attention of parliamentary committees; all of them attracted the interest of thoughtful men who, with Adam Smith's picture of the mechanism of organized economic life in their minds, thought of them as interrelated and attempted to explain them in some consistent and comparatively simple way. Out of the discussions of the period, in pamphlets and controversial tracts, there emerged a formal system of political economy. It owed much to Smith, but it stressed matters to which he had given little or no attention, and emended his views at a number of important points. This newer political economy was concerned more largely with abstract general relations, but it dealt with real problems.

For convenience, the period of which we are now speaking may be taken as definitely beginning with the publication of David Ricardo's *Principles of Political Economy and Taxation* in 1817, and as culminating with the publication of John Stuart Mill's *Principles of Political Economy* in 1848. One who compares the economic tracts and the systematic treatises of that period with the *Wealth of Nations* will be impressed with the increased importance given to a group of problems which have continued to be principal concerns of economics, problems now commonly grouped under the head of theory of value (*see* VALUE, THEORY OF) and distribution (*q.v.*). The theory of value attempts to explain why goods exchange at particular prices, why some are expensive and others cheap. The modern theory of distribution is really a part of value theory, dealing with the prices of produc-

tive services, with a view to explaining the sharing of the national income or social dividend, or why some are poor and others rich. The classical economists found it useful for analytical purposes to classify the total product into three distributive shares—wages of labour, profits of capital and rent of land. Later on, the conception of a fourth share, the profits of enterprise, or of the successful direction of production, was taken over from the French economists (Say and his followers); the earnings of capital, separated from the entrepreneurial functions of management and responsible risk-taking, came to be called interest (whether actually paid out for borrowed money or imputed to that of the owner, an individual or a group).

The classical theory of value stressed chiefly the tendency of the prices of goods produced and sold under competitive conditions to be proportionate to the costs of producing them. However, costs meant not the money outlays of the producers (entrepreneurs) but the "real" costs, human sacrifice or pain. For Ricardo this appeared to mean quantity of labour. Some of his writing seems to suggest that labour alone is really productive, other factors only assisting. This extreme form of the labour theory of value, which doubtless was never held by Ricardo, was taken over in a variety of modified forms by the various schools of socialists and economic radicals, notably by Karl Marx (*q.v.*) in his theory of surplus value, which maintained that all distributive shares other than wages must come out of the difference between what labour produces and what it earns, *i.e.*, that rent, interest and profits must all represent exploitation of labour. Later, the notion that the abstinence involved in saving and accumulation of capital is also a true cost was introduced by Nassau William Senior in *An Outline of the Science of Political Economy* (1836). The socialists, of course, scornfully rejected this innovation.

The classical economists did not see clearly that what is economized is the use of resources, both human and nonhuman, and that the ultimate meaning of the cost of any product is the nonuse of resources for some other end. This fact is now known as the alternative cost principle. But the alternative end sacrificed is not always and entirely a quantity of another marketable product; it may be the leisure use of time and labour, or some direct (nonmarket) use of any other resource. It should be noted that, as all modern economists have recognized, the cost explanation of value applies only in a long-run view, over time sufficient to adjust production to demand. The classical economists freely recognized that over short periods price depends on demand and supply, *i.e.*, the demand for the existing supply already produced, or for which commitments have been made. For example, the price of a commodity in short supply is likely to rise well above its cost of production until its output has time to catch up with demand.

A similar division between short-run and long-run views was inevitable in connection with the theory of distribution. Neither theory has stood up well under later criticism, though many important facts and principles were recognized.

In the long-run theory of distribution, the idea that the standard of living determines wages is in effect a cost-of-production theory of the price of labour. This doctrine rested upon the theory of population associated with the name of Thomas Robert Malthus (*q.v.*), though it was clearly stated in general terms by Adam Smith and by still earlier writers. In the later form, the notion of subsistence, as a physiological minimum, was replaced by, or interpreted to mean, a standard of living, a scale or level which labourers think of as necessary in order to undertake family life. If wages fall below that level, it was thought, the rate of growth of the working population will be negative (births fewer than deaths), and the decline in the labour supply will raise wages. If wages are above this level, population will increase and wages will fall—unless a higher standard of living becomes effective as a control of marriage. Somewhat similar reasoning was applied to profit, the rate of return on capital. The supply tends to increase as long as the return is above what savers generally consider sufficient to compensate for the abstinence required to save, and will decrease when it is below such a level; hence the rate of profit tends toward this level as a position of equilibrium.

The rent of land, however, was held not to be affected by the principle of cost. Land was thought to be permanently fixed in supply; it was defined by Ricardo as "the original and indestructible powers of the soil." Hence, a rise in rent will not tend to counteract itself by bringing forth an additional supply—or reciprocally for a decline. Correspondingly, rent was not supposed to be a part of or to influence the price of its produce, which in this view is determined by the cost (wages plus profit) on land barely worth using and yielding no rent—or by the cost at the intensive margin. Changes in rent were thus the effect, not the cause, of changes in product prices.

In the classical system of distribution as a whole a very important place was ascribed to the "law of diminishing returns," in a particular long-run or historical interpretation. As the theory ran, the growth of population, itself dependent on growth of capital, required resort to poorer land and also to more intensive cultivation of land already in use. In either case, the increase of product would not be proportionate to the increased amount of labour (and capital). Manufactures, in contrast, were thought to be subject to increasing returns, because of larger opportunities for the economies of the division of labour and for invention and for the application of the fruits of scientific progress to industry. Agriculture also benefited by technical progress, but here the possibility of improvement was thought to be smaller and to be more than counterbalanced by the increasingly disadvantageous proportioning of labour and capital to land. Since labourers must always get the same real wages—the means of subsistence—the profits of capital must decline, until the growth of population and wealth would come to an end in a stationary economy. Taken as a prophecy, this doctrine has not been entirely disproved by the course of events. It is true that the possibilities of improvement in agricultural technique were underestimated by the classical economists; new lands of good quality have been brought under cultivation and their produce brought to market by cheap transportation; and the Malthusian "principle" has been partly falsified by some at least temporary declines in birth rates. But in recent years increasing concern has been felt about the continued rapidity of population increases, particularly in the so-called underdeveloped areas, and the Malthusian prediction has to some extent returned to fashion. (*See* ECONOMIC DEVELOPMENT.)

Any general system of value theory must have something to say about the value of money or the general price level. This problem was of especial concern to Adam Smith because of the price revolution which had swept over Europe after the discovery of America and of its startling effects. Later this interest was nourished by the monetary and price changes of the period of the great wars of the French Revolution and of Napoleon. On this point the classical school held to the doctrine later known as the quantity theory of money: other things being equal, the value of money (and reciprocally the price level) depends on its quantity in relation to the volume of production and trade. (*See* QUANTITY THEORY OF MONEY.) Allowance would also be made for the use of money substitutes, such as bank credit, already familiar in Europe. As a long-run view, this doctrine was supplemented by the notion that the quantity of money is determined by the costs of mining the precious metals. Among different countries, whether or not they possess mines of precious metals, prices would tend to be equalized by a flow of money or bullion from countries in which foreigners would buy less to those in which they would buy more.

It would be an error to think of these earlier economists as altogether preoccupied with abstract theories, or not to recognize that their interest in these matters was born of an interest in practical problems. And in general, they were not such uncompromising opponents of any sort of interference by government in industry as some later critics and pretended expounders of their views have made them out to be.

The Critical Schools.—Before reviewing the later progress of economics, especially the developments of the later 19th century, it will be helpful to look at the principal types of criticism which have been directed against the older political economy and at the conceptions which have been proposed as replacements. In the

first place, romanticists like Adam Müller in Germany and John Ruskin in England intensely disliked the new individualistic economic mechanism, the workings of which the economists were trying to probe. They particularly disliked the defense of this mechanism of economic laissez faire, which the economists in general did defend, by statement or implication. They preferred an ordered society with economic values subordinated to moral or religious or aesthetic values, such as they thought had been more or less fully embodied in the social structure of the middle ages. Work, they inclined to insist, is not merely a means to an end, particularly what are called economic ends; good work is worth doing for its own sake and for its effect upon character. They did not impugn the fitness of economics as an instrument of attack upon its special problems so much as they belittled these problems.

Another group of writers, for whom there is no better descriptive name than "the critical school," came much closer to meeting the orthodox economists upon their own ground. One of the earliest and the most influential of them was Simonde de Sismondi (*Nouveaux principes d'économie politique* [rev. ed. 1827] and other works). Other able writers, notably Thorstein B. Veblen in the United States, took a similar position. These critics urged that more attention be given to the defects of the competitive economic mechanism, even viewed merely as a means of providing for material needs. They contended that the economists, contemplating the long-run or normal tendencies and the theoretical beauties of the automatic processes by which the pursuit of individual economic interests becomes organized into a vast scheme of economic co-operation, forget how often the mechanism breaks down and normal economic life is interrupted by crisis and depression; how unemployment, chronic as well as epidemic, is a disease of this economic order; how unequally the aggregate product is distributed among individuals or families; and how many of the things men do for their own economic advantage are in fact inimical to the interests of the community. As later critics have put it, businessmen are interested primarily in making money, which does not always mean making more goods. The picture of the economic harmonies (the title of a mid-19th century French apologetic work) requires, it is urged, rationalizing of the facts to an unwarranted degree. These criticisms also undoubtedly go too far. They unduly play down the role of the abstract principles stressed by the older economics in the general course of the economic activities of the community. And no economist of the first rank has ever been a devotee of the pure automatism of the market. But the critical school has had a wholesome influence on the progress of economic science. It should be observed that this school occupied a position between that of the orthodox school and that of the socialists who denounced the works of the latter as mere apologetic, a product of the existing economic order and prompted by the interests of those who benefit by its iniquities.

Another line of attack was adopted by the historical school, or more accurately, schools, since the term covers several different groups. This position has been represented in all countries, but it has been most influential in Germany. The most important of its early exponents were Friedrich List (*Das Nationale System der politischen Ökonomie* [1841]) and Wilhelm Roscher (*Grundlagen der Nationalökonomie* [1854] and other works). The form of a nation's economic life, said these critics, is a historical category, peculiar to a given nation at a given time, a product of its past and, therefore, only to be understood through a study of that past. The wisdom of particular economic policies is relative to conditions of a place and time, and the supposedly universal laws of abstract economics need to be supplemented by or even subordinated to study of concrete facts of the national situation. If they had gone no further, the historicists would have found many to agree with them. But they tended to make of the historical method something arbitrary and doctrinaire. (Karl Knies, whose work *Die politische Ökonomie vom Standpunkte der geschichtlichen Methode* appeared in 1853, is a notable exception.) Not content with looking to history for the causes of these concrete differences of economic structure in which they were interested, they proposed to derive from history itself universal and binding laws, akin to those of the physical sciences. They were fond of schemes of stages of economic development through which they thought every nation must pass. In these speculations they were really elaborating suggestions found not in historical research but in the Greek speculative historians. They regarded the forms taken by economic life, past and present, as inevitable products of historical forces; and at the same time, unconscious of the inconsistency, they advocated a rather heavy-handed control of economic activities by the state.

The British and French economists had looked upon the organization of economic life as being shaped and determined by the interplay of the interests and rational activities of individual men, and had viewed the state as an instrument of individual purposes—well-being as judged, in the main, by each person for himself. The spokesmen of the historical school, in contrast, were strongly influenced by the philosopher Georg Wilhelm Friedrich Hegel, who ascribed a prior and independent value to the state, with individuals somewhat in the role of means, on the analogy of cells or organs in the human body; the view is related to that of the mercantilists though more sophisticated. Although they pushed their views to extremes, they gave a needed emphasis to what has come to be called the institutional view of economic activities, as contrasted with the individualistic or contractual aspect. But both the older historicists and the later institutionalists (largely a U.S. movement of the early 20th century) slurred over the contrast between two kinds or meanings of institution; *i.e.,* patterns of action moving in predestined grooves under the influence of relatively unconscious social forces versus those embodying deliberate organization and control, such as the political organs of the state. The state, in turn, was conceived by the older schools in what would now be called totalitarian terms, while the institutionalists, like the socialists (in contrast with the communists), thought of it as democratic. Historical economists have also been more ready to think of change, as contrasted with finality, in the pattern of economic organization, and they give a useful impulse to the study of economic history, which is valuable both in itself and as a complement to economic theory. Under the influence of historical study the old dogmatism of the historical economists gradually gave way to a realization of the variety and complexity of the fabric of economic history; and the newer schools of historical economics under the leadership of such scholars as Gustav von Schmoller in Germany and Ashley and George Unwin in Great Britain were primarily devoted to historical research. The movement also broadened out, particularly in Germany, under such leaders as Max Weber and Werner Sombart, into what is often called sociological economics, a position also well represented in France (François Simiand, Maurice Halbwachs, C. Bouglé).

The Marginal Utility Analysis.—The older classical economists, as we have seen, centred their attention on the long-run relations between value and costs and were generally content to dispose of short-run variations of price by merely invoking the formula of demand and supply. This was used without careful analysis of the short-run situation, particularly of the role of demand. Work directed toward filling in this gap had important effects in changing the whole conceptual picture. Similar steps introducing the new analysis were taken independently and almost simultaneously in the early 1870s by William Stanley Jevons (*q.v.*) in England, Karl Menger in Austria and Marie Esprit Léon Walras (*q.v.*) in France and Switzerland. (It presently became known that they had been in part anticipated by earlier writers who were ignored and forgotten.)

Adam Smith, in a famous passage, had contrasted value in use with value in exchange, noting that the former is high for water and low for diamonds, and conversely for the latter. The new discovery was that there is nonetheless a definite relation between value in use (or utility) and exchange value, hence price. The value in use is not properly measured by the difference between having the normal supply of a good and having none at all but by the difference it makes to have a little more or a little less. Thus where water is scarce its value—both use and exchange value—is exceedingly high, because the marginal use meets an intense desire or need; that is, because an addition to our supply

of water on a desert trip can add very substantially to our well-being. If diamonds were abundant enough their value would be small because we would benefit very little from further additions to our stock of diamonds. Goods, however important, that are superabundant, the supply being unlimited by any cost, have no economic utility or economic value, though to common sense this seems a paradox.

Perhaps the most important feature of the new views, considered as theories of demand and of price, was not the psychological explanation but clarification of the nature of what Adam Smith called the "effective demand." It was seen that the demand for a commodity by any consumer or in any market is not a definite magnitude but a functional relation showing the different quantities that will be purchased as the price changes. It is assumed that in most cases a higher price will reduce the quantity demanded. The actual quantities depend on both the tastes of the consumers and on their purchasing power, and in addition, on the availability of other products competing for the consumers' income and the price of these other items.

This idea served to clarify the relation between price determination in the short run and that in the long run. In the former case, the supply is typically the amount already on the market, and the price is the marginal demand price for this amount. But in the longer run, production itself responds to price and price to supply, so that the long-run or normal or equilibrium price is that at which the amount consumers will take is equal to the amount which producers find it profitable to produce. This advance is largely to be credited to Alfred Marshall (*Principles of Economics* [1890] and numerous later editions, considerably revised).

It was also gradually recognized that costs of production consist of the payments which at the same time constitute the shares in the distribution of the product among the different productive agents. Thus a rational conception of production in terms of the allocation of productive capacity among alternative modes of use, through the competitive bidding of business units (or their managers or entrepreneurs), explains at the same time the prices of final products, the costs of production and functional distribution. Personal distribution depends in addition on the amount as well as the value of the productive services of all kinds that are owned or controlled by the various participants in economic activity.

Goods are usually produced by the co-operation of various kinds of productive services, and the special problem of distribution, in modern terms, is that of the division of this joint product among the different kinds of co-operating productive services or agents. (*See* DISTRIBUTION.)

At the end of the 19th century a number of writers (especially John Bates Clark and Philip Henry Wicksteed) sought to analyze distribution in a manner analogous with the marginal utility theory of consumer demand. It was argued that a business firm, too, would be willing to pay a productive agent only what he adds to the firm's well-being. It is clearly unprofitable to buy *e.g.*, a man-hour of labour if it adds less to its buyer's income than the labour cost him. This marginal yield of a productive input came to be called the value of its marginal product, and the resulting theory of distribution which states that every type of input will be paid the value of its marginal product is called the marginal productivity theory of distribution, a theory which still has its place in current economic literature.

This theory, or principle, that every agent tends to get what it produces does not mean that each person gets what he deserves, and in fact tells us little about the ethical quality or social desirability of the result. It must be remembered that differences in training and opportunity greatly affect men's productive capacities as workers, and that institutions, especially that of inheritance, enter into this picture as well as into the ownership of property and the opportunity to accumulate. And the swift process of change in technology and demand often robs men of the fruits of skill acquired at great cost—and also of the savings committed to particular industries. In particular, such innovative activities as invention and exploration for minerals may yield anything from zero to a reward quite disproportionate to the outlay in effort or money.

The rate of interest received much attention in the discussion of this period. Controversy was stimulated in particular by the publication in the 1880s of two books by Eugen Böhm-Bawerk, a disciple of Karl Menger. He propounded two views of interest, both foreshadowed a half century earlier in the work of N. W. Senior. One is a reworking of the abstinence theory into one of postponement or waiting, or discount of the future. Interest is viewed as the reward or necessary inducement for saving, hence as the measure of the superior attraction of present over future consumption. The other view regards interest as the yield or productivity of investment due to the greater efficacy of more roundabout processes, *i.e.*, processes in which raw materials are first transformed into producers' goods which are in turn used to make consumers' goods.

The interest rate on loans tends to equal the yield obtainable on investments; *i.e.*, the ratio of the net rental on capital goods (after provision for maintenance and eventual replacement) to their cost; and the cost is the value of consumable goods sacrificed in using productive capacity to create them. (*See* CAPITAL AND INTEREST.) The theory of interest is of the greatest importance in the general system of value theory, since the value of all durable goods bought and sold is immediately determined by the capitalization of the expected future income. This tends to be the same as their cost, since no such good will be produced, or long maintained, unless it is expected to yield at least the going rate on its costs, and if it yields more, new supply will lower the rate. But errors and unexpected changes in conditions often cause capital goods to be worth more or less than cost (to yield less or more than interest on cost).

The discussion of distribution at the beginning of the 20th century also produced significant contributions to the theory of profit, particularly by Frank H. Knight and Joseph A. Schumpeter. In ordinary business usage, profit is a mixed form of income, containing elements of interest and of wages for that vaguely distinguishable part of management activity which may be treated as labour; and both the amount of the owner's capital and the proper rate of interest to allow are also uncertain. The distinguishing mark of profit is that its amount is not stipulated in any agreement or fixed in an exchange but is contingent upon the success of a particular enterprise or undertaking. According to Knight, profit arises from error or imperfect foresight on the part of the responsible entrepreneur, in making policy decisions or in delegating these to salaried managers as his agents (in a corporation, the agents of the voting stockholders as a group). Pure profit is the amount left over after making all stipulated payments for productive services, raw materials, etc., and after deduction of the going rate of payment for the entrepreneur's own capital and services. It may be a negative as well as a positive sum, and, Knight suggests, it is impossible to say conclusively whether the gains are greater or less than the losses in the aggregate for a whole economy. Pure profit is, of course, increased in any individual case by greater accuracy in the ultimate managerial decisions, and tends to be decreased by excessive optimism on the part of entrepreneurs.

According to Schumpeter, whose views are compatible with the preceding discussion, profit is the reward to the entrepreneur for successful innovation. To him the primary task of the businessman is not the running of routine operations, but the putting of new ideas into effect. He is always seeking new products, new sources of supply and new productive technology, and if he can effect these innovations before it is done by his competitors, he obtains a profit over and above the regular interest on his investment and the wages of his day-to-day managerial labour.

The end of the 19th century produced another important contribution which continues to occupy the attention of economists. Even more than from his work on marginal utility theory, Léon Walras' influence today stems from his invention of general equilibrium analysis. This approach is characterized by its recognition of the interdependence of the various parts of economy. For example, a fall in meat prices is not only likely to affect sales of poultry and fish but also to change the amount of money con-

sumers have left over for the purchase of all other goods. Indeed, a change in practically any economic variable has direct or indirect effects on innumerable other magnitudes, and it is this complex network of interrelationships which general equilibrium theory undertakes to analyze. This analysis is necessarily of such complexity that the use of mathematical equipment becomes absolutely essential. In the simplest general equilibrium systems demand and supply relationships are expressed as functions of all prices in the economy, and the requirement that demand for every commodity in the economy be equal to its supply thus constitutes a system of simultaneous equations which can normally be solved to obtain the unknown magnitudes of the prices. Subsequent work in the area has involved more complications and more advanced mathematical techniques.

A number of concrete economic phenomena can be explained meaningfully only in such a general equilibrium context. This is true of any problem involving the allocation of national resources, such as the production of guns or butter in wartime, because any increase in one output can be evaluated only in terms of possible reductions of production of other items. Similarly, the analysis of monetary and, in particular, of interest rate phenomena must involve general equilibrium considerations because they materially affect every sector of the economy. Most recently, general equilibrium theory has also led to the input-output analysis of Wassily W. Leontief (*The Structure of American Economy, 1919–1929* [1941]) in which the technological interrelationships of production in entire economies are investigated empirically and interpreted as a system of simultaneous equations which can be solved for the total input and output requirements involved in the production of any particular collection of consumers' goods.

Recent Contributions to Economic Analysis.—It is possible to list the main developments in economic analysis since the 1920s under four headings: welfare economics, the theory of monopolistic competition, the theory of the determination of national income and employment and mathematical economics. All of these grew out of earlier work but their systematic analysis and the widespread attention they have received are fairly recent.

This is particularly true of welfare economics whose subject matter has to some extent been discussed throughout the history of economics but which has only in the 20th century been established as a separate and well-defined branch of the discipline. Welfare economics may be interpreted as the theory of economic policy. It investigates the effects of various economic phenomena and governmental policies on the well-being of the community. Its emphasis has largely been on the consequences of various market forms such as monopoly and competition for the allocation of the economy's resources and its relation to the desires of the public. The effects of various types of taxes, import duties, price controls, rationing devices, nationalization and socialism have also been studied. The first systematic work in this area which perhaps is still the most important contribution is that of Arthur Cecil Pigou (*The Economics of Welfare* [1920]). Work in the late 1940s turned more to quasi-philosophical issues involved in the foundations of welfare economics, but more recently interest has swung back primarily to applications of the subject to problems such as those involved in investment decisions by government agencies.

The second major recent development of economic theory, the theory of monopolistic competition, gave full recognition to the range of market structures in between the extremes of pure competition and pure monopoly to which earlier writings had largely been devoted. (*See* COMPETITION, ECONOMIC; MONOPOLY.) Important earlier contributions to the subject had been made by many economists including Jacob Viner, Roy F. Harrod and Frederik Zeuthen. But the attention of the profession was fully captured by two works, Edward Hastings Chamberlin's *The Theory of Monopolistic Competition* (1933) and Joan Robinson's *The Economics of Imperfect Competition* (1933). The theory encompassed a variety of market phenomena including product differentiation, a situation in which each seller carries goods which have some unique properties in the view of the consumer (brand names, special ingredients, accompanying customer services, etc.) so that the seller may be considered to have a partial monopoly. Also analyzed were oligopoly, which is characterized by an industry composed of a small number of large firms; discriminating monopoly, where a given item is sold at different prices to different customers; and monopsony, that is, a single (monopolistic) buyer. Since the bulk of business in developed capitalist economies is conducted under conditions of product differentiation or oligopoly the enthusiasm with which the analysis was received was understandable. Unfortunately, the theory involves difficult problems which have so far prevented its complete integration into the body of economic analysis.

The third of the major recent developments, the theory of income determination, is associated primarily with the work of one man—John Maynard Keynes (*q.v.*) who published his fundamental volume, *The General Theory of Employment, Interest and Money* in 1936. The Keynesian analysis takes the position that, at least in the short run, the level of effective demand for consumers' and producers' goods may either fall short of or exceed a nation's capacity to produce. In the former case the result will be unemployment and depression, while the latter event (where effective demand exceeds productive capacity) will lead to inflation. The important Keynesian analytic innovation consists in his discussion of the determinants of effective demand. Overall consumer demand is, on this view, determined largely by national income, that is, by the amount of purchasing power which flows into the hands of consumers. Over-all demands for producers' goods, on the other hand, depend primarily on profit prospects and the terms on which businessmen can finance their purchases of equipment, inventory and other inputs. If rates of interest are high it will be expensive to borrow the funds used to construct new plants and equipment and so high interest rates will reduce the demand for producers' goods.

This at once suggests a number of policy instruments for the control of unemployment or inflation. For example, in an inflationary period it may be appropriate to reduce effective demand by use of one or more of the following actions: (1) reduce the money supply, which will tend to raise rates of interest and so decrease the demand for producers' goods; (2) reduce governmental expenditure, thereby directly decreasing total demand for goods; (3) raise taxes or sell government securities to the public, thereby reducing the purchasing power in the hands of consumers. Of course, none of these techniques is without its drawbacks but if problems of unemployment or inflation become sufficiently serious, action of this sort is likely to be worth the price.

One characteristic of these policy measures is particularly noteworthy. It provides the means for the government to help combat inflation or unemployment without detailed central direction. Basically, the method consists in additions to or withdrawals of purchasing power and it is left entirely up to consumers and businessmen to decide to what uses these funds will be put (or from what types of expenditure they will be withdrawn). Keynes also emphasized that wage reductions are not an effective and dependable cure for unemployment. They result, at least in the first instance, in a reduction in costs of production, but they also reduce the public's purchasing power.

Keynes' work is important analytically because it provides a systematic explanation of the determination of over-all effective demand and hence of the level of production (national income). It is very much in the spirit of general equilibrium analysis, with the interdependence of production and monetary phenomena playing a crucial role. However, Keynes achieves a considerable amount of simplicity and analytic power by his exclusive attention to broad categories; for example, the category of consumers' goods is never discussed in terms of the specific industries and products of which it is composed. Economic analysis conducted at this level of aggregation has proved particularly helpful in the systematic investigation of policy problems and has been given the name *macroeconomics* in contrast with *microeconomics*, the study of the individual units which compose the economy.

A fourth major recent phenomenon is the expansion of the field of mathematical economics. This is a far more complex and

heterogeneous development than those which have just been discussed and its origins go back at least to the first half of the 19th century. Though there are even earlier writings in the area, the first systematic work is probably that of the French economist, mathematician and philosopher, Antoine Augustin Cournot (*Recherches sur les principes mathématiques de la théorie des richesses* [1838]). Cournot recognized that if businessmen adopt policies which yield them maximum profits, the differential calculus permits the prediction of the nature of their price and output decisions, the reaction of their prices to changes in taxes, etc. For the differential calculus is the classical mathematical tool of maximization and minimization computations, so that given enough information it can tell us what levels of outputs and prices are necessary to obtain maximum profits for the firm. Largely on this basis, Cournot was able to develop a rich and informative theory.

For the next half century mathematical analysis received little attention from economists. Only with the work of the marginal utility theorists did interest in this area become more widespread. An outstanding example is the role of mathematics in Walras' general equilibrium analysis which has already been referred to.

Until recently, the differential calculus was the most important tool of mathematical economics. Eugen E. Slutsky in 1915, John Richard Hicks and R. G. D. Allen in 1934, and Paul A. Samuelson in 1947 all made important contributions to the analysis of the behaviour of the consumer and the business firm. Using the so-called higher order maximum conditions of multivariable functions under constraints they were, for example, able to derive fruitful theorems about the reactions of the utility maximizing consumer and the profit maximizing firm to price changes.

More recently, mathematical economics has turned to other types of problems and other types of mathematical techniques:

1. *Economic Dynamics.*—With this technique the structure of economic processes and economic developments over time is studied in detail. Particular attention has been paid to the sequence of developments involved in business fluctuations and to the analysis of the long-run mechanism of expansion of an entire economy. The mathematical techniques which most frequently have been employed here are difference and differential equations. Roughly, a difference equation may be described as a relationship between the current value of some variable and the values of this and possibly some other variables at various dates in the past. These are obviously a suitable instrument for economic dynamics, particularly because economic data are reported and acted upon at discrete intervals (perhaps once a month) rather than continuously as a differential equation would imply.

2. *Activity Analysis.*—Economic problems are frequently characterized by what the mathematician calls inequality constraints. For example, the total output of the economy is limited by the available mineral resources, its labour supply, etc. The amount of any such resource actually employed must aways be less than or equal to the total amount available. Any attempt to use a nation's resources in an optimal manner must take these constraints into account. The analysis of maximization or minimization problems involving such inequality constraints required a new set of mathematical techniques called mathematical (or in a special simple case linear) programing, which are most closely associated with the work of mathematician George Bernard Dantzig. These methods have been employed to extend the theory of welfare economics, general equilibrium analysis and the theory of economic growth, in all of which such constraints play an obvious role. These applications of mathematical programing, many of which are the work of Tjalling C. Koopmans, have been given the name "activity analysis."

Game Theory.—The analysis of problems of oligopoly and other related market situations underwent a major reorientation as a result of the work of John von Neumann and Oskar Morgenstern (*Theory of Games and Economic Behavior* [1944]) in which the analogy between business competition and rivalry in games was exploited as an analytic tool (*see* GAMES, THEORY OF). Work in this area and the other problems of mathematical economics which have just been described continues to be a major preoccupation of economic theorists.

This discussion has been confined almost entirely to economic theory with no attention to the large variety of empirical, institutional and applied work which has become important. As in other disciplines, work in economics has become increasingly specialized into such areas as international trade, labour economics, money and banking, and public finance, each with its large and growing body of literature. Moreover, work in the collection and analysis of statistics has developed rapidly. Reliable records of economic activities are brought together and published by governments and private organizations on a scale which would have excited the envy of the earlier economists. Analytic statistical techniques and the investigation of their foundations have evolved from the primitive political arithmetic of the 17th century into the complex and sophisticated methodology which is known as econometrics (*q.v.*). All of these developments together constitute the discipline of economics which continues to be in a state of ferment and rapid growth.

See also references under "Economics" in the Index volume.

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ECONOMICS, PRIMITIVE: *see* ECONOMIC ANTHROPOLOGY.

ECONOMIC UNION. In the widest sense this term designates any form of co-operation in the economic field between two or more countries. The Universal Postal union (*see* POSTAL SERVICES), for example, or the former European Payments union (*q.v.*) may be regarded as economic unions, though each was confined to a limited and specific set of problems. The concept is used more frequently for the establishment of a common market between two or more countries; this, in turn, is a special form of customs union. A customs union is an agreement between two or more countries stipulating: (1) the elimination of tariffs and other trade barriers between the member territories; (2) the establishment of a uniform tariff and other rules regulating imports from outside the union; and (3) apportionment of customs revenue between the members in accordance with an agreed formula. An economic union goes further in that it normally also embraces agreements on the flow of investment between the member countries and may include other aspects of economic relations such as the migration of labour among the members of the union.

History.—Preferential arrangements relating to international

trade were concluded in the middle ages and even earlier, but the idea of a genuine customs union did not arise until the early 19th century. Only after the end of the Napoleonic wars did the idea of a customs union take hold. The German *Zollverein*, formed in 1834, is the most important customs union of the pre-World War II period and has often served as a model. In the course of the 19th century various countries which acquired colonies practised customs assimilation, a policy which has many similarities with a customs union. Customs assimilation involves the establishment of a uniform trade area between the mother country and the colonies, with free trade within the customs area and a common tariff barrier to the outside. Among the chief protagonists of colonial customs assimilation were the United States and France. Great Britain and Germany did not practise assimilation but treated their colonies as separate entities for customs purposes, though in some cases they accorded them preferential treatment.

In the period between World War I and World War II several unsuccessful attempts at forming regional customs unions were made, but the first effective customs union to come into existence was Benelux (*q.v.*), the union of Belgium, the Netherlands and Luxembourg, formed in 1944 by governments at that time in exile in London. The Benelux union did not begin operations until Jan. 1948. A customs union between France and Italy (Francita) was projected, but negotiations for this union were dropped in favour of the establishment of a wider union, the European Economic Community (E.E.C.), which included France, Italy and the German Federal Republic in addition to the Benelux countries.

The European Economic Community.—This community, known as the European Common Market or sometimes abbreviated to "Euromart," was formed by a treaty signed in Rome on March 25, 1957, among six countries which had already been united in the European Coal and Steel Community. The treaty provided for the gradual abolition of tariffs and quotas among the six member states over a period of from 12 to 15 years. One year after the signing of the treaty the six countries were obliged to reduce their mutual tariffs uniformly by 10%, 18 months later by another 5%–10% and one year after that by another 5%–10%, so that by the end of the first phase their tariffs were to be reduced by 25%. The complete removal of trade barriers was to be accomplished during a second and third period. At the same time a common tariff was to be worked out which would be equal to the average of tariff rates as they existed before the treaty. However, in 1959 negotiations carried on among the countries tended to lead to a reduction in tariffs on 70% of their trade items, an increase on 15% and unchanged rates on another 15%. The treaty of 1957 provided, in addition, for setting up a bank designed to finance investment schemes, expenses due to reconversion needs and basic industrial developments in the less developed areas of the community. A special fund of close to $600,000,000 was also to be made available during the first five years of the union for development of the overseas territories of the member states.

The formation of the European Economic Community had an immediate and strong impact upon the other countries of western Europe. Negotiations were carried on with other countries, especially with Great Britain, relating to their accession to the community. But because of its desire to maintain a policy of imperial preference, Britain did not join, nor did certain other countries. The main objection of the other countries was the joint tariff of the E.E.C.

During 1958 and 1959 negotiations among the European countries continued, and during 1959 it became clear that Great Britain, the three Scandinavian countries, Switzerland and Austria would join a common market area. Finally on May 4, 1960, the European Free Trade association (E.F.T.A.) was formed by a treaty signed by seven countries—Austria, Denmark, Norway, Portugal, Sweden, Switzerland and the United Kingdom. The purpose of the E.F.T.A. (often called "the seven" to distinguish it from "the six," or E.E.C.) was to move gradually toward free trade among its members and to reduce trade barriers to other countries in step with the E.E.C. while maintaining such preferences as those enjoyed by the members of the British commonwealth.

During 1960 the two unions extended various concessions to one another. Five nations—Greece, Iceland, Ireland, Turkey and Spain—belonged neither to E.E.C. nor E.F.T.A., though they were members of the O.E.E.C. (*see* ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT) and expressed interest in one or the other of the European trading groups. Greece's application to join the E.E.C. as an associate member was approved in 1961; Finland became an associate member of E.F.T.A. in the same year.

The idea of a common market was taken up with alacrity in other parts of the world. After 1957 talks on the formation of a common market in Asia and Africa went forward. In Latin America a treaty establishing a free-trade zone among Argentina, Brazil, Chile, Mexico, Paraguay, Peru and Uruguay was signed in Feb. 1960. None of these organizations, however, was a genuine customs union such as the German *Zollverein*.

Economic Aspects of Economic Unions.—The main advantage that the participating countries expect to derive from an economic union is an improvement of the level of income. The greatest benefits are derived if the countries forming the union have complementary production patterns, *i.e.*, if one group of countries is predominantly agricultural and another predominantly industrial or if their resources supplement one another in other ways. An economic union produces an increase in internal trade and in time a higher degree of specialization, and hence brings cheaper costs of production in the various parts of the union. But an economic union surrounding all its members with a common tariff wall does not necessarily lead to optimum specialization of production on a world scale, and some members of the union—especially those with low tariffs before the formation of the union—may be worse off with respect to certain goods. In general, the larger the number of countries in a common market the greater the benefits, and it may sometimes be preferable to have a partial lowering of tariffs among many countries rather than a complete removal among a few and the maintenance of high tariffs against nonparticipating countries.

Political Aspects.—The main political problems associated with the formation of economic unions concern the obligations which participating countries may have toward third countries under most-favoured-nation agreements (*see* MOST-FAVOURED-NATION TREATMENT). Political problems also concern the question of whether the formation of an economic union is a step toward closer political unification.

Countries forming an economic or customs union do not have to extend to third countries the benefits they extend to each other. This principle is based in part on the customary exception in commercial treaties of customs unions from most-favoured-nations obligations. But the point has been contested in cases in which tariffs were not removed completely between participating countries. In the case of the formation of the European Common Market the claim was made by the U.S.S.R. that under its most-favoured-nation rights the participating countries should grant the same reductions to Soviet goods as they did to the commodities of the members of the union. This claim was rejected but, as noted above, political pressure by the U.S.S.R. on Finland was strong enough to induce that country to refrain from joining the E.F.T.A.

More important than the most-favoured-nation claim is the expectation that an economic union may lead eventually to political unification. This issue was prominent, for example, in the proposed customs union between Germany and Austria of 1931, which was seen by some as a first step to political unification. The same issue played an important role in the formation of the E.E.C. U.S. support for this form of economic integration of the major countries of the European continent was motivated largely by the expectation that it would lead to greater political unity, and the reluctance of the Scandinavian countries to join the common market may partly be explained by their close economic relations with Britain and partly by their fear that they might lose more political autonomy than they were willing to give up.

Finally, economic unions tend to create new supranational political and administrative agencies. Even in a simple customs union a supranational body to supervise the collection and imposition of joint tariffs must be created. In the *Zollverein* this task was assigned to the *Zollparlament*, which may be regarded as the

forerunner of an all-German parliamentary body. In the E.E.C. five supranational institutions were formed: (1) the assembly, which forms the parliament of the union; (2) the council, which is the main decision-making organ; (3) the committee, which administers the treaty; (4) the court of justice, which performs judicial functions; and (5) the economic and social committee, which is charged mainly with research and advisory functions. As can be seen, the general administrative framework of the union is modeled on the organization of the United Nations. *See* also PAN-EUROPEAN MOVEMENT.

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ECONOMIC WARFARE. This term has been variously defined—by some on the basis of the measures employed, by others on the basis of the objectives sought. In both Great Britain and the United States it was used originally to refer to all measures—diplomatic, military, economic—taken to impair an enemy's support of his war effort. In the United States, the Industrial College of the Armed Forces in 1956 sought a definition that would result in a manageable administrative task for the agency to be assigned responsibility for waging economic warfare; the proposal was that economic warfare be defined as "the use of economic measures for attack on economic targets." Such a definition, it was explained, would not preclude the economic warfare agency from working closely with the diplomatic, military and psychological warfare agencies in planning other kinds of attack on economic targets: In strategic bombing, for example, the economic warfare agency would establish the desired priority of targets in the light of economic warfare strategy, but actual operations would be entirely the responsibility of the military. If economic mobilization, *i.e.*, a nation's mobilization of its resources for war, may be considered as one side of the coin, the reverse side would be economic warfare; *i.e.*, disruption of the enemy's economic mobilization. (*See* also MOBILIZATION, ECONOMIC.)

The term first came into common use in Great Britain during the years immediately preceding World War II. It reflected an evolution from the earlier concepts of blockade (*q.v.*) and interception of contraband (*q.v.*) in light of the radical changes brought about by aerial and submarine warfare. In the 1930s the British government laid plans for creating a new department, the ministry of economic warfare, to take the place of its World War I ministry of blockade. Instead of limiting itself to the traditional practice of blockading enemy ports and intercepting ships on the high seas, the new ministry, according to plan, would seek to control enemy trade at the source and thus shift the focus of control "from the seas to the quays." The aim of the proposed ministry, as stated in the plans, was "so to disorganize the enemy's economy as to prevent him from carrying on the war."

The essentially military character of economic warfare has been recognized both in England and in the United States. The British doctrine, as cited by W. N. Medlicott in *The Economic Blockade*, was as follows (by permission of Her Britannic Majesty's Stationery Office):

> Economic warfare is a military operation, comparable to the operations of the three services in that its object is the defeat of the enemy, and complementary to them in that its function is to deprive the enemy of the material means of resistance. But, unlike the operations of the Armed Forces, its results are secured not only by direct attack upon the enemy but also by bringing pressure to bear upon those neutral countries from which the enemy draws his supplies. It must be distinguished from coercive measures appropriate for adoption in peace to settle international differences without recourse to war, *e.g.* sanctions, pacific blockade, economic reprisals, etc., since unlike such measures, it has as its ultimate sanction the use of belligerent rights.

In the United States, Pres. Franklin D. Roosevelt, in implementing the act of July 2, 1940, authorizing the control of exports, declared the administration of the act to be essentially a military function and issued a military order, in his capacity as commander in chief, instead of the usual executive order.

Economic warfare measures include export and import controls, trade agreements with neutral nations, shipping controls (navicerts, ship navicerts and ship warrants), black-listing, pre-emption (or preclusive buying), financial measures, the blocking of enemy exports, prevention of smuggling and other measures.

Export and Import Controls.—Export control is usually the first measure of economic warfare or economic sanctions to be taken by a nation at war or when war is imminent. The control may be employed to prohibit or regulate the export of commodities to destinations from which they or similar goods may reach the enemy; to prevent the accumulation of war materials by potential enemies; to bring pressure to bear on neutral nations; and to implement war trade agreements. The licensing of exports may also be used for purposes other than economic warfare; *e.g.*, the conservation of needed materials. Export controls were applied in Great Britain at the outbreak of war in 1939, and had been in effect to a limited extent before that time. After the fall of France and the Low Countries in 1940, when the enemy shore line was vastly extended and British naval forces were spread thin, effective physical blockade and naval interception became impractical. The British, seeking to control the flow of goods at the source, appealed to the United States to adopt export controls. By the act of July 2, 1940, congress authorized the president to prohibit or curtail the export of munitions, military equipment and related machinery and supplies whenever he determined that such action was necessary in the interests of national defense. While at first the emphasis was on conservation of materials for defense needs, the policy also was influenced by economic warfare considerations; *i.e.*, denial of critical materials to the Nazis.

Import controls have a much more limited use in economic warfare. Their primary purpose is to conserve shipping space and foreign exchange, but they may also be used in economic warfare to bring pressure to bear on neutrals. In a "cold war" they may be employed to deny a prospective enemy the opportunity to earn foreign exchange.

War Trade Agreements.—In war, neutral countries are a coveted source of, or channel for, the supply of critically needed materials, and thus become important battlegrounds of economic warfare. From the beginning of World War II Great Britain sought to arrange trade agreements with various neutrals and during the war conducted negotiations with Norway, Sweden, Denmark, Iceland, Belgium, the Netherlands, Switzerland, Hungary, Greece, Italy, Spain, Portugal and the Soviet Union. The efforts met with varying degrees of success. Even where agreements were consummated, there was almost continuous negotiation throughout the war concerning proposals for amendments, protests for alleged violations, and the details of supply-purchase agreements supplementing the trade agreements. The degree of neutrality varied from country to country and from time to time, according to the progress of the war and the position of the neutrals in relation to the belligerents. The United States on its entry into the war became a party to certain of the agreements and negotiated new agreements with the Latin-American countries in an extensive, preclusive buying campaign.

Shipping Controls.—The principal instruments for control of shipping were the navicert, the ship navicert and the ship warrant. Collectively they were referred to as the "paper blockade," but the term was not applied in any derogation of their power or effectiveness. The system of licensing automobile drivers furnishes an analogy. It would be physically impossible in modern highway traffic to stop every vehicle to inspect the driver's licence. Yet the fact that a driver may be stopped, and that the penalties for violation are severe, is an effective deterrent to unlicensed driving. So in modern commerce it is impractical to intercept all shipping on the high seas to determine whether or not the cargo has been licensed or navicerted. But the fact that a vessel might be intercepted, and that the naval forces were able to concentrate on vessels known or suspected to be carrying unnavicerted cargo, facilitated the enforcement. Thus the mere threat of interception was a strong deterrent to unnavicerted shipping, and the extent and effectiveness of the controls were far greater than could have been achieved by naval power alone. The navicert, an abbreviation for "navy certificate," was devised by the U.S. consul general in London in World War I to facilitate the passage of U.S. shipments through the British blockade. In effect, the ship navicert was a

form of commercial passport covering all or part of a ship's cargo. In World War II navicerts were made compulsory in July 1940, thus in effect making all unnavicerted cargo contraband and subject to seizure. Similar documents—the mailcert and the aircert—were designed for shipments by mail and air.

A ship navicert permitted a vessel to make a single voyage through naval controls. It was issued when all the items on the vessel's manifest had been approved. It required a description of the ship and its proposed itinerary, approval of its cargo, passenger list and crew, and an agreement for the examination of mail. A ship warrant entitled a vessel to use Allied and Allied-controlled facilities for bunkering, ships' stores, repairs, insurance and other services. It was issued only after the owner or master had agreed to certain terms, including an agreement that no ship owned or controlled by him would sail to or from the navicert area without a ship navicert. The compulsory navicert, restrictions on insurance and port facilities and rationing of adjacent neutrals were interrelated and mutually supporting economic warfare measures.

Business Controls.—Black-listing was a powerful weapon of economic warfare directed against individuals. In Great Britain the black list was known as the "Statutory List" and in the United States as the "Proclaimed List of Certain Blocked Nationals." In Great Britain and also in the United States after Pearl Harbor, the persons on these lists were regarded as enemy nationals and thus became "untouchables." No Allied national could trade with them; if they or their property came within Allied control, they were subject to seizure. There was also the threat of postwar reprisal. Not only was the actual black-listing effective but the fear of it was a deterrent. Originally the British list consisted chiefly of enemy nationals located in the neutral countries of Europe, and the U.S. list, those in the Latin-American countries. After the United States entered the war the two lists were closely co-ordinated. At one time there were over 15,000 names on the two lists. The number had declined to approximately one-third that figure when the lists were abolished in 1946.

Pre-emption (or preclusive buying, as it is designated in the United States) is a method of acquiring supplies in neutral areas to prevent their acquisition by the enemy. In general, it is a useful instrument of economic warfare only in cases where the supply of the item is limited or where there is an agreement to limit production or prohibit or curtail exports to the enemy. In the absence of such an agreement, attempted pre-emption may defeat its purpose by stimulating further production.

Financial measures may be used in economic warfare to interfere with the enemy's foreign trade, to prevent the building up of the enemy's external assets, to seize such assets as exist or to immobilize them by preventing their transfer, and to bring financial pressure on neutral nations and their nationals. These objectives may be accomplished by foreign exchange controls, transactions controls and the export and import licensing of gold, silver and currency. But the detection of disguised transactions and accounts in neutral banks and trading firms is often difficult if not impossible.

The first financial control measure taken by the United States in World War II was the freezing of all Danish and Norwegian assets in the United States on April 10, 1940. All Dutch, Belgian and Luxembourg assets were frozen on May 10, and French assets were impounded on June 17, following the invasion of those countries. The primary purpose was to protect the property of their citizens. On June 14, 1941, all German and Italian assets in the United States were frozen, and in July Japanese assets were frozen by both the United States and Great Britain. These measures and the publication of the Proclaimed List marked the final commitment of the United States in the economic warfare which had begun a year earlier with the passage of the Export Control act. The economic battle line was thus drawn between continents and the means of more effective control at the source had been achieved.

Prevention of Enemy Exports.—The primary purpose of preventing exports by the enemy is to deny him foreign exchange to finance his agents abroad. This goal was achieved in part in World War II by paper controls, backed by naval interception. Certificates of origin and interest were required for all exports by the European neutrals. These certificates were issued by the Allied blockade authorities only on evidence that neither the item nor any substantial part of it was of enemy origin and that no enemy national was interested directly or indirectly in the transaction.

Prevention of Smuggling.—The foregoing measures were designed primarily to control the movement of bulk cargo and the regular mails. There were, however, many less bulky but highly strategic commodities, such as industrial diamonds, platinum, quartz crystals and certain drugs, which lent themselves to smuggling operations. The fantastic prices prevailing in the black markets of the European neutrals for these commodities made this a lucrative business. The possibilities seemed limitless with the obscure and devious channels and devices that were employed. The countermeasures applied by the Allies with partial success included the use of undercover operatives, diligent search and pre-emption.

Strategy and Tactics.—Of the foregoing measures, control of exports, war trade agreements and pre-emption were used in an effort to stop the enemy's supplies at the source; black-listing and financial controls to hinder the trading for supplies; the navicert and the ship warrant to prevent their transport; and, finally, interception of unnavicerted ships and apprehension of smugglers to prevent penetration of the blockade. The sum of these measures formed the economic warfare strategy of World War II. Tactically they were applied in planned campaigns against particular areas, commodities or firms and individuals. Simple in concept, they were tremendously complicated in execution. Their adoption even belatedly was a significant contribution to victory.

Organization.—In Great Britain during World War I an attempt was made to carry out the blockade by interdepartmental co-ordination, but this failed completely and resulted in the establishment of the ministry of blockade to which the relevant departments of the foreign office were transferred. As a result of the planning in the critical years preceding World War II, a subcommittee of the committee of imperial defense in 1938 proposed the plan for a ministry of economic warfare, that name having been adopted as more expressive of the broader concept of the measures designed to restrict the enemy's support of his war effort. The ministry came into being at the outbreak of war and functioned effectively throughout.

U.S. participation in the blockade in World War I was centred in the War Trade board, which in 1917 rapidly developed an effective organization, collaborating with the ministry of blockade in the Allied Blockade committee. In World War II economic warfare planning was begun in a small unit in the Army Industrial college (later the Industrial College of the Armed Forces) in 1940. When the Export Control administration was established, the economic warfare unit was transferred to that agency. The Export Control administration later was transferred to the Economic Defense board, which became the Board of Economic Warfare, later the Office of Economic Warfare, and finally was merged with the Foreign Economic administration. None of these successive agencies, however, was devoted entirely to economic warfare, nor were all economic warfare activities delegated to one agency. In both the United States and Great Britain, economic warfare activities and the responsible personnel were about equally divided between intelligence and operations, and these two functions were closely integrated.

Economic Defense.—This term usually is applied to measures taken in peacetime to limit the war-making potential of a possible enemy or aggressor nation. The effectiveness of such measures depends on collective action by the international community. Collective economic sanctions were hopefully envisioned by the League of Nations after World War I as a preventive of war, but they were applied only falteringly and belatedly in the Italian invasion of Ethiopia and not at all in the Japanese invasion of Manchuria. Germany and Japan were practically unhampered in their preparation for World War II and continued to receive strategic materials from the western hemisphere through the greater part of 1941. In the Korean War the United Nations resolution of May 18, 1951, called for embargoes on shipment of certain categories of strategic materials to Communist China and North

Korea. The resolution met with varying degrees of compliance which fell far short of economic blockade. As part of its "cold war" strategy the United States in 1948 adopted strict controls on exports to the Soviet bloc and in 1950, after the outbreak of hostilities in Korea, imposed a strict embargo on goods and services to Communist China. In 1950 a number of the western nations, acting through an informal co-ordinating committee at Paris, adopted controls on the export of certain strategic materials to the Soviet bloc. The restriction of trade between the Soviet bloc and the free world, however, was a highly controversial issue, and the list of controlled materials was shortened in 1954 and from time to time in the years that followed.

See BLOCKADE; CONTRABAND; INTERNATIONAL LAW, PUBLIC; LAWS OF WAR; NEUTRALITY; SANCTION AND GUARANTEE.

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ÉCOSSAISE, a dance in quick 2/4 time, similar to a *contredanse* and first known in France in the early 18th century where its popularity rivaled that of the *anglaise* and the minuet. The Scottish origin of the French *écossaise* is unproved, though Scottish tunes are believed to have accompanied the dancing of *écossaises* in England toward the end of the 18th century. In the early 19th century the *écossaise* flourished in Germany where it was succeeded by the *schottische,* a round dance which had an affinity with the polka. The vogue of the *écossaise* inspired compositions for piano bearing this name by Schubert and Chopin, and by Beethoven, who also wrote *écossaises* for military band and small orchestra.

ECTON, a small village in Northamptonshire, Eng., lies off the main road from Northampton to Wellingborough. Pop. (1961) 461. It is famous as the birthplace of Benjamin Franklin's father, Josiah, a soap and candle maker by trade, who emigrated to Boston, Mass., in 1683. The family, which had lived for several centuries in the village, owned a small freehold and were also the village blacksmiths. In 1758 Franklin visited Ecton, saw the family house (no longer standing) and inspected the tombstones of his uncle and aunt, Thomas and Eleanor Franklin, which are still in the churchyard.

William Hogarth, the painter, often stayed at the beautiful rectory (rebuilt in 1693). In the church (13th century, with 14th-century tower) is a monument with a bust by J. M. Rysbrack to John Palmer, archdeacon of Northampton, rector from 1641 to 1679. The hall has associations with Thomas Percy, editor of the *Reliques of Ancient English Poetry,* the manuscript of which was formerly preserved there. In the village Henry Bagley, who cast the bells in many local churches, had a foundry from 1687 to 1703. (P. I. K.)

ECUADOR (officially LA REPÚBLICA DEL ECUADOR), next to Uruguay the smallest independent state in South America, is bounded on the west by the Pacific ocean, on the north by Colombia and on the east and south by Peru. The country derives its name from the fact that the equator passes through it. Until 1830 the name of the region in which the present nation is located was Quito, named after an Indian group that occupied a part of the highlands. Geographically Ecuador is a region of great contrast. It has semidesert lands and steaming tropical jungles, low-lying coastal belts and Amazonian plains separated by mighty ranges of the Andes which provide a galaxy of snow-capped peaks within a few miles of the equator. The economy of the republic is overwhelmingly agricultural, and farm and forest products constitute its principal exports. The inhabitants are largely of American Indian and Indian-European (mestizo or cholo) extraction. A majority of this group lives at subsistence or below subsistence level as farmers, farm hands, servants and day labourers in the cities. Next to Paraguay, Ecuador in the early 1960s had the lowest per capita income of any state in South America. A large share of the cultivated lands and urban properties are controlled by those of European backgrounds, who represent only a small percentage of the total population. Ecuador traditionally has been one of the strongholds of the Roman Catholic Church in Latin America. The political history of the republic has been marked by turmoil and tyranny punctuated by periods of able and statesmanlike leadership. (J. J. J.)

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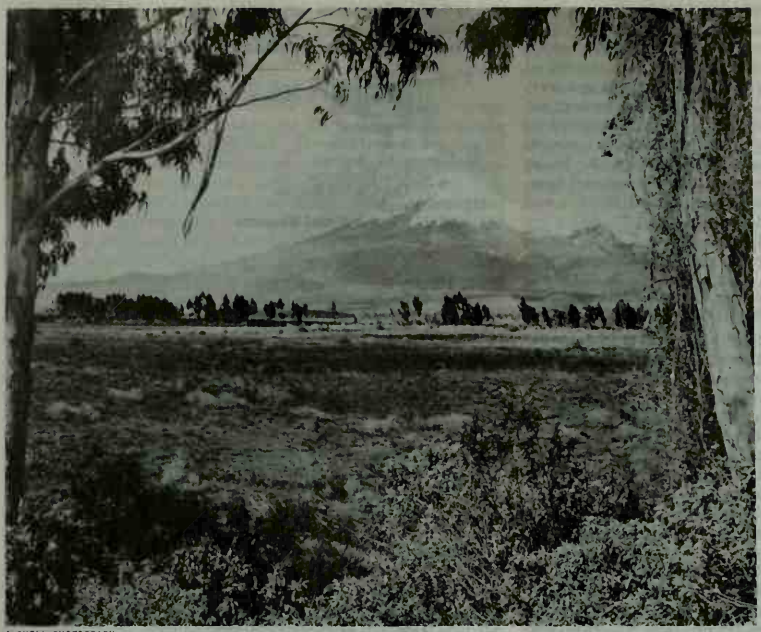
I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—*Sierra Region.*—The dominating physical feature of Ecuador is the great range of the Andes that runs north and south across the country from the border of Colombia to the border of Peru. The uplands of the Andes form the Sierra or highland region, and present a formidable barrier to east-west movement. The Andes are composed of two distinct cordilleras, joined in several places by ridges or spurs which separate some 10 intermontane basins. The Eastern Cordillera is made up of gneiss, mica schist and other crystalline rocks, similar to the geological formations underlying the Cordillera Central of Colombia. The Western Cordillera, on the other hand, is made up of porphyritic eruptive rocks of Mesozoic Age, and some Mesozoic sedimentary strata chiefly Cretaceous.

In the Andes of Ecuador there is one of the world's chief concentrations of volcanic activity. The highest peak in the country is Mt. Chimborazo, an inactive, cone-shaped volcano that stands boldly above the Western Cordillera southwest of Ambato. Its peak is 20,560 ft. above sea level. Between Mt. Sangay (17,159 ft.) in the Eastern Cordillera and the northern border of Ecuador there are about 20 active volcanoes. The world's highest active volcano is Mt. Cotopaxi (19,347 ft.), in the Eastern Cordillera about midway between Ambato and Quito. Other well-known volcanic peaks include Antisana, Cayambe, Tungurahua and Pichincha. All these volcanoes are acidic, explosive and cone-shaped. Earthquakes occur frequently, and sometimes with great violence, such as the one that completely destroyed Ambato in 1949.

Between the two cordilleras there is a string of intermontane basins. Those that lie north of latitude 2° S. are deeply filled with volcanic ash, blown from the volcanoes and carried by the prevailing wind westward into the basins. The ash fill is recent in origin, and in a few places contains plant fossils. These basins are quite complex in surface form. In the northernmost basins there is a terracelike rim of higher surface around the margin, with a lower inner basin excavated by river action. In the basin of Ibarra, for example, the terrace remnants stand between 7,000 and 8,000 ft. above sea level. The town of Ibarra and numerous



A SHELL PHOTOGRAPH

COTOPAXI VOLCANO, 19,344 FT. HIGH, CENTRAL ECUADOR. THE HIGHEST ACTIVE VOLCANO IN THE WORLD

other small villages stand on this terrace. Far below, at an altitude of only about 2,500 ft., is the flat valley bottom along the Río Chota, a tributary of the Río Mira. A similar situation exists in the Quito basin. Quito itself is built on the lower slopes of the volcano Pichincha and on a terrace remnant of volcanic ash standing about 9,300 ft. above sea level. At the eastern edge of the city of Quito the terrace ends with an abrupt scarp which drops to the floor of the basin, about 7,500 ft. above sea level. The lower part of the basin has a level floor across which the headwater tributary of the Río Guaillabamba winds. This river, like the Río Mira farther north, passes through the Western Cordillera in a deep gorge and crosses the western lowlands to the Pacific.

Just south of the Quito basin there is a ridge of high country that connects the two cordilleras. South of that is the basin of Latacunga, drained by the headwaters of the Río Pastaza which runs eastward to join the Marañón. In this deeply dissected basin are the towns of Latacunga and Ambato. To the south this basin is cut off by the massive pedestal of Mt. Chimborazo from the basin of Riobamba, which is also drained by one of the headwaters of the Río Pastaza. South of this the basin of Alausí is formed along one of the west-flowing tributaries of the Río Naranjal. The large basin of Cuenca is drained by the headwaters of the Río Santiago, a tributary of the Marañón. Still farther south are the small river basins of Oña, Loja and Zaruma. The basin of Alausí, and the others farther south, are not filled with volcanic ash.

There are no low passes over the Andes in Ecuador north of latitude 4° S. In southern Ecuador and northern Peru the Andes are deeply dissected by the Río Marañón and its tributaries, and there passes as low as 7,000 ft. exist, but they are not used.

Coastal Region.—The coastal region is made up of a mixture of low crystalline hills, with a maximum elevation of 2,500 ft. west of Guayaquil, swampy alluvium along the river flood plains, and huge alluvial fans along the western Andean piedmont. The crystalline hills are low and rounded in form. The alluvial fans, in many cases made up of porous volcanic ash eroded from the highland basins, spread out from the major river mouths, especially those rivers that have cut back into the intermontane basins. At Guayaquil the drainage of the low country through the Río Guayas is collected in a single channel, confined on the west by a spur of the crystalline hills, and on the east by the huge fan built by the Río Naranjal and the Río Chimbo. Upstream the lowland widens and is drained by four tributaries of the Guayas that meander through a maze of oxbow lakes and natural levees. West of Quito the little frontier town of Santo Domingo de los Colorados stands almost at the apex of the alluvial fan built by a tributary of the Río Esmeraldas. The elevation of the fan where it emerges from the mountains is nearly 2,000 ft. above sea level. North of Esmeraldas the coastal region is low and swampy, similar to that of southwest Colombia. In the south the coastal region is embayed by the Gulf of Guayaquil.

Oriente.—The third major physical division of Ecuador is the Oriente, the part that lies east of the Andes. The boundary of Ecuador and Peru was drawn about 50 mi. above the head of launch navigation on the Amazon tributaries. The Oriente, therefore, is a little-known area, difficult of access from either west or east. Compared with the country farther east in Peru, this Andean piedmont is somewhat higher in elevation. Along the eastern base of the mountains there is a zone of upended strata forming cuestas (steep ridges facing the Andes), and in the midst of the dense forest east of the cuesta belt there are isolated mesas.

2. Climate.—The climate of the highlands varies with the elevation and with the exposure to rain-bearing winds. Because of the mountainous terrain there are sharp climatic contrasts between nearby areas. For example, although most of the highlands receive abundant rainfall, immediately to the north of Quito there is a dry area that is not reached by the rain-bearing winds. On the trip that tourists often take to the equatorial line, the road out of the city enters the dry area abruptly and the monument on the equator is in the midst of arid country.

The vertical zones of climate are similar to those of Colombia. From sea level to about 3,000 ft. is the *tierra caliente*, with temperatures averaging between 75° and 78° F. and with a range of only 3° or 4° between coldest and warmest month. From 3,000 to about 6,500 ft. is the *tierra templada*, with temperatures averaging between 65° and 75°, and with a range of only 2° or 3°. Between 6,500 and about 10,000 ft. is the *tierra fría*, with temperatures averaging between 55° and 65°, and with a temperature range of less than 1°. Still higher are the paramos (high, bleak plateaus) with temperatures averaging under 55°. The lower limit of permanent snow is about 14,500 ft. above sea level. The very slight differences of temperature throughout the year are characteristic of tropical high-altitude climates. The differences between day and night, or between sunshine and shade, are much greater.

In the coastal lowland of Ecuador there is a zone of transition from the wet north to the dry south. From the town of Esmeraldas northward the climate is rainy, warm and humid throughout the year. There are two rainy seasons separated by two seasons of somewhat less rain. There are never any heavy winds or storms. South of Esmeraldas there is one rainy season (January to May),

and one really dry season the length of which increases as one proceeds southward. At the tip end of the Santa Elena peninsula, west of Guayaquil, the climate is arid; and this arid condition is found east of the Gulf of Guayaquil in southern Ecuador.

The Oriente has a climate typical of the equatorial Amazon basin. Its temperatures are not excessively high—never over 100°; nor are they ever low. The rainfall of this area, however, exceeds 80 in. and humidity is always high.

3. Vegetation.—The vegetation of Ecuador reflects the climatic differences among the regions. The wet lowlands of the Oriente, and of the Guayas lowland and the coastal area north of Esmeraldas, are covered with a tropical rain forest containing many different species of trees, some of great size, and many epiphytes and lianas. At higher levels the forest becomes thicker in the zone of maximum rainfall—about 4,000 to 5,000 ft. above sea level. Here there is a montane rain forest that is very difficult to penetrate. Still higher is the *ceja de la montaña*, or eyebrow of the forest, a moss-covered thick growth of woodland similar to the vegetation described elsewhere in the tropics as an "elfin forest." Above the upper limit of trees—between 10,000 and 11,000 ft.—there are tall mountain grasslands that extend up to the snow line. There are parts of the intermontane basins where the ash fill is so porous that the grasslands or brushlands extend much farther down than is generally the case. For example, in the basin of Latacunga at an elevation of only a little over 8,000 ft. the original vegetation cover was a scrub woodland. In the dry area north of Quito there is drought-resistant vegetation with bare ground between the plants.

As one goes southward along the Pacific coast from Esmeraldas the rain forest gives way to deciduous scrub woodland that drops all of its leaves during the dry season. Between Esmeraldas and Manta there is a narrow zone of tropical semideciduous forest in which some of the trees drop their leaves during the dry season. There is a fringe of thick mangrove forest all along the Pacific ocean wherever there is a swampy coast, especially around the Gulf of Guayaquil and the islands in the mouth of the Guayas river. Swamp forest is also found on the flood plains of the rivers. In the forests of Ecuador there are a number of species of plants that are of economic value, and some are actually exploited. In the Guayas valley and on the lower Andean slopes there is the balsa tree (*Ochroma lagopus*), which furnishes the world's lightest lumber. In the scrub woodland of the coastal region there are scattered palms that produce ivory nuts (*phytelephas macrocarpa*) used in the manufacture of buttons. There is also the plant (*Carludovica palmata*) that furnishes fibre for the manufacture of Panama hats. This plant is not a palm, although it is often described as such in popular terminology. On the rainy eastern slopes of the Andes the forests contain cinchona trees, formerly of great value as a source of quinine. The cinchona belongs to the family Rubiaceae, closely related to the coffee tree and to the tree that produces ipecac. It is native to the eastern Andean slopes of this part of South America. Several species of trees in the rain forests east of the Andes were once used for the production of rubber. These forests include a great variety of useful species, but the forests of Ecuador have not been exploited much because of their isolation.

4. Animal Life.—The fauna of Ecuador is closely related to the vegetation cover. In the tropical rain forests there are relatively few mammals but a wide range of species. There are, for example, numerous species of monkeys. The flesh-eating animals include the jaguar, puma, ocelot, fox, weasel, tayra, otter, skunk, grison, raccoon, coatimundi and kinkajou. The hoofed mammals include the tapir, deer and peccary. There are numerous rodents and a variety of bats, including some vampire bats.

Ecuador is rich in the variety of its bird life. About 1,500 species have been identified. The bird population varies with altitude, and in the lowlands is distinctive in the rain forests, the scrub woodlands and the dry areas. Also, Ecuador is the winter home of a number of well-known North American species of birds. Among them are the Carolina rail, the blue-winged teal, the kingbird, the barn swallow, the red-eyed vireo, the redstart, the rose-breasted grosbeak, and the scarlet tanager.

The fishes and reptiles of Ecuador include a great variety of species. The fishes are similar to those of the Amazon region, but the Pacific side lacks such species as the electric eel and the piranha. All the major groups of reptiles have been found, including a variety of dangerous snakes. Two species of large marine turtles are hunted, one for meat and the other for tortoise shell. Lizards are abundant and variable.

Ecuador also abounds with insects. There are many kinds of butterflies, moths, beetles, grasshoppers, bees and ants. There is one species of giant beetle that grows to a length of five inches; and there are many beetles that are interesting because of the phosphorescent light they emit. Many species of insects in Ecuador harass man, his crops and his domestic animals; they bite, sting, suck blood and carry disease.

The Galápagos Islands (*q.v.*) between 500 and 700 mi. W. of the coast of Ecuador, became famous when they were visited by the English naturalist Charles Darwin in the 1830s. The unusual native animals, including giant turtles, had never developed fear of man because the islands had been isolated throughout the course of history. Bathed by the cool Peru current, the islands have a cool temperature and limited rainfall. They contain a notable fauna quite unlike that of the mainland, and serve as a wildlife sanctuary.

II. GEOGRAPHIC REGIONS

Of Ecuador's three geographic regions the area of chief commercial production is the coastal area. It is occupied by people who take their politics seriously and includes Ecuador's chief city, Guayaquil. The Andean highlands, in the Sierra region, are occupied mostly by people of pure or nearly pure Indian ancestry who are little interested in commerce or politics. The highland population is grouped in about ten intermontane basins, each more or less isolated. It is in the midst of this high country that Ecuador has its capital, Quito. The third physical division of the country, the Oriente, is so thinly inhabited that it remains largely outside the effective national territory of Ecuador.

1. The Highlands.—The highland region is made up of a series of more or less separate clusters of people each located in and around the margins of one of the intermontane basins. These basins, described above, are between the two cordilleras of the Andes at elevations between 7,000 and over 9,000 ft. Outside of Quito and Cuenca, the second and third cities of Ecuador in terms of size, the population is predominantly Indian. In Quito and Cuenca are concentrated the relatively small proportion of people of pure or nearly pure Spanish ancestry. These people own large tracts of land in the high basins, usually the most productive parts of these basins. The pure-blooded Indians are concentrated on the poorer lands or work as tenants or as wage labourers on the large properties. The poorer lands that are left to the Indians are the more porous soils and the drier areas of the basins, and the steep slopes of the bordering mountains.

Land use throughout the highland region depends to a great extent on altitude. In the deeply cut valleys that lie well below the general level of the basins there are plantations of sugar cane. The best lands of the basins, however, are used for the growing of maize and the pasture of dairy cattle. This combination of maize production and dairy pasture is found all the way from the basin of Ibarra in the north to Loja in the south. The greatest concentration of dairying is in the basin of Quito and the basin of Cuenca. Still higher and on the poorer lands left to the Indians the chief crops are potatoes and barley, which the Indians use for their own food supply. So great is the pressure of people on the land that these crops are grown high above the basins on the steep slopes of the bordering mountains. On the slopes of Mt. Pichincha west of Quito, Indian subsistence farmers occupy every available bit of land above the Quito basin up to elevations of nearly 12,000 ft. Potatoes can be grown to an average elevation of 10,500 ft., and to an extreme elevation of 11,800 ft. Still higher, the grass-covered slopes below the snow line are used for the pasture of sheep. The high basins are tied together by a railroad, all-weather automobile highways and airplane service.

2. The Coastal Region.—The second of the two major regions into which Ecuador may be divided is the coastal region, which lies between the western base of the Andes and the Pacific ocean. Within this region there are two major subregions and two smaller subregions. The largest concentration of people, and the area in which most of Ecuador's export products originate, is in the lowland of the Guayas and along the eastern side of the Gulf of Guayaquil. This region centres on Ecuador's largest city, Guayaquil. The population of this area is predominantly mestizo, a mixture of Spanish and Indian. Production comes chiefly from large estates on which there are tenant farmers or on which workers are paid wages. The wet lowland upstream from Guayaquil, drained by the four tributaries of the Río Guayas, has long been used for the production of cacao. In fact this is one of the best places in the world for the growth of the cacao tree. But long neglect of methods of cultivation and resulting high costs of production make it difficult for Ecuador to compete with the cacao areas of Africa and Brazil. This is still one of the cacao-producing areas of the world, but no longer a major one.

The crop that brought speculative prosperity to Ecuador after 1940 was the banana. Banana plantations invaded the cacao area and extended southward along the western piedmont of the Andes, east of the Gulf of Guayaquil. The United Fruit company established a large demonstration plantation in this area, near Tenguel, but most of the bananas are produced on small, independently owned plantations. No banana-loading facilities were built in Ecuador during the 1950s, for the stability of this product remained to be proved. Bananas are brought down the Río Guayas in barges, and are loaded on the banana ships which lie at anchor in the quiet waters of the Gulf of Guayaquil. After 1940 there was a considerable increase in the land devoted to rice and to sugar cane in this same area. Bordering the agricultural lands there is a large area of grass pasture on which beef cattle are prepared for market—mostly for use in Ecuador, but some to be exported.

The second of the major subregions of the coastal region is between Manta and Chone on the Pacific ocean. The population of this area is almost pure Indian—but it is lowland and not highland Indian. A fairly dense population of farmers working their own small pieces of land occupies this subregion. There in the zone of transition between semideciduous forest and scrub woodland, the Indians have been able to compete successfully with Negroes migrating southward from Colombia. In the hilly country to the east there are small plantations of coffee. But the chief crop of this area is cotton. In the scrub woodland south of Manta much land is used for the grazing of goats.

The two smaller subregions are pioneer zones of new settlement: one is around Esmeraldas, the other inland at the base of the mountains around Santo Domingo de los Colorados. The latter place was opened up as an area of settlement when the road to Quito was completed in 1947. Bananas, the first crops to be produced there, were sold in the Quito market. More recently cacao, also sold only in Quito, has proved more profitable than the banana. The land is divided into medium-sized properties, and during the 1950s Indians from the highlands replaced Negroes as the hired workers.

SURFACE FEATURES AND MAJOR TOWNS OF ECUADOR, SOUTH AMERICA

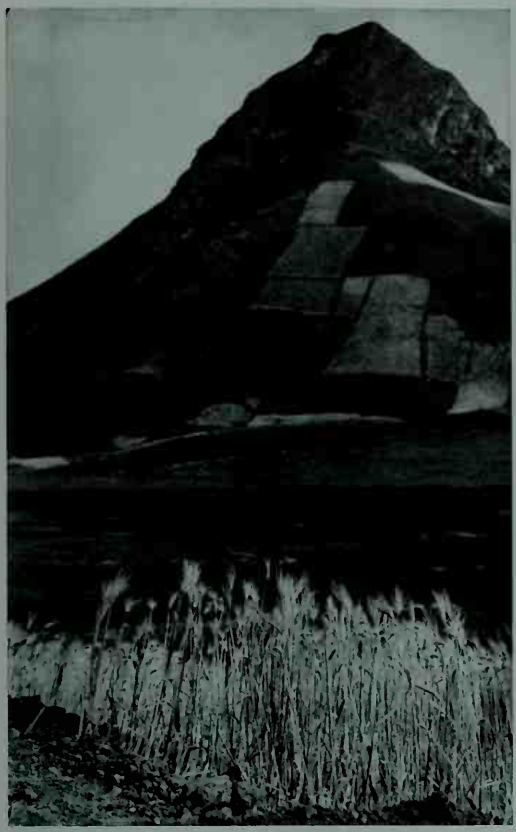
Esmeraldas is the focus of another area of new settlement, but this one is almost exclusively Negro. In the tropical rain forests the Negroes have proved to be better subsistence farmers than the lowland Indians. Bananas have been planted all along the highway that connects Santo Domingo with Esmeraldas; but the product is sent by truck to Esmeraldas only from the plantations within less than 100 mi. of the coast. At the port the bananas are loaded on ships from lighters, while the ships lie at anchor in the open ocean. The Negro farmers have at times produced a little gold by washing the stream gravels inland from Esmeraldas.

The chief use of the land, however, throughout the coastal lowland is for the pasture of beef cattle. Even beyond reach of the all-weather roads, cattle can be driven to market on the hoof.

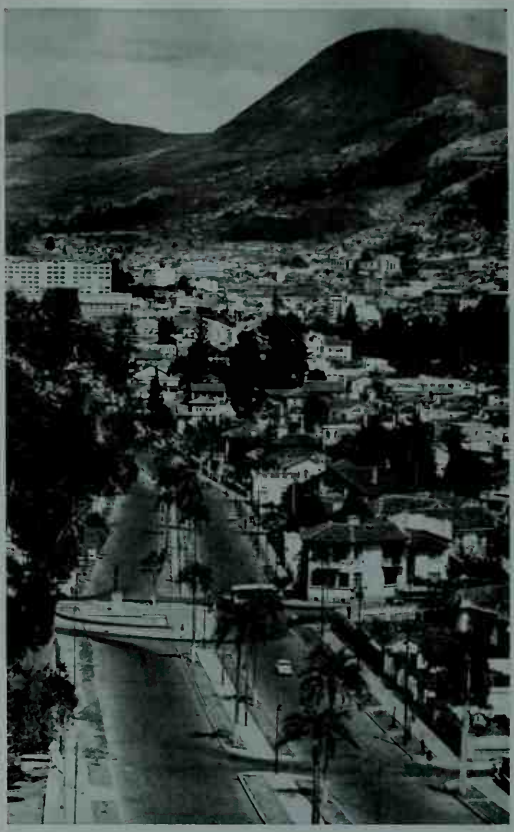
(P. E. J.)

III. THE PEOPLE

1. Historic Racial Elements.—The estimated 800,000 Indians living in Ecuador when the Span-



In Indian fields, 12,000 ft. high in the Andes, special strains of wheat grow. The terrain is such that mechanization is impossible



Quito, the capital of Ecuador

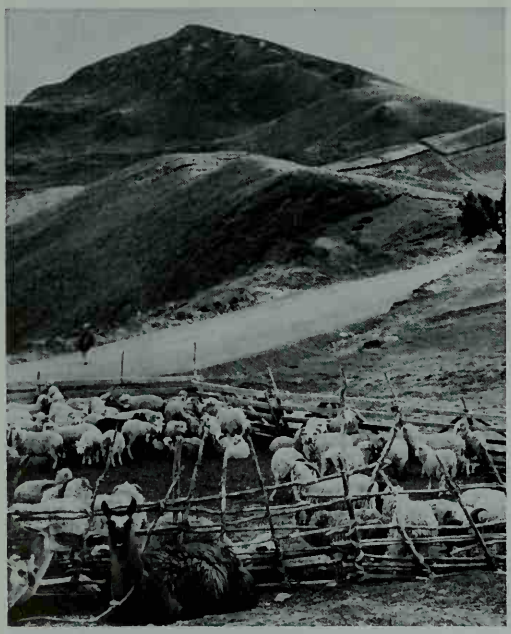
A typical banana plantation in the Guayas lowlands of Ecuador

RURAL AND URBAN SCENES IN ECUADOR

PHOTOGRAPHS, CAMERA PRESS—PIX, INC.

ECUADOR

Worker in Guayaquil shoveling dried cocoa beans into sacks for shipment to Europe



Llamas and sheep are herded at heights in the Andes where most crops will not grow

A modern refinery on the Santa Elena peninsula which supplies part of Ecuador's petroleum products

ECONOMIC CONTRASTS IN ECUADOR

PHOTOGRAPHS, CAMERA PRESS—PIX, INC.

iards arrived were, like all other American Indians, members of the Mongoloid stock. The Spanish conquest saw the introduction of two new racial elements: the Caucasian Spaniards and Negroes who were brought in as slaves. Neither settled in Ecuador in large numbers. The non-Indians in the country are still a minority. The white population of Ecuador has been estimated at between 8% and 27%, with the lower figure probably being more nearly correct. The Spaniards and Negroes first settled on the coast, displacing many Indians who moved to the highlands. Unlike the Spaniards, the Negroes remained almost entirely on the coast. Those who escaped from slavery either formed small communities of their own or intermarried with the local Indian population. By mid-20th century the proportion of the coastal population having Negro blood was estimated to be as high as 45%. Besides pure-blood Negroes and mulattoes, there are also *montuvios,* who are persons of Negro-Indian ancestry. The Indians of the coast are much reduced in number and racially mixed. All have lost their tribal identity except for the Cayapa and Colorado, who together number no more than 2,000.

The composition of the highland population is estimated at 28% white, 30% pureblood Indian and 40% mestizo. Many so-called mestizos are probably pure Indians physically because the word mestizo is commonly used to refer to a person of mixed Indian and Hispanic culture, regardless of his race.

The Oriente is peopled almost exclusively by full-blooded Indians.

2. Languages.—Several families of languages were spoken in coastal and highland Ecuador before the arrival of the Incas. But, except for Chibchan, which was spoken by several tribes in the north, it has not been possible to identify any of these early languages with certainty. After the Inca conquest, Quechua, the language of the empire, was introduced and became well established. The Spaniards found Quechua useful for administrative purposes and promoted its spread at the expense of the surviving native languages. By the end of the 18th century Quechua was universally spoken in the highlands. While Spanish is the official language of modern Ecuador, Quechua is spoken by the greatest number of people.

Several indigenous languages survive in the Oriente, the three most important families represented being Jivaroan, Zaparoan and Tucanoan. Some tribes, such as the Canelo, Cofan and Auishiri, speak languages that have not been linked to any recognized families.

3. Cultures.—When the Spaniards arrived the most important peoples of Ecuador were the Esmeralda, Manta, Huancavilca and Puná on the coast, and the Cara, Panzaleo (Quito), Puruhá and Cañari in the highlands. While most of these groups had been incorporated into the Inca empire they still maintained a measure of cultural identity. Politically they were organized into petty states and confederacies ruled by chiefs renowned for their military prowess. The chiefs owned much wealth and had many wives and retainers, some of whom were buried with them at their death. The basis of subsistence was intensive agriculture, which in some areas involved irrigation.

The principal crops were maize, quinoa, beans and potatoes. In the warmer valleys fruits such as pineapples and avocados were grown and sweet manioc was raised on the coast. The women did most of the farming because the men were frequently occupied with war. When not fighting the men engaged in arts and crafts such as weaving, metallurgy and stone carving. They used spears, slings, clubs and axes of stone and copper in warfare. Houses had wooden frames daubed over with mud and roofed with thatch. The typical dress consisted of a long sleeveless shirt or wrap-around skirt with a blanket thrown over the shoulders.

Marriage was monogamous for commoners, but a noble or chief could have many wives and concubines. Class differences existed and were reflected in the fine raiment and jewelry worn by the upper classes. Religion was based on a belief in gods and spirits, many of whom were associated with volcanoes. Shamans and priests interceded with the deities on behalf of the people. Animal and human sacrifice was practiced on important occasions.

Trade flourished, especially along the coast where items of maritime commerce were carried in dugout canoes and in large rafts with sails. From the wild tribes of the Oriente the highland peoples obtained *achiote* (a red dye), parrots and monkeys; they gave blankets, salt and dogs in return.

Following the Inca conquest, oca, sweet potatoes and peanuts were added to the cultivated crops of Ecuador. The llama was raised more widely and its wool was used for weaving. The chewing of coca, previously absent, became prevalent. To facilitate civil administration the Incas built fortresses and extended their highway system as far north as Quito.

The Spanish conquest led to the final breakdown of the Ecuadorian chieftaincies, a process that had already begun under Inca domination. With the establishment of the *encomienda* system the exploitation of the Indians began. The Spaniards established haciendas in the lower and more fertile valleys and those Indians who were not forced to work these holdings retreated to less favourable farming areas in the highlands. By the 1960s the number of Indians who lived in native villages and engaged in subsistence farming was less than the number who made their living in whole or in part by working for white *hacenderos.* Some Indians and mestizos worked for wages on haciendas, but migrated seasonally, as from the highlands to the coast at rice harvest time. Others were tenant farmers who worked a *patrón's* land and were paid partly in money and partly in the crops they could grow on the small parcels of land allotted to them. In the highlands many Indians worked a certain number of days a week for the *patrón* in exchange for the rights to pasture their sheep on his land, or obtain water or firewood from it.

The tribes of the Oriente have cultural affinities with the Indians of the Amazon basin rather than with those of the Andes. The Incas made no attempt to conquer these tribes, and Spanish efforts to pacify them proved unsuccessful. Disease and the abuses of rubber gatherers and other exploiters reduced their number from 200,000 to about 80,000, but those that survived retained their political autonomy into the 20th century.

These tribes have many culture traits in common. All of them practice slash-and-burn agriculture, with sweet manioc as the staple crop. Hunting is carried out chiefly with spears, blowguns and traps. Fish are drugged with barbasco. Villages generally consist of a single communal house of pole-and-thatch construction. Nakedness is common, but some tribes wear garments of cotton or bark cloth. The hammock is in general use, but the Jívaro employ the platform bed. Watercraft consist of dugout canoes and balsa wood rafts. Warfare is declining but is still not uncommon, especially among the Jívaro and the Auishiri. The lance is the principal offensive weapon, and shields are sometimes used for defense. The commonest motivation for war is revenge, and the taking of trophy heads occurs among some tribes, notably the Jívaro.

The chewing of coca does not occur in the Oriente, but tobacco smoking is important, especially as an adjunct of shamanistic curing. The hollow log drum is employed by some tribes for communication.

Of the tribes of the Oriente the Jívaro are unquestionably the best known, principally because of their use of blowguns and poisoned darts and their custom of shrinking the heads of slain enemies. The Auishiri or "Auca," came into prominence in Jan. 1956 when they killed five American missionaries. (R. L. C.)

4. Religion.—Roman Catholicism is the traditional religion of Ecuador, having been established with the Spanish conquest. For a time after the middle of the 19th century the government was so closely tied to the church that only practising Roman Catholics were recognized as Ecuadorian citizens. Ecuador dedicated itself to the Sacred Heart of Jesus in 1873, both by church council and by act of congress. The importance of the church was shown in 1950, when a 17th-century devout Ecuadorian, Mariana de Jesús, was canonized as a saint. Further, in 1952, the first Ecuadorian cardinal was appointed by the Vatican.

Since the advent of the Liberals to power in 1895, church and state have been separate. Education has been secularized, though the church has been granted the right to conduct schools; church property has been confiscated; and freedom of religion is guar-

anteed by the constitution. Extremely friendly relations, however, continued to exist between church and state, and Roman Catholic religious orders have been particularly active in Ecuador. Quito, the seat of the archbishopric, has often been cited for its numerous churches, with their treasures of art and sculpture. Protestants first went to Ecuador after 1895, and they achieved some success in Guayaquil. Both Catholic and Protestant missionaries have been active among the Indians of Oriente.

IV. HISTORY

1. Pre-Spanish Era.—Before the advent of the Spaniards, the Ecuadorian highlands and adjacent lowlands were occupied by aborigines of comparatively primitive cultures. They were located between the more highly developed Chibcha-speaking groups to the north in central Colombia and the Quechua-speaking groups to the south in highland Peru and Bolivia. The Ecuadorian highland basins were inhabited by six linguistic groups—the Pastos, Caras, Panzaleos, Puruhás, Cañaris and Paltas (from north to south in the order named). Their languages, now extinct, were mutually unintelligible; their customs and beliefs differed significantly. However, these groups shared a basic Andean culture in their adaptations to the highland environment. They were sedentary agriculturists, cultivating maize, beans, potatoes, squash and quinoa, a pigweed cereal. The only domesticated animals were dogs and guinea pigs. Among some of the peoples, handicraft was especially well developed in the making of gold and copper objects and pottery. (*See* also ANDEAN CIVILIZATION; SOUTH AMERICA: *Anthropology.*)

The prehistoric aborigines of the coastal region and of Oriente were more primitive than the highland peoples. The coastal inhabitants lived mostly by fishing and hunting and traded salt and fish with the highland tribes for cloth and gold and silver. The large island of Puná near the Guayas estuary was inhabited by a particularly vigorous tribe. The islands of La Plata and Santa Clara, off the coast of Manabí, were considered sacred and were used as sites for burial of tribal chieftains. Except for the Cayapás and Colorados, who live in the upper reaches of the northwestern coastal rivers, the coastal aborigines disappeared or mixed thoroughly with white and Negro to form the *montuvio*. The tribes of Oriente, on the other hand, remained little changed by time, largely because of the effective isolation of the Amazonian region. Antagonistic to western civilization, they live by hunting and fishing and by tilling the soil in a primitive way. The Jívaros and Záparos have been particularly warlike.

By the first part of the 15th century the Caras had conquered the Quitus and had taken possession of northern Ecuador. The kingdom of the Shyri, the ruler of the Caras, was then extended southward to the middle part of the Sierra. This kingdom, along with the tribes to the south in highland Ecuador, was conquered by the Incas in the second half of the 15th century. The southern tribes were brought under control of the Inca empire by 1480, after long struggles, and the tribes farther north finally were subdued after several more years of bitter struggle.

Where resistance was especially strong, the Incas uprooted a great part of the population and replaced it with forced colonists from Peru or Bolivia; and these transplanted foreign groups served as centres of Inca influence among the native peoples. The Incas established the use of the Quechua language and introduced new plants, llamas as beasts of burden, irrigation projects and a road system.

The Inca Huayna Cápac divided his empire, before his death in 1525, between his sons Atahualpa, the Shyri heir on his mother's side, and Huáscar, his son by an Inca princess. Atahualpa inherited the northern part of the empire, the so-called kingdom of Quito, and Huáscar received the Cuzco domain in Peru and Bolivia. In the war that ensued, Atahualpa was victorious over Huáscar, who claimed the entire empire. His victory, however, was short-lived. He was seized by newly arrived Spaniards and in 1533 was put to death by his captors. (D. R. D.)

2. Spanish Colonial Period.—Modern Ecuador was first sighted in 1526. In that year a ship outfitted on the isthmus by Francisco Pizarro and his partners and captained by the pilot Bartolomé Ruiz cruised along the coast to a point south of the equator. Ruiz discovered three large settlements of Indians, who received him in a friendly manner. The Indians possessed wealth in jewels and gold in large quantities. During the next several years the Spanish made a number of landings in Ecuador as the final preparations for the conquest of the Inca empire were carried out.

Pizarro landed his forces at the Bay of San Mateo in Ecuador early in 1532. It was from there that the Spaniards began their devastating march down the coast on the way to the heart of the Inca civilization.

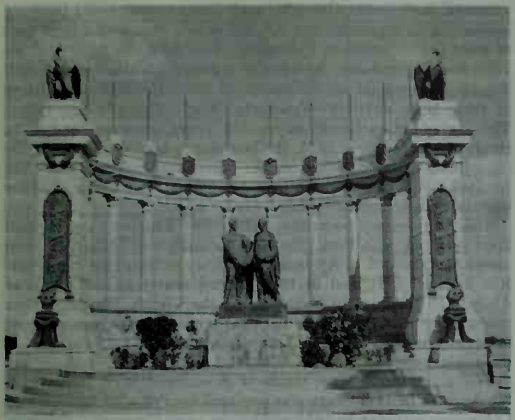
The conquest of Ecuador fell to Sebastián de Benalcázar (Belalcázar), a lieutenant of Pizarro. Starting from San Miguel, the base founded by Pizarro in what is now northern Peru, Benalcázar moved north into the highlands of Ecuador against limited Indian opposition. He founded the Villa de San Francisco de Quito in 1534 on the site of the Cara town left in ruins by the retreating Indians. Guayaquil was founded by Benalcázar's forces in 1535.

In 1539 Gonzalo Pizarro, brother of Francisco, was made governor of Quito, the name by which the territory was known. When the first viceroy to Peru, Blasco Núñez Vela, arrived in Ecuador on the way to Lima he found the colonists in revolt under Gonzalo Pizarro. The viceroy's forces were defeated by Gonzalo near Quito in 1546. Gonzalo was in turn defeated in 1548. Ecuador thereupon settled down to a peaceful existence. Land and Indians had been divided among the conquerors immediately following the conquest. Institutions were implanted in much the same fashion as in the remainder of the Spanish colonies of the new world. The conquerors initially acquired considerable wealth in jewels and gold, but within a short time the colony began an essentially agricultural existence based on large estates and Indian labour. European animals for work and food, in addition to plants, were imported to supplement the relatively wide variety of indigenous crops that the Indians cultivated.

By 1600 a half-dozen towns had been founded. Quito, however, had clearly established itself as the administrative, economic, cultural and religious centre of the colony. In 1563 Quito had been made the seat of a royal *audiencia*, a judicial agency which in certain instances was constituted into a legislative body. Quito enjoyed the advantage of being on the overland route between Cartagena, on the Caribbean in present-day Colombia, and Lima, capital of the viceroyalty of Peru, of which Ecuador was a part throughout the 16th and 17th centuries. In 1545 the bishopric of Quito was founded; from that point forward Quito remained the religious centre of the *audiencia*, and largely as a result of that circumstance, the cultural and intellectual centre. The religious edifices of Quito possessed some of the outstanding examples of painting and sculpture found anywhere in America. In 1594 the Jesuits established the Seminary of San Luis and in 1622 the University of San Gregorio Magno. In 1688 the Dominicans founded the University of Santo Tomás de Aquino. The quality of instruction in those schools was not equal to that offered by the "major" universities of Spanish colonial America, but they did give the colony an intellectual tone. The three centres of higher learning were fused in 1769 to form the institution known as the Central University of Ecuador (Universidad Central del Ecuador). The exploration and discovery concomitant to missionary activities from Quito into the Amazon territory added to scientific and geographic knowledge throughout the 17th century.

In 1717 the *audiencia* was removed from the viceroyalty of Peru and made a part of the viceroyalty of Nueva Granada, created to tighten Spain's control over its colonies as the competition with Great Britain for empire mounted. In 1723 Ecuador was returned to Peru when the viceroyalty of Nueva Granada was temporarily suppressed. When it was reconstituted in 1740, Ecuador was returned to it. Ecuador henceforth remained a part of Nueva Granada until independence was achieved.

In the late 18th century Ecuador began to feel the developments that led to discontent and finally rebellion throughout the Spanish empire. There was fear of future oppression, dissatisfaction of



BY COURTESY OF HAMILTON WRIGHT

MONUMENT AT GUAYAQUIL TO JOSÉ DE SAN MARTÍN (1778–1850) AND SÍMON BOLÍVAR (1783–1830)

the Creole elements with their share in government, the dissemination of foreign ideas—English, French and North American—and the invasion of the Iberian peninsula by the forces of Napoleon. Francisco Eugenio de Santa Cruz y Espejo, a doctor and journalist of part Indian extraction, and Juan Pío Montúfar provided the intellectual and organizational leadership for those who were becoming increasingly restless under Spanish domination.

The "Patriots," composed of both Creoles and *Peninsulares* (Spaniards), raised the "first cry" of Ecuadorian independence on Aug. 10, 1809, in Quito. This uprising was put down in late October of the same year, and as the first anniversary of the revolt approached, the imprisoned leaders were executed. On Oct. 11, 1810, a Quito group proclaimed the province to be independent. That attempt at independence failed by Dec. 1812, when the authority of Spain was reaffirmed. Meanwhile the independence movement swirled about the *audiencia* borders as the struggle between Spaniards and patriots gathered momentum. In 1821 it reached again into Ecuador when forces from both Colombia and Peru entered the *audiencia*.

Antonio José de Sucre, the trusted and able lieutenant of Simón Bolívar, with soldiers from at least a half-dozen future countries of South America in his ranks, at the battle of Pichincha on May 24, 1822, won Ecuador's freedom from Spain. Two days later the last president of the *audiencia* formally capitulated.

Both Colombia under Simón Bolívar and Peru under the Argentine general José de San Martín vied for control of Ecuador. At the historic meeting of the two at Guayaquil on July 26, 1822, Bolívar triumphed. Under the name "department of the south," Ecuador joined with Venezuela and Colombia in the confederacy known as Gran Colombia. From the time Ecuador became a part of Gran Colombia until 1830 it was in an almost perpetual state of agitation. It was caught in the engulfing tide of continental history as Bolívar fought to sustain his authority over Peru and Bolivia as well as Gran Colombia. (J. J. J.)

3. Early Republican Period.—In Sept. 1830 Ecuador withdrew from Colombia, as Venezuela had done in Nov. 1829, and began its independent existence. A national constitution was adopted and the first president, Venezuelan Gen. Juan José Flores, was elected. The first 15 years of the republic were fraught with the strife and difficulties associated with the development of a new nation. Flores dominated political affairs, holding office from 1831 to 1835 and from 1839 to 1845. His persistence in keeping power by changing the constitution, which originally prohibited presidents' succeeding themselves immediately, ended in revolution and exile of the "foreign" general. During the administration of Vicente Rocafuerte (1835–39) some progress was made in the legislative framework, public education, religious freedom and freedom of the press and social welfare of the Indians.

From 1845 to 1860 five presidents held office during the most turbulent years in Ecuador's history. Foreign relations were troubled by wars with Peru and Colombia, anticlericalism was rampant and the country was disintegrating internationally as a result of establishment of independent town governments. Out of the breakdown of any semblance of a national government emerged a strong leader, Gabriel García Moreno, who served as president for two periods (1861–65 and 1869–75). Under García Moreno, crop production was increased and eucalyptus trees were introduced into the treeless highlands. Roads were improved and the Guayaquil-Quito railway started. The educational system was extended and prison reforms were introduced. Discipline was enforced among the members of the clergy and the army. García Mareno, an austere Roman Catholic himself, sought to create a strong, united Ecuador by means of religious discipline. The church received complete charge of education, and a concordat with the Vatican (1863) guaranteed the church strong control in civil affairs. Under the constitution of 1869 only persons who were practising Catholics qualified for citizenship. Such a strong program was attained by dictatorial powers, which, however, were unable to stop the slowly growing liberalism in the country, typified by the writer Juan Montalvo. When García Moreno attempted to win re-election for a third term in 1875, he was assassinated.

For 20 years following the downfall of García Moreno, Ecuador experienced considerable turmoil. The Conservatives, essentially the feudalist-Catholic regime of the Sierra, managed to retain control most of the time; but liberalism, fostered by international connections through the expanding export economy of the coast, gained momentum. Sectionalism—represented by *costeños* ("people of the coast") and *serranos* ("people of the Sierra")—entered strongly into the picture. Finally the Guayaquil Liberals came under the leadership of Eloy Alfaro, who had been engaged in liberal movements in Central America. Alfaro (a *costeño*) succeeded in gaining control of the government in 1895 after a year of civil war, and was elected president under the constitution of 1897.

4. Later History.—The Liberal movement received great impetus during the terms of Alfaro (1897–1901 and 1906–11) and of Leónidas Plaza (1901–05 and 1912–16). The main object of the government's attention was the Roman Catholic Church, which was separated from the state and divested of its exclusive control over education. Action was taken to guarantee freedom of worship, of thought and of the press. Civil registry of marriage was made obligatory and divorce laws were enacted. Real property owned by the church that was not directly used for religious purposes was confiscated in 1908, and the state assumed control of large estates. Material achievements of the period included improvements in public health, educational institutions and utilities, such as water, sewer and electric service. Construction of the Guayaquil-Quito railway was continued until that transportation link between lowland and highland was completed in 1908. Extensions of the railway system were made during Plaza's second term, and the telegraph and telephone lines were extended. A start was made also on improvement of sanitation in Guayaquil, which had suffered loss of trade due to endemic conditions of yellow fever and plague at the port. Alfaro was killed by a mob when he tried to return to power in 1912. Plaza managed to finish his second term in spite of formidable opposition.

From 1916 to 1925 the political life of the nation was dominated by coastal financial interests, particularly the Commercial and Agricultural bank at Guayaquil. The country's economy expanded rapidly as the sugar industry and the petroleum industry were developed, new manufacturing industries were established and labour unions were formed. Troubles appeared, however, in the cacao industry as diseases took their toll and the post-World War I business recession caused widespread unrest. The army (composed chiefly of *serranos*) ended the coastal bank's domination in 1925 and created juntas to govern.

Serious economic and social problems faced the governments that held office during the world depression of the 1930s. From 1935 to 1940 seven chief executives—presidents, provisional presi-

dents or dictators—headed the government.

Carlos Arroyo del Rio, a Liberal, was elected president in 1940. Peru invaded Ecuador in the following year and, after a short campaign, succeeded in annexing a large part of Oriente by the protocol signed at the Pan-American Foreign Ministers' conference at Rio de Janeiro in 1942 (see *Boundaries,* below). The administration was criticized for the loss, but under wartime powers Arroyo del Rio held tight control of the nation and vigorously suppressed his opponents. A loose coalition called the Democratic Alliance, comprised of various extreme elements, including Communists, formed an underground opposition. When it seemed apparent that Arroyo del Río would try to control the next presidential election to ensure the election of his candidate, a revolution overthrew the government and José María Velasco Ibarra was brought back as president in 1944.

Velasco Ibarra had been elected president previously in 1933 as an official Conservative candidate, though he was supported by most Liberals. When he tried to dissolve congress, however, he was deposed before the completion of his first year in office. His accession to office in 1944 was supported by the Democratic Alliance, but he soon alienated his Socialist and Communist supporters, particularly after his suspension of the 1945 radical constitution in 1946. He retained thereafter the support of only the Conservatives, who formed the constituent assembly which wrote the constitution of 1946 (see *Administration and Social Conditions; Constitution* below).

The apparent contradictions and shifts in Velasco Ibarra's policies alienated other groups, moreover, and economic difficulties immediately following World War II caused considerable unrest. As a result, in Aug. 1947 the army ousted Velasco from office. A series of provisional governments followed until free elections were held in 1948, resulting in the election of Galo Plaza, son of former Pres. Leónidas Plaza.

Galo Plaza was supported by a group composed of individuals from several parties—a departure from the traditional party politics. He attempted to follow a moderate course, aimed at businesslike and democratic administration and recognition of public opinion and the rights of the individual. Action was taken to improve crops and livestock strains, to extend soil conservation practices and irrigation programs and to encourage Ecuadorians to move from the densely settled Sierra basins to the coastal lowlands along new highways. Galo Plaza finished his term in 1952 without spectacular achievements, though progress had been made on several basic problems.

Velasco Ibarra was returned as president in 1952. A $50,000,000 four-year road and railroad construction program was inaugurated in the following year, with the basic aim of linking Sierra and coast together more effectively. Foreign trade increased significantly and higher government budgets were balanced in the mid-1950s. Camilo Ponce Enríquez, the candidate of the Conservative party, which obtained a majority in congress, was elected president by a narrow margin in 1956. He became the third president in succession to take office constitutionally.

In 1960 former president Velasco Ibarra, who had gone into exile in Argentina in 1956, returned to Ecuador and was elected president for a fourth term. He ran as an independent and defeated the candidates of the traditional parties. He resigned in Nov. 1961 in the face of public unrest under inflation, new taxes and declining trade and was succeeded by his vice president, Carlos Julio Arosemena Monroy.

On July 11, 1963, the nation's armed forces ousted Arosemena from office and established a four-man military junta to rule the country. The presidential elections scheduled for 1964 were canceled.

5. Boundaries.—Ecuador's boundaries were set by the protocol of Rio de Janeiro, to which Ecuador agreed after defeat by superior Peruvian forces in 1941; under it Ecuador lost about 70,000 sq.mi. of territory. The area of the country in 1960 was 105,684 sq.mi. (including the Galápagos Islands, an area of 3,028 sq.mi.).

In principle, Ecuador has always maintained rights to the area of the former presidency of Quito. According to the royal cedula of 1740, the presidency of Quito was assigned limits within the viceroyalty of Nueva Granada; such limits encompassed territory amounting to approximately 400,000 sq.mi., including a large part of what is now southern Colombia. Following the successful revolts for independence, the Spanish regions of northwestern South America formed the confederation of Gran Colombia, consisting of three large districts—Venezuela, Nueva Granada and Quito. The confederation lasted only a few years, however; and, as a result of separation in 1830, the boundaries agreed upon with the republic of Colombia following the provisional agreement of 1832 resulted in the loss of more than 125,000 sq.mi. leaving Ecuador with an area of approximately 275,000 sq.mi.

The 20th-century boundary problems of Ecuador have focused upon relations with Peru. In 1904 Ecuador was obliged to yield about 27,000 sq.mi. of Amazonian territory to Brazil by the Tobar-Río Branco treaty and in 1916 yielded nearly 65,000 sq.mi. of Amazonian territory to Colombia by the Muñoz Vernaza-Suárez treaty. By 1916 Ecuador's national territory had been reduced to approximately 180,000 sq.mi.—less than one-half the size of the original claim.

The accession of large tracts of Ecuador-claimed territory in the Amazon basin by Peru was prefaced by Peruvian accession of Colombian territory in 1922 and by the brief Peruvian-Colombian war of 1932. By 1941 relations between Ecuador and Peru had become severely strained over territorial claims. The United States, Brazil and Argentina offered to serve as mediators in the dispute, but Peru invaded southern Ecuador in 1941, overwhelming the poorly equipped Ecuadorians. As noted previously, Ecuador ceded to Peru more than 70,000 sq.mi. of territory—nearly two-thirds of Ecuador's Oriente or Amazonian hinterland. The loss of territory was agreed upon in the protocol (of peace, friendship and boundaries) of Rio de Janeiro in 1942 during a conference of western hemisphere foreign ministers. The task of fixing the new boundary line in difficult, unexplored areas was continued for many years by an Ecuadorian-Peruvian commission, but the boundary still had not been completely surveyed by the latter 1950s. In 1960, when Velasco Ibarra became president, he declared that Ecuador would no longer recognize the 1942 treaty boundary. (D. R. D.)

V. POPULATION

The first national census for Ecuador was taken in 1950 and recorded a population of 3,202,757. The 1962 census showed a population of 4,581,476. The coastal region contained about 46% of the country's population, the Sierra about 51% and the Oriente about 2%. The remainder (less than .5%) of the population lived in the Galápagos Islands.

Although the people of Ecuador are frequently referred to, in popular parlance, as belonging to different "races," it is more accurate to describe their social groups as classes rather than races. The distinctions among them are based not on skin colour or other physical characteristics but rather on the languages they speak, the cultures in which they participate, their styles of dress, whether they live in rural or urban areas, and, to a certain extent, the region in which they live. Also, it is possible, although not easy, for a person to move from one class to another. For example, when intermarriage occurs, husband and wife usually become members of the same class. The "whites" are people who, regardless of their skin colour, speak Spanish, participate in the Spanish rather than the Indian culture, and usually live in the cities. Mestizos participate in both cultures. Indians speak indigenous languages rather than Spanish and tend to be rural rather than urban dwellers. Thus defined, Indians account for about 60% of the national population, mestizos 25% to 30% and "whites" at most 15%.

Immigration statistics indicate that, since the achievement of its national independence in 1830, Ecuador has not attracted significant numbers of European immigrants, although the country has on occasion made official attempts to draw new citizens from Europe. During World War II, war refugees were invited to settle in the country; and, throughout the period of Hitler's rule in Germany (1933–45), about 1,000 Europeans, many of them Jews, came to Ecuador as immigrants. All in all, however, there was

Area and Population of Ecuador

Political divisions and capital cities with 1962 populations	Area (sq.mi.)	Population (1962 census)				
		Urban	% of total	Rural	Total	Density per sq.mi.
Total	105,684	1,616,584	35.3	2,964,892	4,581,476	43.4
Provinces:						
Azuay (Cuenca, 75,286)	3,011	70,194	25.5	205,564	275,758	91.6
Bolívar (Guaranda, 14,407)	1,242	14,937	10.8	123,061	137,998	111.1
Cañar (Azogues, 9,816)	1,034	14,598	13.4	97,660	112,618	108.9
Carchi (Tulcán, 22,152)	1,383	27,317	29.1	66,507	93,824	67.8
Chimborazo (Riobamba, 61,509)	2,379	60,141	21.5	219,466	279,607	117.5
Cotopaxi (Latacunga, 47,881)	1,781	24,382	12.6	169,547	193,929	108.9
El Oro (Machala, 33,890)	2,288	68,859	42.4	93,736	162,595	71.1
Esmeraldas (Esmeraldas, 33,578)	6,134	39,671	31.8	85,071	124,742	20.3
Guayas (Guayaquil, 515,491)	8,208	576,036	58.4	410,520	986,556	120.2
Imbabura (Ibarra, 35,001)	1,854	47,526	27.3	126,615	174,141	93.9
Loja (Loja, 37,891)	4,438	48,556	17.0.	236,795	285,351	64.3
Los Ríos (Babahoyo, 20,892)	2,292	50,334	20.2	199,317	249,651	108.9
Manabí (Portoviejo, 38,600)	7,306	125,597	20.4	489,206	614,803	84.2
Morona-Santiago* (Macas, 1,777)	...	4,433	15.8	23,607	28,040	...
Napo† (Tena, 3,463)	...	1,804	7.4	22,683	24,487	...
Pastaza† (Puyo, 3,778)	...	2,353	17.0	11,487	13,840	...
Pichincha (Quito, 361,914)	6,474	374,718	63.8	212,884	587,602	90.8
Tungurahua (Ambato, 53,745)	1,237	62,829	28.3	159,021	221,850	179.3
Zamora-Chinchipe* (Zamora, 1,404)	...	1,939	16.6	9,733	11,672	...
Territory:						
Galápagos Islands (San Cristóbal, 1,404)	3,028	...	...	2,412	2,412	0.8

*Morona-Santiago and Zamora-Chinchipe together formed, until Nov. 10, 1953, the province of Santiago-Zamora: area 18,358 sq.mi. Separate area figures not available.
†Napo and Pastaza provinces formed Oct. 22, 1959, from old province of Napo-Pastaza. Separate area figures not available.

probably a smaller proportion of new blood brought into Ecuador after independence than into almost any other country of South America. (G. I. B.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

Ecuador, the smallest and weakest of the states formed from the breakup of Gran Colombia, during its turbulent political history as a constitutional republic developed a conservative centralized government giving considerable power to the president. Its history has been marked by the conflict of Conservatives and Liberals, represented in large part by sectional differences between the Sierra and the coast, and the conflict of the state with the strong temporal power of the Roman Catholic Church.

1. Constitution.—The constitution of Ecuador adopted in 1946 was largely the work of Conservatives, though it maintained all of the basic Liberal principles and social goals. It provided for a unitary republic with the usual legislative, executive and judicial branches. It also provided for a council of state to represent congress when the latter is in recess and to act as liaison between the president and congress. The senate and the chamber of deputies comprise the congress. Senators, totaling 45, are elected for four years. The 15 main provinces elect two senators each, the two eastern provinces and the Galápagos Islands (Archipiélago de Colón) one each; and, in addition 12 "functional" senators are elected by special economic or cultural groups, representing education, coastal and Sierra agriculture, business, industry and labour, the armed forces, journalism and learned societies. Deputies are elected for two years. The three smallest provinces elect one deputy each and the remainder of the nation has one deputy for each 50,000 inhabitants or fraction in excess of 25,000. The president and vice-president are elected for four years and are not eligible for immediate re-election. All candidates for national offices must be Ecuadorian-born citizens; the minimum-age qualifications are 25 years for deputies, 35 years for senators and 40 years for the president and vice-president. All are elected by direct, secret vote. Suffrage is granted to all literate men and women over 18; voting is compulsory for men and optional for women. Members of the armed forces and the national police force do not enjoy suffrage, however.

2. Local Government.—In 1960 there were 19 provinces and the territory of the Galápagos Islands. The provinces were divided into 97 *cantones*, which, in turn, were divided into 791 *parroquias* ("parishes")—168 urban and 623 rural. Each province is ruled by a governor, each canton by a *jefe político* and each parish by a *teniente político*. The Galápagos Islands are administered through the ministry of national defense and are, technically, a naval command. Ten of the provinces belonged essentially to the Sierra and five to the coast. The largest in area were Napo-Pastaza and Santiago-Zamora, the two sparsely populated Oriente provinces which were divided into four separate provinces, and Guayas and Manabí in the Pacific coastal region. The largest Sierra provinces were Pichincha, which includes considerable Pacific lowland area, and Loja. The largest in terms of population were Guayas (986,556), with Guayaquil; Manabí (614,803); and Pichincha (587,602), with Quito.

3. Public Health. — Ecuador's public health program has made remarkable improvement through national efforts and international co-operation. The eradication early in the 20th century of yellow fever, which had retarded the development of Guayaquil, was the beginning of progress in improving health conditions. Considerable progress also has been made in combating malaria and tuberculosis. In co-operation with the United States Institute of Inter-American Affairs, Ecuador virtually eliminated malaria as a cause of death (as late as 1942 nearly 25% of all deaths were caused by that disease). In co-operation with the World Health organization, the country also introduced programs to prevent and control tuberculosis, which in recent times caused one-fifth of all deaths. Public health measures were also instituted to control venereal diseases, smallpox, typhus and plague. The increased availability of potable water has contributed appreciably to the health of the republic.

Ecuador has a high rate of infant mortality. It has been estimated that about 140 out of each 1,000 infants die in their first year and that only about 40 of every 100 children born survive the age of five. Some progress was made in the reduction of infant mortality, however, through various general public health measures and through the establishment of a few maternity hospitals and child-health clinics in Guayaquil, Quito and some of the larger towns.

Malnutrition is also prevalent in Ecuador. The diet of the vast majority is not only deficient in proteins, vitamins and minerals, but the total intake of food is extremely low. A great majority of the inhabitants can afford only about one-half the daily intake of calories considered necessary by health authorities. The lack of roads to open up new food-producing areas, the relatively low literacy rate and poor habits of hygiene contribute to malnutrition in a country apparently well suited to support a relatively high level of health. Such foods as milk, eggs and vegetables are luxuries for the people who produce them.

Ecuador has a social security program providing for health and maternity benefits, compensation for workmen injured during the course of their employment and old-age pensions.

4. Education.—Though primary education is free and compulsory for children from 6 to 12 years of age, opportunities for school attendance were limited in the 1950s by the shortage of schools and of teachers, especially in rural areas. About 300,000 children of school age, for example, were unable to enroll in any of the primary schools in 1955. During that year, however, a sizable school construction program was initiated, and the need for increased aid to education was reflected in the national budget.

Ecuador's five universities are autonomous. The most important are Central university at Quito and Guayaquil university. The universities of Cuenca and of Loja serve the southern sections of the Sierra. A Catholic university, headed by Jesuits, was opened in Quito in 1946. The National Polytechnic school, a government-supported institution, opened in 1946.

The illiteracy rate is high. According to the 1950 census, 43.7%

of all inhabitants over ten years of age were illiterate. Probably not more than 20% to 25% of the population possessed the academic skills ordinarily associated with commerce and "factory" industries.

5. Defense.—Although the armed forces have had a strong voice in politics throughout its history, Ecuador has had fewer military regimes than many other Latin-American countries. After 1948, moreover, only civilians were appointed to the post of minister of defense. The armed forces are charged with defending the constitution and the country from attack.

Approximately two-thirds of the defense expenditures go to the army, a little less than one-fifth to the navy and about 15% to the air force. Military training for one year is compulsory for all men 20 years of age. A standing army of from 7,000 to 9,000 men is maintained. The Military college enrolling about 200 cadets and an aviation cadet school are at Quito; an aviation officers' training school is at Guayaquil. The naval school is at Salinas.

VII. THE ECONOMY

A. Production

Economic development in Ecuador has been regional and often local rather than national in scale. Contrasts are especially apparent between the Sierra and the coast. The Sierra lacks the agricultural land needed for expanded production and suffers from a surplus of unskilled labour. The coast, on the other hand, has an abundance of land but lacks the labour force needed for its efficient utilization. The Sierra produces mostly grains, fruits and vegetables, chiefly for domestic consumption, whereas coastal agriculture is commercialized and enters extensively into international trade, the principal exports being bananas, cacao, coffee and rice.

1. Agriculture.—Although only about 5% of the land is under cultivation, Ecuador is predominantly agricultural. About one-half of the economically active people are employed in agriculture, with the next largest group (one-fourth) employed in handicrafts and manufacturing industries. Cultivated land is about equally divided between the Sierra and the coast, amounting to approximately 650,000 ha. (one hectare equals 2.471 ac.) in each region. The Sierra, however, contains a larger percentage of land unsuited for cultivation because of cold, ruggedness and aridity.

The principal staple foodstuffs grown in the Sierra are maize, potatoes, barley, wheat and beans. Maize, which along with barley constitutes the basic diet of the Sierran working population, is the most extensively planted crop, though it is exceeded by potatoes in quantity of production. It is also a principal staple foodstuff grown in the coastal region, along with bananas, rice, sugar and sweet potatoes. Fifteen per cent of all land under cultivation is devoted to maize and barley. Barley grows at elevations up to 11,500 ft., as do potatoes. Wheat production is concentrated in the zone from 7,000 to 10,000 ft. Wheat yields are extremely low as a result of inefficient methods, lack of fertilizers, irregularity of rainfall and other factors. In fact, yields of nearly all Sierra crops are low. The most productive inter-Andean basins are those around Ibarra, Quito, Ambato and Cuenca. Some irrigation systems have been built to modify problems of water supply and porous volcanic soils.

Although bananas had been exported from Ecuador from the 1920s, large-scale commercial production did not take place until after 1945, stimulated by high prices and production decreases in Caribbean countries caused by plant diseases, hurricanes and labour trouble. The construction of new roads in the Pacific coastal region aided the industry greatly. Most of the new banana farms are small holdings; foreign-owned plantations account for only a small percentage of total production. The exporting centres are Guayaquil, Puerto Bolívar and Esmeraldas.

Beginning about 1870, Ecuador produced significant quantities of the world's finest cacao and occupied first place in production until the mid-1920s. In the peak year of 1916 nearly 50,000 metric tons were produced. Serious outbreaks of monilia disease in 1916 and of witches'-broom disease in 1922, however, caused the abandonment of many of the huge plantations in the Guayas lowland. The development of cacao-producing areas in other tropical regions, notably west Africa and Brazil, also affected Ecuador's position. By 1940 Ecuadorian production had reached its lowest point, accounting for only about 14,000 tons, less than 2% of the world's production and only a little more than 10% of the nation's total export value. With the rise of cacao prices after World War II the industry began to recover and Ecuador again became a major producer.

The largest coffee-producing areas of Ecuador are the hilly sections near the coast northwest of Guayaquil and the flanks of the Andes to about 5,000 ft. elevation southeast and east of Guayaquil. In contrast with cacao, coffee trees are planted usually in small plots rather than on large plantations. Production more than doubled during the two decades preceding the mid-1950s especially in response to the sharp rise in world market prices after 1945.

Rice, a staple food in the coastal region and also much in demand in the Sierra, has fluctuated greatly in its role as an export crop. It figured significantly in the national economy when cacao failed, though its value was erratic. In 1926 and 1937, for example, it accounted for less than 1% of the exports. A peak in production (112,000 tons) was reached in 1947, even though the maximum area under cultivation was not reached until 1949. Rice held first place among Ecuador's exports during and for a short time after World War II but thereafter dropped behind bananas, cacao and coffee.

Ecuador's production of sugar for export is not important. In fact, domestic production occasionally has not been sufficient to meet domestic demands. About two-thirds of the sugar cane is grown in the coastal region, where two large mills located on the Guayaquil-Quito railway produce nearly all of the refined sugar. Cane is also grown rather extensively in the lower Sierra valleys, and is used chiefly for the production of *aguardiente*, the white rum sold through government monopoly.

Attempts have been made to satisfy domestic demands for cotton by local production, but crops have been poor except in a few years. The main area of production, the drier part of the coast near Manta, is beset by difficulties of plant disease and erratic rainfall. Successful production requires irrigation and the use of mineral fertilizers.

The livestock industry, though not well advanced in Ecuador, is especially important in the highlands, where grazing haciendas occupy large tracts. The Sierra supplies Guayaquil with much of its meat.

2. Forestry.—Forests, which cover an estimated 65% of Ecuador's land area, provide a number of products of economic importance. Lack of transportation, coupled with other problems associated with tropical logging, hindered the development of a significant export lumber industry. The forests, however, yield a considerable amount of material for domestic construction materials, including the giant bamboo which grows profusely along tropical riverbanks. Balsa wood proved to be a significant export product, especially during World War II. It comes chiefly from the northeastern tributaries of the Guayas river.

Tagua, or vegetable ivory, comes from the seeds of a small palm fern which grows wild in the tropical forests of western Ecuador and Colombia. Although the tagua industry suffered from competition with substitute products for the manufacture of buttons, it still held a basic place in the early 1960s.

The forests of Manabí and Esmeraldas also are the source of *toquilla*, a long fibre used for the fabrication of Panama hats and other straw products, which is in great demand. Kapok, a light fibre that is moisture resistant, also has had strong demand, especially during World War II. Rubber is gathered in the western lowlands and, to some degree, in the Amazonian lowland as well. Cinchona bark, yielding quinine, is an Ecuadorian forest product of importance, but it felt the competition of synthetic rivals. It is gathered chiefly from the forests of the middle western slopes of the Andes.

3. Mining.—Mining has not played as important a role in Ecuador's economy as it has in the other Andean countries. The most extensive mineral exploration was done in Oriente, where potentialities of petroleum deposits are considered favourable.

Between 1937 and 1949 two companies worked in association in the Amazonian basin, but withdrew because their findings did not warrant the construction of costly pipelines to transport oil from that isolated region.

Petroleum deposits have been exploited, however, in the coastal region. Petroleum was discovered before World War I on the arid Santa Elena peninsula, north of the Gulf of Guayaquil. British and Canadian oil companies started work after 1918 and one of the British companies first exported crude oil in 1925. The Canadian company finally abandoned its concessions in 1947. The other British company also had little success and its concessions were taken up in 1951 by a United States company, which opened a small refinery in 1953. Several Ecuadorian oil companies have also been active. Nearly 90% of the country's oil production was controlled in the early 1960s by the British concern, which constructed an 11-mi.-long pipeline from Ancón to the port of La Libertad.

Gold has been the chief mineral mined in Ecuador. Placer mines were in operation along some of the streams flowing eastward from the Andes and in the rivers of the northwestern coastal region in the latter 1950s. The first large company to enter the field (1895) was a United States concern, which obtained a goldmine concession at Portovelo, in the southernmost province along the Gulf of Guayaquil. By 1950 the concession, about 35 mi. back in the Andes, was abandoned because of exhaustion of the ore, which consisted of silver and copper as well as gold. From 1940 to 1946 copper, as well as some gold, silver and lead, were produced from a mining concession in western Cotopaxi province.

4. Industries.—Industrial development in Ecuador has been confined largely to the manufacture of consumer goods for a relatively small domestic market. Manufacturing embraces principally the preparation of foodstuffs, textiles, shoes, furniture and small wares destined for local markets. Apart from many small factories located in various parts of the country, there are two large sugar mills, a large flour mill using imported wheat and two relatively large edible-fat factories in the coastal region. The brewery at Quito uses Sierra-produced barley, whereas the Guayaquil plant uses barley imported from Chile.

The textile industry is the most important in the country in terms of number of workers employed, capital invested and volume of production. Quito is the centre of most of the textile factories; there are a few at Ambato, Riobamba and a few other Sierra towns. Lack of raw materials has plagued the industry at times. Handicraft textiles, especially the woolen goods of the Indians of Otavalo, are notable.

Ecuador is famous for the handicraft manufacture of Panama hats, so named because they were first distributed for sale in large quantities in Panamá. *Toquilla* fibre was first used for straw hats in the coastal province of Manabí, where the finest hats are still made in the towns of Jipijapa and Montecristi. The centre of production later shifted to the southern Sierra provinces, which account for about 80% of all hats exported. Several thousand weavers, mostly women, are engaged in part-time work at home making straw hats. The centre of the industry is Cuenca, where middlemen obtain the fibre from the coastal region and distribute it to the weavers, and where the finishing stages of washing, bleaching, ironing and shaping are done, generally in large workshops run by export companies.

B. Trade and Finance

1. Trade.—Ecuador, like many other Latin-American nations, is essentially an exporter of raw materials, chiefly agricultural, and an importer of manufactured goods. It regularly has the lowest value of trade per capita among the South American republics. The United States holds a dominant position in both the import and export trade of the country.

Exports.—The total value of Ecuador's exports, which had averaged about $12,000,000 annually between 1936 and 1940 and about $25,000,000 between 1941 and 1945, amounted to approximately $140,000,000 by 1960. Some of the increase was attributable to inflation, but the quantity of the leading export products, particularly bananas, increased significantly. Cacao, coffee, crude petroleum and gold were the main exports in the latter 1930s. Rice assumed first place among exports during and for a short time after World War II but dropped and became erratic in the export trade after 1950. Agricultural products amount to about 90% of all export value, followed by manufactured products, minerals and forest products.

During the 1930s the United States and western Europe, particularly Germany, shared about equally as markets for Ecuador's exports, each region taking more than one-third of the exports. The remainder was taken by Latin-American nations and by Italy and Japan. During World War II Ecuador's export trade shifted almost entirely to the United States (nearly 60%) and to Latin America. The ascendancy of rice exports during that period was largely the result of Ecuador's provision of rice to Latin-American countries whose traditional supplies from the far east had been cut off. After World War II, western Germany, Italy and Japan resumed trade with Ecuador but not on as large a scale as before.

Imports.—The value of imports followed more or less the same pattern as exports. From an average of $11,000,000 annually between 1936 and 1940, imports increased to about $17,000,000 between 1941 and 1945 and exceeded $100,000,000 in the early 1960s. Machinery and vehicles accounted for 30% of all import value followed by food, drink, tobacco and textiles. The large importation of foodstuffs, particularly wheat flour, wheat, milk and fish, indicates the limited development of some segments of domestic agriculture. Lack of raw cotton is indicated by the sizable imports of cotton and textile materials, as well as clothing. Imports of metals and metal manufactures, of chemicals and pharmaceuticals and of other industrial products are significant.

Trade Relations.—Ecuador's balance of trade has been favourable for the most part. The government occasionally restricts the export of certain items in order to assure supplies for the home market. Export duties are imposed on many products. No direct restrictions were imposed on imports in the 1950s, though import permits were required to conserve foreign exchange. The system of selective imports in effect in the early 1960s involved a threefold classification of imports. Essential goods, such as certain foodstuffs, machinery and tractors, were not taxed nor were surcharges levied. Less essential goods (group B imports) were taxed 33%; yet, like essential goods (group A), they were bought with foreign exchange supplied by the Central bank at the official rate. Luxury goods (group C), such as radios, refrigerators and silk and nylon goods, were taxed 44%; moreover, the importer was required to surrender to the Central bank foreign exchange purchased in the free market (at a higher cost than the official rate).

2. National Finance.—The basic unit of the Ecuadoran monetary system is the sucre, named in honour of the hero of the independence movement, Antonio José de Sucre. The main source of revenue for the national government is commerce and transportation taxes, especially customs duties. This is clearly reflected in the fact that the coastal province of Guayas alone contributes about one-third of the revenue. Almost every economic activity and every transaction is taxed. State monopolies provide nearly 10% of the government's revenue. Losses of the alcohol monopoly are made up by profits from the tobacco, salt and match monopolies.

The largest part of the foreign debt of Ecuador in the early 1960s was due the bondholders of the Guayaquil-Quito railway, mostly United States investors. Although no payment had been made on the principal for many years, the debt was being serviced. The other large item—loans from the Export-Import bank—was being punctually serviced. Ecuador's internal debt increased in the 1950s through issues of bonds and through loans from the Central bank to cover budget deficits.

The Central bank, a private institution from 1927 to 1948 when it was nationalized, heads the banking system. It controls credit and foreign exchange, extends loans to the government and controls monetary policy. It is the sole bank of issue. A system of development banks, headed by the Banco Nacional de Fomento, was created in 1943 to make loans for the promotion of commerce, agriculture and industry.

C. Transport and Communications

Difficulties arising from extremely mountainous topography and dense tropical forested lowlands have hindered the development of both transportation and communications. Approximately 8,500 mi. of telegraph lines link the principal cities and towns but nearly all of the equipment was in need of repair and modernization in the latter 1950s. A major problem facing both telegraph and radio communications within the country was the exemption of more than three-fourths of the communications from payment. In 1953, however, free transmittal of government business, which accounts for the majority of messages, was abolished.

Natural and financial difficulties have hampered the development of lines of transportation in Ecuador. In turn, inadequate means of transportation hindered the development of the nation by continuing isolation of the two main regions of the country—coast and Sierra—and by preventing widespread participation in international trade.

Considerable use of waterways is made in the lowlands. The several large streams of the Guayas system are much used by rafts, launches and canoes. Most of the rivers of the northwestern coastal region are navigable for considerable distances and are major transportation ways. In Oriente the rivers are primary means of transportation.

There are approximately 720 mi. of railways, all narrow gauge. The main line is the Guayaquil-Quito railway, which extends 288 mi. from Durán to Quito. Built by foreign enterprise and opened to traffic in 1908, it was nationalized, along with all of the other railroads, in 1944. The Guayaquil-Salinas railway, extending for 95 mi. directly west from Guayaquil, was finally closed to traffic in 1953 because of unsuccessful competition with an excellent highway running almost parallel to it. In 1957 the Quito-San Lorenzo line was officially opened.

By the early 1960s more than 6,000 mi. of roads were in operation; however, only a little more than one-half were all-weather highways. Particularly in the coastal region, where at least four months of unfavourable weather occur, most roads are impassable for a part of the year. During the 1950s the World bank made large loans to Ecuador for road construction and for a new port at Guayaquil that would be more accessible to ocean-going ships.

The principal road is the Pan-American highway, extending about 680 mi. from the Colombian border through the inter-Andean basins to the Peruvian border. The highway averages 20 ft. in width, has a maximum gradient of 8% and consists of cobblestoned and unpaved sections. The Pan-American highway has been complemented by several main roads leading westward down to the Pacific coast. The northernmost (built between 1946 and 1957) links Quito to the port of Esmeraldas by way of Santo Domingo and has a total length of 192 mi. The longest (224 mi.) connects the port of Manta to Quevedo in the Guayas lowland and to Latacunga on the Pan-American highway.

Ecuador joined with Colombia in the ownership of the merchant ship line Flota Mercante Gran-Colombiana and holds a 20% interest in the enterprise. Large seagoing vessels cannot dock alongside piers in Ecuadorian ports because of shallow water. Guayaquil, the chief port, is 30 mi. from the mouth of the estuary. Other ports, where large vessels also must anchor offshore, are Puerto Bolívar, La Libertad, Manta, Bahía de Caráquez, Esmeraldas and San Lorenzo.

Ecuador is served by several national and international airlines.

See also references under "Ecuador" in the Index volume.

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ECUMENICAL MOVEMENT, the name given to a movement for co-operation and unity among most Christian churches. The English word "ecumenical" is derived from the Greek participle *oikoumene* ("inhabited"), used in classical times as a noun to mean the "inhabited world." Later an ecumenical council was so called because its members represented churches throughout the inhabited world; it could thus claim to be general or universal (*see* Council). About the middle of the 19th century, mainly through the influence of a particular usage of the word *oecuménique* in French, the word ecumenical acquired the significance of "that which is concerned for the unity and renewal of the church." It is in this special sense that it is used throughout this article.

Earlier Centuries.—Concern for the unity and the renewal of the church is not a matter of one time of place; it is a thread that runs through the whole of church history. From the beginning there have been elements of division in the church, and at all times there have been persons concerned to safeguard the unity or to restore it if it has been broken. Until the 16th century the great instrument of unity was the council. Many councils produced more divisions than they healed, but this should not throw doubt on the desire of many of the bishops who attended the early councils, and of the emperors who convened them, to see division brought to an end and unity restored. One of the last great attempts on this line was the Council of Ferrara-Florence (*q.v.;* 1438–45), in which for a brief space the Western and the Orthodox halves of the church were brought together in fellowship.

When the Reformation was threatening Christendom with a deep doctrinal division, great hopes were placed in the convening of a council. The Council of Trent (*q.v.*) served only to deepen the divisions. Yet this was the great century of the theologians, in which leaders on the Catholic and the Protestant sides met frequently, notably in the colloquies of Ratisbon (1541) and Poissy (1561). Little but frustration came of these meetings, yet they served to indicate that in some sense Christendom was still a reality and a unity.

In the 17th century the most notable work was done by individuals, of whom the Scottish Protestant John Dury is typical. Wholly consecrated to the ideal of the unity of the church, Dury traveled tirelessly, attempting to influence leaders in church and state, writing, arguing and preaching. But the 17th century was a time of inflamed theological passion; the failure of the Anglicans and the Presbyterians in England to agree at the Savoy conference in 1661 indicates the almost universal inability even of men of good will to come together in that century. In the 18th century the rulers took a hand. Under the influence of Daniel Ernst Jablonski a plan was launched to introduce episcopacy into the church of Prussia and to bring it into unity with the Church of England. These and similar negotiations led to nothing, and it was not until 1817 that Frederick William III of Prussia produced, in the Prussian Plan of Union between Lutherans and Calvinists (a loose and very undogmatic unity), the first example of a real union of churches in modern history.

The 19th century was the great age of the voluntary Christian societies (*see* Missions; Bible Societies). Mainly as a result of the evangelical revival, missionary societies and such corporate efforts as the British and Foreign Bible society, the Young Men's Christian association and the Young Women's Christian association brought Christians together for a variety of specific purposes. But these were unions of heart and feeling rather than of doctrine. Loyalty to Christ was felt to be so all-important that questions of denomination were rarely raised, and differences of denominational loyalty were not felt as a hindrance to co-operation. In

all these movements there had hardly been any official co-operation of the churches as such. The modern ecumenical movement began when the churches themselves began to be engaged in the search for the unity and renewal of the Body of Christ.

Beginning of the Modern Movement.—The modern ecumenical movement is generally held to have taken its rise from the first World Missionary conference, held at Edinburgh in 1910. This movement was the offspring of the widespread missionary activity of the time. Living as a tiny minority amid vast populations of non-Christians, missionaries and their converts had found themselves driven into alliance with one another. Where the church was less highly organized and less rigid than in the west, many forms of co-operation had proved possible. The world-wide sense of fellowship had found expression in a series of conferences, which had created a deep impression but had been loosely organized and had no permanence. Edinburgh was different from all that had come before in three vital ways. First, it had been well organized under the direction of J. H. Oldham, who was later to have a hand in the organization of many other ecumenical gatherings. Second, though from the church point of view an unofficial conference, it had taken steps to draw in the churches insofar as possible. It was significant that the Society for the Propagation of the Gospel, which, with its strong church sense, had tended to hold aloof from all interchurch movements, agreed to be represented, and the archbishop of Canterbury, Randall Davidson, addressed the conference. Third, the conference established the very first permanent instrument for international Christian work outside the Church of Rome, the continuation committee of the conference. Out of this grew in 1921 the International Missionary council (I.M.C.). John R. Mott, an American Methodist who had been chairman of the Edinburgh conference, became first chairman of the I.M.C., contributing greatly to the development of ecumenical confidence and mutual trust, particularly in the formation of national Christian councils in many parts of Asia and Africa.

From one field Edinburgh had been debarred by common consent. Nothing had been said about problems of faith and order, but it was clear that they could not remain forever undiscussed. Under the inspiration of Charles H. Brent the American Episcopal Church took up the call for a world conference on faith and order, at which the churches should meet precisely to discuss those things about which they differed. The secretary of the commission was a layman, Robert H. Gardiner. Immense difficulties had to be overcome. A great many church leaders believed that such a meeting might do more harm than good. There were no precedents and no assurance that such a conference could in fact be held.

The first conference met in Lausanne in 1927, under the chairmanship of Brent. If the conference had done nothing else, it would at least have shown how necessary it was; it revealed the extent to which the churches had lived in separation from one another and how ignorant they were of one another's beliefs and practices. But the conference did much more than this. It appointed a continuation committee and set in motion a process of joint theological study. Further world conferences on faith and order were held at Edinburgh (1937) and Lund (1952).

It is to be noted that the Church of Rome declined to have anything officially to do with the Lausanne conference, but that the Orthodox churches, which had not been present at Edinburgh in 1910, were well represented.

Yet a third stream of ecumenical activity was beginning to develop during and after World War I, under the leadership of Nathan Söderblom (*q.v.*), at that time archbishop of Uppsala. During the war Söderblom had made heroic but largely ineffective efforts to mobilize the churches in the cause of peace. When peace returned, he felt that the time had come to ask whether the churches had a word to say to the world of men outside its own narrow limits, or a practical, social message to give. Similar questions were moving in many men's minds. They had inspired, for instance, in England the Conference on Politics, Economics and Citizenship held at Birmingham in 1924. The first Universal Conference on Life and Work met at Stockholm in 1925, with Söderblom as chairman and G. K. A. Bell as editor of the report of its proceedings. A survey was made of the great problems of man in modern industrialized society. The size and complexity of these problems was realized. This conference, like the others, appointed a continuation committee, which accomplished much in the education of all the churches as to the social responsibilities implicit in the gospel.

There were now three ecumenical bodies, each with a standing or continuation committee, and the expectation of a succession of world conferences organized by each of the three. There was considerable overlapping of personnel and an increasing duplication of effort. At the meetings of Faith and Order at Edinburgh, of Life and Work at Oxford, both in 1937, and of the International Missionary council at Tambaram near Madras in 1938, the question was raised of the formation of a World Council of Churches, in which the first two movements would merge, the third being associated with it. The proposal met with little opposition and much ready acceptance. A provisional committee was appointed to plan for formation of the council, with William Temple (*q.v.*) as chairman and W. A. Visser't Hooft as secretary. It was intended that the first meeting of the council should take place in 1941, but it was postponed by the outbreak of World War II. During the war years the World council, though still only "in process of formation," made contacts with the churches on both sides of the barrier of war, and, through its service to prisoners of war and refugees and later to the devastated countries, made itself a living reality to the world.

The World Council of Churches.—All this preparation reached its fulfillment in the official formation of the World Council of Churches on Aug. 23, 1948 (*see* WORLD COUNCIL OF CHURCHES, THE). One of the principal achievements of the third assembly of the World council (1961) was the integration of the World council and the International Missionary council into one single great ecumenical body. There had been considerable opposition to this step in conservative circles and in the Orthodox world; but the steady support of the younger churches and the widespread conviction in the Christian world that it is unreasonable to have two major ecumenical bodies in existence made it almost a foregone conclusion that this further step toward unity would be taken. Another achievement of great significance for the ecumenical movement was the admission of the Orthodox Church of Russia (and with it the Orthodox Churches of Bulgaria, Rumania and Poland) to membership in the World council.

It is necessary to recognize the limits of the World council. It does not include the Roman Catholic Church or certain great Protestant bodies, such as the Southern Baptist Churches in the United States. But it does include representatives from the separated Eastern Churches, from the Orthodox Churches of Greek, Arabic and Slavonic speech, the Old Catholics, all the Anglican Churches in the world; the great churches that stem from the Reformation—Lutheran (though not all), Reformed, Congregationalist, Baptist (again, not all); many of the churches of more recent development, such as the Methodists and the Disciples of Christ; some of the Society of Friends, and the Salvation Army. The enthusiasm with which the more recently founded churches in Africa and the east have adhered to it is notable; these churches seem to feel very strongly the value of a great international fellowship, in which they are welcomed on terms of full spiritual equality.

The World council is not, does not aspire to be and should never become a church or a superchurch. It can issue no instructions to its member churches, which retain their full autonomy. Its declarations or utterances on public affairs have no authority other than that which may accrue to them in view of the wisdom with which they have been made.

The World council increasingly commands the confidence of the churches; it has not interfered in their internal affairs; it has continued to work for the two great objectives, the unity and the renewal of the church; it is recognized by churches throughout the world as providing a better instrument than they have ever had before for frank discussion, for consultation and for co-operation in practical service for the well-being of mankind.

Other Forms of Ecumenism.—It would be a mistake, how-

ever, to identify the ecumenical movement with the World Council of Churches or to limit the use of the word to this particular form of ecumenism. At least four other lines have to be taken into consideration.

Roman Catholic Church.—This church on its own principles refuses to have official dealings with other churches or movements. But it is deeply concerned about unity and pursues its own way toward it, especially by the development of the annual week of prayer for unity (Jan. 18–25), forwarded by Paul Couturier of Lyons and officially adopted by the Faith and Order section of the World Council of Churches in 1941.

The appointment in 1960 by the pope of a special commission for ecumenical affairs, with Augustin Cardinal Bea as president, the first official recognition by the Roman Catholic Church of the existence of the ecumenical movement, was of the greatest importance.

Movement for Church Union.—Between 1910 and 1961, 42 mergers of churches took place in various parts of the world, the most striking being the Church of South India. Only one of these, the union of the French Protestant churches (1938), took place directly under the influence of Faith and Order; the other movements occurred independently. Yet they profited by the ecumenical climate of the 20th century and contributed to its strength.

Denominational Ecumenism.—Every one of the main confessional groups has its international organization (the earliest, the Presbyterian alliance, 1875). This movement could become a danger to the wider ecumenical movement; but the denominations defend themselves by saying that, if ecumenism is not to be a lowest-common-denominator fusion, they can make their best contribution by understanding better their own denominational treasures and bringing them undiminished into the movement.

Evangelical Ecumenism.—Small groups are engaged in bitter warfare against the World Council of Churches; these can be disregarded here. But other large groups, of which the International Fellowship of Evangelical Students (1947) is typical, continue the 19th-century tradition of fellowship, demanding only loyalty to Jesus Christ as the qualificaton for membership, and are suspicious of the wider ecumenical movement.

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ECZEMA: *see* SKIN, DISEASES OF.

EDAM, a town in the province of North Holland, Neth., is situated on the shores of the IJsselmeer, 21 km. (13 mi.) N.N.E. of Amsterdam by road. Pop. (1960) 14,440 (mun.). The little town is dominated by the large church of St. Nicholas, rebuilt after a fire in 1602 destroyed almost the whole town. The town hall (1737) has interesting wall paintings and furniture; the city museum (1895) has a floating cellar; and the tower of the former Ons Lieve Vrouw church contains a very old carillon made by Pieter van den Gheijn of Malines. In the Nieuwenkamp museum, named after the well-known painter and etcher (1874–1950), are etchings, and art treasures from Bali. The famous Edam cheese (*zoetmelks kaas,* "sweet milk cheese"), made throughout North Holland, is the town's chief product; others are earthenware, packing materials (jute, paper, plastics), coal brushes, tools, door and window furniture and ladies' underwear. Edam took its name and origin from the dam built on the Ye, which joined the Purmer lake with the Zuider Zee (*q.v.*). It became an important harbour and shipbuilding centre when a large dock was built on the Zuider Zee in 1357; in the same year Edam received its civic rights from William V of Bavaria, count of Holland. In the 17th century most of Adm. M. A. de Ruyter's fleet was built in Edam, as well as "de Halve Maen" (the "Half Moon"), the ship Henry Hudson used in 1609 in his search for the northwest passage. When Philip II of Spain ordered a sluice to be built into the dock in 1567 to prevent flooding into the reclaimed land, the inhabitants opposed it in vain. The sluice caused the harbour to silt up and commercial and industrial activity waned. (C. G. M. v. B.)

EDBERT (EADBERHT) (d. 768), king of the Northumbrians from 737 to 758, succeeded on the resignation of his cousin Ceolwulf. He was a strong king whose reign was regarded by Alcuin as a golden age. He fought the Picts in 740, conquered Kyle in 750 and with Pictish help he forced the Britons to come to terms at Dumbarton in 756, though his army met with disaster nine days later. His brother Egbert became bishop of York in 732 and, receiving the pallium in 735, was the first archbishop of York. Church affairs prospered under the care of the two brothers, and York became a famous centre of learning. A letter from Pope Paul I, remonstrating with them for giving three monasteries to a noble, suggests that they had suppressed some spurious monasteries, as Bede had advised. Edbert was in contact with the Frankish kingdom, and received gifts and letters from Pepin the Short.

Edbert resigned in 758 and became a cleric at York. He and his brother Egbert were buried at York, in the same chapel. His son Oswulf, who succeeded him, was killed within a year and the throne passed to a nobleman called Aethelwald Moll.

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EDDA, the name given to two books written in Iceland in the 13th century. These are commonly distinguished as the *Prose Edda* and the *Poetic Edda.* The name *Edda* was applied first to the *Prose Edda* and belonged originally to that book alone.

The Prose Edda (also called the *Younger Edda, Snorri's Edda*) was written by the Icelandic chieftain Snorri Sturluson (1179–1241), probably during the years 1222–23. It is preserved in several medieval manuscripts, the oldest of which, written about 1300, is kept in the library of the University of Uppsala, Swed., and bears the colophon "this book is called *Edda,* and was put together by Snorri Sturluson . . ."

The meaning of the name *Edda* has been disputed and many interpretations have been offered, although few deserve to be repeated. According to one interpretation, the name is identical with the Icelandic word *edda,* "great-grandmother," and implies that the book is a collection of ancient tales. Others suggest that *Edda* is derived from *Oddi,* the name of the farm where Snorri was brought up and educated. An equally plausible explanation is that the name *Edda* is derived from *óðr,* "poetry," and that it means "poetics." Whatever the meaning of its name, the *Prose Edda* is, in fact, a handbook of poetics.

The *Prose Edda* is divided into four sections, Prologue, *Gylfaginning, Skáldskaparmál, Háttatal.* The last section, the *Háttatal* (List of Verse Forms), was probably written first; it consists of a poem in three parts addressed to King Hákon (1204–63) and Earl Skúli (d. 1240), the rulers of Norway. The poem contains 102 strophes, which exemplify 100 different forms of verse. The distinctive features of each form are explained in a running commentary, which makes the *Háttatal* an invaluable source for the study of early Norse measures and verse forms.

Interesting as it is for the student, the *Háttatal* is of little value as literature. It is preceded by the *Skáldskaparmál* (Speech of Poetry), in which Snorri explains the diction of poetry, and especially that of the poetry of the scalds. The chief characteristic of scaldic diction was in its kennings, or periphrases, many of which are obscure. These kennings might be based upon similes drawn from the world of nature, for example, the ship could be called the "horse of the sea." Alternatively, they might be based upon allusion to an incident in myth or legend, in which case the kenning could be explained only by telling the story. To take one example, gold is called the "corn of Fýrisvellir" or the "corn of Kraki." These kennings were based on a legend about a raid which Hrólf Kraki, king of the Danes, was supposed to have made on the king of the Swedes in the 5th century. The king of the Danes and his champions had seized the Swedish treasure and, as they rode away over the plains of Fýrisvellir, they escaped capture

by strewing gold behind them, as if it were corn, causing the Swedes to stop and pick it up.

In other chapters of the *Skáldskaparmál*, Snorri retells legends of Sigurd, Brynhild, the Burgundian heroes and the Norse gods. He includes the story of the origin of poetry, the precious mead brewed by the dwarfs, and afterward stolen by Odin (Óðinn). It is largely for stories such as these that the *Skáldskaparmál* is read today, but it also contains much information about the history of Icelandic and Norwegian poetry. The various types of kennings are illustrated with examples from the works of poets who had lived between the 9th and 12th centuries. This poetry had been preserved orally and much of it is recorded nowhere else.

The *Skáldskaparmál* is preceded by the *Gylfaginning* (Beguiling of Gylfi), which is the most interesting section of the *Prose Edda*, serving as an introduction to the *Skáldskaparmál* and the *Háttatal*. Both the diction and the subjects of poetry were closely associated with myths of the gods and poetry could not be properly understood without some knowledge of mythology. The *Gylfaginning* is an account of the Norse gods and, like many learned works of the middle ages, it is cast in the form of dialogue.

Gylfi, described as king of the Swedes, comes to Ásgard, the citadel of the gods, intending to discover the source of their power. The gods, by virtue of their magic, deceive his eyes, and Gylfi is brought into the presence of three figures, High, Equally High and Third, all of them emanations of Odin. Answering his questions, they tell Gylfi about the beginning of the world, the adventures of the gods and the fate in store for all in the Ragnarök (Doom of the Gods). The sources which Snorri used for the *Gylfaginning* were chiefly lays about the gods, many of which are preserved in the *Poetic Edda*, although others are lost.

The Prologue of the *Prose Edda* stands somewhat apart. In it the descent of the Norse gods is traced from heroes of Greece and ultimately from Adam. The influence of European and especially of early English genealogies is patent.

The *Prose Edda* has won universal admiration as a masterpiece of narrative art, but its value as a record of mythology has been much questioned and some critics of the early 20th century rejected it altogether. In recent years, however, scholars have seen reason to place greater faith in Snorri's knowledge of pagan tradition, even though he was educated as a Christian and worked more than two centuries after Iceland had been converted to Christianity.

The Poetic Edda (also called *Elder Edda*, *Saemund's Edda*) is the name given to a manuscript written in the second half of the 13th century and preserved in the Royal library, Copenhagen, Den. It belonged formerly to the Icelandic bishop Brynjólf Sveinsson (1605–75), who gave it the title *Edda Saemundi multiscii* (Edda of Saemund the Learned), thereby showing that he believed it to be the work of the Icelandic historian Saemund Sigfússon (1056–1133). It is plain, however, that the book was compiled at a much later period than that of Saemund, although some of the poetry contained in it is among the oldest preserved in a Scandinavian language.

The poetry of the *Edda* falls into two groups, the mythological and the heroic. The mythological poetry consists of lays in various metres and of various ages about northern gods. The first in the book is the *Völuspá* (Sibyl's Prophecy), a lay of some 60 strophes, in which the story of the world and of the gods is told from the beginning until the Ragnarök, when the gods will face death. There is no poem in all Germanic literature of greater scope and magnificence.

The *Völuspá* is followed by the *Hávamál* (Words of the High One), which consists of fragments of various poems, all of which are didactic and supposed to be spoken by Odin. The god discourses on social conduct, and speaks finally of the runes and the power of his magic. Other didactic poems in the *Edda* are the *Vafþrúðnismál* (Words of Vafthrúdnir), the *Grímnismál* (Words of Grimnir) and the *Alvíssmál* (Words of the All-knowing). In the *Lokasenna* (Flyting of Loki), Loki, the demon, bandies words with the gods, taunting them with coarse jests. In the *Þrymskviða* a tale is told of Thor and in the *Skírnismál* a love story about Frey (Freyr), the god of fertility.

The ages and origins of mythological poems in the *Edda* have been disputed. While it is nearly certain that the *Völuspá* dates from the end of the 10th century and was composed in Iceland, there can be little doubt that many sections of the *Hávamál* as well as the *Skírnismál* and several other poems are considerably older and of Norwegian origin. Some of the lays may well have been composed by Norse settlers in the British Isles.

A number of mythological poems comparable with those of the *Edda* are found in other manuscripts. Among these may be mentioned the *Baldrs Draumar* (Dreams of Balder [Baldr]) and the *Rígspula* (Song of Rígr).

The second half of the *Poetic Edda* comprises lays about ancient Germanic heroes. The hero of the first of them, *Völundarkviða*, is Wayland the Smith, who was famous as a craftsman in legends of England and Germany as well as of Scandinavia. The heroes of three of the lays are Scandinavians, but those who figure in the rest are all continental Germans. Nearly all of the lays are associated with legends of Sigurd, Brynhild and the Burgundian heroes. Like the mythological lays, the heroic ones are of various ages and origins. Some of them, such as the *Hamðismál* (Words of Hamdir) and the *Atlakviða* (Lay of Atli) appear to be derived from continental poems as old as the 5th and 6th centuries, although later recast in the Norse language. Others appear to have been composed in Norway and in Iceland between the 10th and the 12th centuries, and one, the *Grípisspá* (Prophecy of Grípir), can hardly be older than the 13th century. *See* also ICELANDIC LITERATURE.

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There are many editions of the *Poetic Edda* and among the best are *Norræn Fornkvæði*, ed. by S. Bugge (1867); *Die Lieder der Edda* I–IV, ed. by B. Sijmons and H. Gering (1888–1931); G. Neckel, *Edda* I–II (1927 and 1936), vol. *i* rev. by H. Kuhn (1962); J. Helgason, *Eddadigte* I–III (1951–52). Facsimiles: *Codex Regius af den Ældre Edda*, ed. by L. Wimmer and Finnur Jónsson (1891); *Codex Regius of the Elder Edda* (*Corpus Codicum Islandicorum Medii Aevi*, vol. x), introduction by A. Heusler (1937). The best English trans. is that of A. Bellows, *The Poetic Edda* (1923). (G. T.-P.)

EDDI (EDDIUS or AEDDI) (*c.* 650–*c.* 720), also known as Stephanus, a Kentish monk and choirmaster, was employed by Wilfrid, bishop of York, to organize services in Northumbria. The *Life* of Wilfrid is ascribed to him, though without any very strong evidence. It is of great value, though very partisan in feeling, and was used by Bede.

See B. Colgrave (ed.), *Life of Wilfrid* (1927), with introduction and Eng. trans., and "The Earliest Saints' Lives Written in England," in *Proceedings of the British Academy*, pp. 55–60 (1958). (PL. GN.)

EDDINGTON, SIR ARTHUR STANLEY (1882–1944), British astronomer, particularly known for his studies of stellar motion and composition and for his support of the theory of relativity, was born at Kendal, Westmorland, on Dec. 28, 1882. He was educated at Owens college, Manchester, and at Trinity college, Cambridge, where he was senior wrangler in 1904 and Smith's prizeman in 1907. In the latter year he was elected a fellow of Trinity. From 1906 to 1913 he held the post of chief assistant at the Royal observatory at Greenwich. In 1913 Eddington was elected to the Plumian professorship of astronomy and experimental philosophy at Cambridge as successor to Sir George Darwin, and in the following year he became director of the university observatory, succeeding Sir Robert Ball.

Eddington's earliest papers dealt with problems of stellar motions and distribution, and in 1914 his first book, *Stellar Movements and the Structure of the Universe*, was published. A model of scientific exposition, it contains what is probably the best general discussion of moving star clusters. Its final chapter, entitled "Dynamics of the Stellar System," marks the foundation of an important branch of astronomical research. Eddington was the father of dynamical stellar astronomy.

In 1916 Eddington began the fundamental researches which cre-

ated the present-day theory of the internal constitution of a star. His crucial hypothesis was that the energy emitted as light and heat from the stellar surface was transmitted throughout the interior in the form of radiation also. He concluded that most stars were gaseous throughout and he made the major discovery that the mass and the luminosity of a star were related. The great densities of the "white dwarf" stars and the nature of the interstellar medium were also illuminated by his work. Eddington drew his researches together in *The Internal Constitution of the Stars* (1926), a book which became one of the classics of astronomy.

Concurrently with these investigations Eddington had, from the year 1917, become deeply interested in Einstein's theory of relativity. He led one of the expeditions to observe the total eclipse of the sun of May 29, 1919. The data he obtained at the island of Príncipe (west Africa) verified one of the predictions of general relativity, namely, that the positions of stars seen just beyond the eclipsed solar disk should be slightly displaced away from the centre of the disk. The existence of this phenomenon had not been suspected until it was revealed theoretically by general relativity. Eddington's books *Space, Time and Gravitation* (1920) and *The Mathematical Theory of Relativity* (1923) did much to make relativity known to the English-speaking world. From 1930 onward he worked on a unification of general relativity and the quantum theory. He believed that he could calculate mathematically, and without appeal to observation, the values of those constants of nature which are pure numbers, for example, the ratio of the mass of the proton to that of the electron. This notion, which has not won general acceptance, was derived from his attitude to the philosophy of science. Eddington believed that a great part of physics simply reflected the mode of interpretation which the scientist imposes on the data of observation. This view was developed mathematically in the *Relativity Theory of Protons and Electrons* (1936), *The Combination of Relativity Theory and Quantum Theory* (1943) and in a posthumous volume edited by Sir E. T. Whittaker, *Fundamental Theory* (1946), works in which an astonishing number of the constants of nature were calculated. Eddington's main philosophical writings are *The Nature of the Physical World* (1928) and *The Philosophy of Physical Science* (1939).

Eddington's influence on modern astronomy was great—not only because of the actual results that he obtained, but also because of the stimulating effect of his writings on the thought and research of other workers. He was, moreover, extraordinarily gifted in popular exposition. He received many honours during his lifetime; he was made a knight bachelor in 1930 and received the order of merit in 1938. He died on Nov. 22, 1944.

See the obituary notice by H. Spencer Jones and E. T. Whittaker in vol. 105 of the *Monthly Notices of the Royal Astronomical Society;* A. Vibert Douglas, *The Life of Arthur Stanley Eddington* (1956).

(W. W. M.; A. A.; G. C. McV.)

EDDY, MARY BAKER (1821–1910), discoverer and founder of Christian Science (*q.v.*), was born July 16, 1821, at Bow, near Concord, N.H., the sixth and youngest child of Mark and Abigail Baker, both Congregationalist descendants of old New England families. Because of frequent interruption due to illness, Mary's formal education was quite limited, but she read and studied at home, aided by her brother Albert. She early began to write both prose and poetry. Her first husband, George W. Glover, whom she married in 1843, died before the birth of their son, George, the only child she was to bear. Because of his mother's ill-health the boy was reared largely by others and had little contact with her.

Suffering almost constantly from a spinal malady, Mrs. Glover was much preoccupied with questions of health. She experimented with homeopathy and in 1853 married Daniel Patterson, a dentist, who shared this interest; the union, which was not happy, ended finally in divorce. Before this occurred, however, Mrs. Patterson had heard of Phineas Parkhurst Quimby (*q.v.*) of Portland, Me., who was performing remarkable cures without medication or surgery. She sought him out and was healed. She was warm in his praise, thought that he had rediscovered the healing method of Jesus, studied his notes, lectured on his method and wrote of it in regional periodicals. How much, if anything, her later discovery of Christian Science owed to the influence of Quimby is one of the moot questions of scholarship. Quimby died, and after a time there was a recurrence of her illness. Then in 1866 she had a bad fall; she asserts that her case was hopeless. She turned to her New Testament, and in reading it was healed. This she regarded as the discovery of Christian Science. Separated now from her husband, she lived for a number of lonely years in rented rooms, all the time seeking to put down in writing her slowly evolving system of Christian Science. She discussed it with some, taught it to Hiram Crafts, Richard Kennedy and others who became successful healers. She began to take students on a fee basis, and her fortunes began to improve. In 1875 she published *Science and Health,* which with many revisions and additions before her death became *Science and Health With Key to the Scriptures,* regarded by her followers as divinely inspired, and, along with the Bible, forming the scripture of the new faith. In 1877 she married Asa G. Eddy, one of her followers.

Mrs. Eddy's first public meetings were held in Lynn, Mass., then in Roxbury and Boston. First formal steps to organize The First Church of Christ, Scientist, were taken in 1879. In 1881 she founded the Massachusetts Metaphysical college, where she taught till it was closed in 1889, to be succeeded by a gradually developed system of primary and normal class instruction. Meetings in Boston were held first in rented halls, but in 1895 The Mother Church was dedicated; it was quickly outgrown, and in 1906 the imposing "extension," still one of the outstanding landmarks of Boston, was completed. Members of branch churches may and many do belong also to The Mother Church. It was governed during her lifetime according to directives issued from time to time by Mrs. Eddy, and these, collected and revised many times by her before her death, form the *Church Manual.* Like *Science and Health,* it is regarded as divinely revealed. The self-perpetuating board of directors, set up by Mrs. Eddy, became the ruling authority after her passing, operating, they affirm, according to the *Manual,* which cannot be amended. In 1883 she founded the monthly *Christian Science Journal;* in 1898 the weekly *Christian Science Sentinel;* and in 1908 the *Christian Science Monitor,* one of the great daily newspapers of the United States. Other machinery for the administration of a growing movement Mrs. Eddy created as needed: the Christian Science Publishing society, the board of education, the board of lectureship, the committee on publication.

Mrs. Eddy made her home for a time in Lynn, then moved to Boston, later to Concord, and finally to Chestnut Hill, where on Dec. 3, 1910, at the age of 89, she died.

Her philosophy and that of Christian Science is a pure idealism. There is only one reality: Mind, God, Good. Matter is unreal; so also is evil. Other idealisms had existed both in the orient and in the west, but few had drawn from the philosophy the practical corollary of healing that Mrs. Eddy drew and made central in her system.

A list of Mrs. Eddy's writings may be found in most editions of *Science and Health.* Among her major works, in addition to those cited, are *Miscellaneous Writings* (1896), *Retrospection and Introspection* (1892), *Unity of Good* (1908) and *Rudimental Divine Science* (1908).

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(C. S. B.)

EDDY: *see* WHIRLPOOL.

EDE, a town in the province of Gelderland, Neth., lies 11 mi. N.N.W. of Arnhem. Pop. (1957 est.) 54,253 (mun.). The museum in the National park, *De Hoge Veluwe,* contains the modern-art collection of Kröller-Müller, particularly paintings by Vincent van Gogh. Ede, which is a garrison town, has five public parks, the Doesburger mill dating from 1507 and an open-air theatre. There is a rayon-yarn factory and other industries include metallurgy and the making of pianos. The surrounding district has a con-

siderable number of dairy and poultry farms and in Ede are factories for processing dairy products and also a dairy research institute. (H. M. Ol.)

EDELINCK, GERARD (1640–1707), Flemish copperplate engraver, who with Robert Nanteuil and Antoine Masson formed the great triumvirate of the best period of French portrait engraving, was born in Antwerp on Oct. 20, 1640. He learned the rudiments of the art in his native town under Gaspard Huybrecht. He then went to Paris in 1665 and worked under F. de Poilly. On the recommendation of Charles le Brun, he was appointed teacher at the academy established at the Gobelins to train workers in tapestry. In his engravings Edelinck excelled in rendering light and shade, colour and the texture of surfaces. He was the first to execute prints in the lozenge shape. Among his works, which number 341, are a "Holy Family" after Raphael, a "Penitent Magdalene" after Le Brun, "Alexander at the Tent of Darius" after Le Brun, a "Combat of Four Knights" after Leonardo da Vinci, "Christ Surrounded by Angels," "St. Louis Praying" and "St. Charles Borromeo Before a Crucifix"—the last three after Le Brun. Edelinck engraved portraits of Louis XIV, Le Brun, Hyacinthe Rigaud, Philippe de Champaigne (which the engraver thought his best), Santeul, La Fontaine, Colbert, Dryden, Descartes, etc. He died in Paris on April 2, 1707. His two brothers, Jean and Gaspard François, and his son Nicolas were also engravers, but did not attain to his excellence.

EDELWEISS (*Leontopodium alpinum*), a perennial plant of the family Compositae (*q.v.*), native of the Alps and the Andes. It is a small ornamental herb about six inches high, with narrow white woolly leaves, and terminal flower heads enveloped in woolly bracts. The woolly covering is assumed to protect the plant, in the exposed situations in which it is found, by preventing its drying up through excessive loss of moisture. It is much sought after by visitors to the Alps. Although rather sporadic in its distribution it is not rare and grows readily in gardens under lowland conditions.

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EDELWEISS (LEONTOPODIUM ALPINUM)

EDEMA is a swelling due to effusion of watery fluid into the intercellular spaces of connective tissue. Edematous tissues are swollen and, when punctured, secrete a thin incoagulable fluid. This fluid is essentially an ultrafiltrate of serum but also contains small amounts of protein. Minor differences in composition are found in various diseases with which edema is associated. The fluid is also called a transudate to distinguish it from the protein-rich, leucocyte-containing exudate of inflammation (*q.v.*). Generalized edema (dropsy, hydrops) may involve the cavities of the body as well as the tissues with the excessive accumulation of fluid. Edema is usually a symptom of disease rather than a disease in itself and may have many causes, most of which can be traced back to gross variations in the physiological mechanisms that normally maintain a constant water balance in the cells, tissues and blood. Among the causes may be diseases of the kidneys, heart, veins or lymphatic system; malnutrition; or allergic reactions. The treatment of edema generally consists of correcting the underlying cause, such as improving kidney or heart function. Edema may be a purely local condition (*e.g.*, hives) or a general one (*e.g.*, nephrotic edema). A swelling of the limbs, face or some other region of the body is sometimes called anasarca. The terms dropsy, hydrops and anasarca are somewhat archaic, however, and edema has come to be the preferred term. A related term, ascites (*q.v.*), is used to describe excess fluid in the peritoneal cavity.

Maintenance of Normal Fluid Balance.—The amount of water in the body at any one time is the balance between intake and output. In healthy persons, water is lost through the urine, sweat, breath and skin and is gained through the intake and metabolism of food and drink. In healthy adults, water makes up from 40% to 60% of body weight. The percentage is higher in infants and children, greater in lean than in fat individuals and higher in men than in women. When the water content rises about 10% above normal, edema becomes noticeable. Body water is considered to be distributed in three compartments or spaces: (1) the intracellular (approximately 70% of body water); (2) the interstitial (22.5%); and (3) the vascular (7.5%). The interstitial and vascular compartments together make up the extracellular space. In addition there are potential serous cavities (*i.e.*, those lined by a membrane whose surface is moistened by a thin fluid derived from the serum or lymph) in the body, such as the pericardial sac, the pleural and peritoneal cavities and the joint spaces, that can become edematous. Normally the serous cavities contain only a few millilitres of lubricant fluid.

Another view of body water distribution does not recognize rigid compartments. The interstitial tissue, or ground substance, is considered to be a gel continuum in which gradients of solute and moisture content normally exist. These "water-poor" and "water-rich" phases of ground substance are in dynamic equilibrium with water in cells, in the body cavities and in the circulation.

Renal control of the amount of water in the body depends on the kidneys' ability to vary excretion and retention of water and solutes, particularly sodium ions, according to circumstance. A highly complex, integrated mechanism assists the kidney: this mechanism involves nervous control of the kidney; blood flow to it; the integrity of renal cellular structure and function; the activity of pituitary, adrenal and other endocrine glands; and a possible regulating system of hypothetical sensing organs (*e.g.*, volume, stretch or chemical receptors). The action of hormones typifies the integrated nature of the supplemental regulators. Steroid hormones (*e.g.*, aldosterone) cause the kidney to retain sodium and other minerals, while pituitary antidiuretic hormone causes the kidney to retain water. A hormone that induces the kidney to excrete minerals also has been suggested. (*See* also URINARY SYSTEM.)

Other factors, in addition to renal control, that affect the distribution of water in the body are those whose actions (1) regulate the passage of water and electrolytes through the capillary wall; (2) affect the permeability of basement membrane, endothelial and other cells; and (3) maintain tissue turgor (interstitial tissue pressure). Among these factors are intravascular hydrostatic pressure; gravity; cardiac output; the resistance of the vascular bed; environmental temperature; the effects of poisons, toxins and chemical substances such as histamine on permeability; the degree of polymerization of interstitial tissue; lymph flow; nutrition; and the osmotic pressure and distribution of the plasma proteins and electrolytes. The plasma proteins—particularly albumin—exert a continuous osmotic pressure in the circulation because the capillary wall is practically impermeable to them.

Translocations of water within the body can be explained only partially by known physical and chemical forces, but it appears that chemical hydration and electric potentials effect the exchange of water within the organism. It has also become apparent that living cell membranes participate actively in fluid exchange, causing water and solutes to move in a direction opposite to their concentration gradient.

Edema in Health.—Swelling due to an accumulation of fluids in the tissue spaces, such as in the feet and ankles late in the day or after standing or walking for lengthy periods, is a common experience. "Shipboard edema" may break out in healthy travelers when they enter the tropics. Edema of these types results from the combined effects of gravity, pressure on veins and distention of peripheral vessels; such edema is likely to occur when pressure in the veins is somewhat higher than normal; *e.g.*, as a result of pregnancy or varicose veins. Normal endocrine activity may also produce accumulations and translocations of water because of its effect on connective tissue and its control of renal function. In women the normal cyclic ebb and flow of hormones associated with menstruation sometimes causes the kidney to re-

tain water and sodium. Total body water increases and a premenstrual weight gain is noted.

Edema Associated With Disease can be divided into three groups: (1) generalized edema; (2) local edema; and (3) collections of fluid in the body cavities.

Generalized Edema.—In cardiac, renal, nutritional, endocrinologic and all other forms of generalized edema there is an increase in total body water; a complex process is invoked to explain its development. For example, in cirrhosis of the liver associated with alcoholism fluid usually collects in the peritoneal sac (ascites) and may collect in the legs, scrotum and pleural cavities. The scars, fibrous tissue bands and regenerating cells in the damaged liver squeeze the portal vein in the liver and raise its interior pressure. This increases the permeability of the portal capillaries and causes water to escape into the peritoneal cavity. In addition, the damaged liver cannot synthesize albumin, and the albumin level in the blood falls. There is consequently a drop in plasma osmotic pressure, and fluid escapes from the blood into the tissues. The loss of appetite causes malnutrition, and the tissues waste. Tissue turgor (interstitial pressure) lessens, and water takes up the slack. The damaged liver cannot inactivate steroids as usual, and they accumulate. Adrenal steroids consequently appear in excess, perhaps through stimulation by a volume receptor that may sense the change in blood volume because of albumin depletion. These steroid excesses increase renal retention of sodium and water. Thus it can be seen that many mechanisms work separately and together to produce edema and ascites. Edema also appears in other types of liver disease, such as schistosomiasis, hepatoma, Chiari's disease and hepatitis. (*See* also Gall Bladder, Biliary Tract and Liver, Diseases of: *Liver.*)

Cardiac failure is often accompanied by edema. If the patient is up and about, the edema settles in the legs; if the patient remains in bed, the edema collects in the sacral skin and subcutaneous tissues. Congestive or backward heart failure is commonly seen with valvular defects. High-output or forward heart failure results from anemia, hyperthyroidism, uremia, cholemia and beriberi. Acute (left-sided) heart failure produces pulmonary edema, which may also result from changes in the permeability of lung capillaries brought about by the inhalation of chemicals such as mustard gas. (*See* also Heart, Diseases and Defects of.)

Renal disease frequently manifests itself through the development of edema, usually in the eyelids and face as well as in the dependent parts; it is most noticeable after lying down for several hours. The reasons why the face and eyelids are involved are not clear. Edema develops commonly in acute Bright's disease (*q.v.*), the nephrotic syndrome and, less commonly, in chronic renal failure. It appears in acute renal failure when excess fluids are ingested. Water intoxication, due to impairment of the kidneys' ability to excrete water, is seen after operations, in acute renal failure and as a terminal event in some cases of liver or heart failure.

Nutritional edema occurs most frequently in one of two forms: (1) starvation, or famine, edema and (2) edema due to a low level of protein intake. Vitamin B_1 deficiency (beriberi) and potassium deficiency also can produce edema. Starvation edema (caused by famine, anorexia nervosa, cancer, etc.) is usually the result of loss of tissue turgor, but other factors, such as renal sodium retention, contribute to the development of edema. Initial treatment of starved patients with salt-containing fluids or food may be dangerous, as the ingested salt may produce edema and heart failure. Protein malnutrition may be due to poor dietary intake, as in tropical malnutrition (kwashiorkor), or to loss of proteins from the skin (as in burns) or their loss through the urine (nephrotic syndrome) or gut (enteropathic hypoalbuminemia).

Edema also may occur in either natural or man-made endocrine disturbances. Generalized edema also occurs in pregnancy as a part of the clinical picture of pre-eclampsia or toxemia. It may appear cyclically in women who have psychoneurosis. It is commonly produced as a side effect of treatment with steroid hormones and may be seen in the newborn children of diabetic mothers.

Local edema usually results from translocations of fluid; the total volume of body water remains unchanged or is increased only slightly. It may result from local changes in capillary permeability due to many types of injury, such as (1) introduction of toxins (*e.g.,* local swelling after mosquito bites); (2) introduction of allergens followed by allergic reactions associated with the release of histamine in the tissues (*e.g.,* angioneurotic edema of lips, tongue and throat); (3) obstruction to venous return (*e.g.,* thrombophlebitis or pressure of tumours on veins); (4) lymphatic obstruction (*e.g.,* elephantiasis due to filariasis). (*See* also Lymph and Lymphatic System: *Diseases of the Lymphatic System.*)

Collections of fluid in the body cavities may occur when the cavities become inflamed or are invaded by cancer; these conditions, however, are not considered to be edematous. Pleural and pericardial effusions are common in states of general edema (*see* also Pleura, Diseases of: *Pleural Effusion*), but effusions into joints (hydrarthrosis) are rare except in rheumatic disorders. Obstructions of veins (*e.g.,* due to portal vein thromboses) or lymph channels also produce effusions of fluid. The accumulation of excess fluid within the ventricles of the brain (hydrocephalus, *q.v.*) is thought to be the result of inflammatory obliteration of the subarachnoid channels through which the cerebrospinal fluid normally circulates.

See E. H. Starling, "The Fluids of the Body," *Herter Lectures* (1909); J. H. Moyer and M. Fuchs (eds.), *Edema: Mechanisms and Management,* a Hahnemann Symposium on Salt and Water Retention (1960). (R. M. K.)

EDEN, SIR (ROBERT) ANTHONY: *see* Avon, (Robert) Anthony Eden, Earl of.

EDEN, a legendary area where, according to the Old Testament, God planted a garden (translated "paradise" in the Septuagint) for Adam, the first man, to inhabit; there grew the tree of knowledge and the tree of life and there the fall of man took place (Gen. ii–iii). Eden itself lay east of Palestine (Gen. ii, 8), or at the source of the Tigris and the Euphrates (Gen. ii, 10–14) or on a mountain in the south (*cf.* Ezek. xxviii, 13, 14; Isa. xiv, 13).

The pentateuchal source "J" (*see* Pentateuch) of Gen. ii–iii worked the material of an older creation myth into his story of the garden of Eden without reconciling some contradictory elements. Thus, in the Genesis story Adam is not totally ignorant (Gen. ii, 20) and being created out of the earth (Hebrew *'adhama*) he is naturally mortal (Gen. ii, 7). The story of the garden of Eden attempts to explain man's progression from the innocence and state of bliss in which he was created to his present condition of knowledge and misery. It attributes the fall to ambition (*hubris*), whereby man is not merely content with obedience to the will of God but also desires the "knowledge of good and evil" (a classic expression for all knowledge) which is the prerogative of God and which in addition has been expressly forbidden to him (Gen. iii, 5). The act of disobedience suggested by the serpent, a subtle tempter (Gen. iii, 1), brought a triple punishment from God: the serpent is to be hated by mankind, the woman is to have painful childbirth and the man is to till the earth, which is henceforth cursed (Gen. iii, 14–19). Death, being the natural result of Adam's earthly nature (Gen. iii, 19), is not part of the punishment. But the tree of life could give him immortality, so Adam has to be driven out of the garden where it grows (Gen. iii, 22–24). Immortality was a stake of the game, lost by the free choice of Adam (his sin properly speaking) for a knowledge which would bring him to an equality with God, but which in fact had a laughable conclusion: the discovery that he was naked (Gen. iii, 7). Thus the story of paradise lost gives a pessimistic verdict on the human race, and shows a fundamental religious distinction in Israel: the distance in essence between man and God, the radical conflict between man's ambition and God's absolute sovereignty. *See* also Adam and Eve.

See Hans Schmidt, *Die Erzählung von Paradies und Sündenfall* (1931); P. Humbert, *Études sur le récit du paradis et de la chute dans la Genèse* (1940). (P. Ht.)

EDENBRIDGE, a market town and civil parish in the Seven-

oaks rural district of Kent, Eng., 11 mi. S.W. of Sevenoaks by road, and with two railway stations. Pop. of civil parish (1951) 3,533. It lies on the Eden, an affluent of the Medway, near the Surrey border, and has considerable agricultural trade. The church of St. Peter and St. Paul is principally Perpendicular. The Crown inn dates to the 15th century. Stangrove park (48 ac.) and another 47 ac. have been developed to house some of London's overspill population. Light industries were also introduced.

Hever castle, 2 mi. S.E., is a beautiful moated mansion of the 15th and 16th centuries on the site of an earlier structure rebuilt by Sir Geoffrey Boleyn, the great-grandfather of Anne Boleyn, who spent much of her life there before her marriage to Henry VIII and was visited there by him. There is a Boleyn chapel in the church of Hever. Near Edenbridge is the modern Chiddingstone castle on an ancient site.

EDEN RIVER, in northern England, rises in the fells that connect the Lake district and the Pennine highlands and flows 90 mi. N.W. through the counties of Westmorland and Cumberland to its estuary in the Solway firth west of Carlisle. From Kirkby Stephen, where its narrow, steep-sided upper valley opens out into the lowland vale between the Pennine and Lake district highlands, it flows in a meandering course among the hummocky moraine surface of the vale past Appleby, which is sited in a river peninsula. It receives short, swift right-bank tributaries from the great Pennine escarpment, and longer left-bank tributaries from the Lake district and its flanking limestone hills. Its main tributary, the Eamont, collects drainage from the heart of the Lake district, including the discharge from Ullswater, and flows into the Eden near Penrith. Where the Eden turns west above Carlisle it receives the Irthing, which collects the drainage from the fells lying north and south of the Tyne gap near the Northumberland border. In its lower course, past Carlisle, the river flows in sweeping meanders across alluvial flats (holms). Carlisle commands the lowest bridge from a defensive site on the south bank, flanked by left-bank tributaries, the Petteril and Caldew, the latter flowing from the northern slopes of Skiddaw. The river, even below Carlisle, is not navigable and discharges by shifting channels through the tidal flats at the head of the Solway firth. Just below Carlisle Hadrian's wall crosses the river toward its western end at Bowness on Solway. (AR. E. S.)

EDENTATA, the mammalian order comprising modern tree sloths, true anteaters and armadillos and extinct ground sloths, glyptodonts and palaeanodonts. Edentates, like man, are placental mammals; that is, the pregnant mother and its developing young are united by a nutritive tissue, the placenta. These mammals, wholly new world in origin, range from southern Argentina northward through South America and Central America to southern Mexico. One species, the nine-banded armadillo, is found as far north as the southern part of the United States. Palaeanodonts appeared in the North American Paleocene epoch about 60,000,000 years ago and died out about 20,000,000 years later, during the Oligocene; their remains have been found in the Bridger formation of Wyoming and the Bad Lands of South Dakota. Ground sloths spread from South America into North America and the Antilles about 10,000,000 years ago and reached Pennsylvania on the east and southern California on the west.

The name Edentata, meaning toothless, is misleading. Only true anteaters are actually toothless. All other edentates lack the first two or three front teeth, or incisors, of each jaw; otherwise they are provided with a series of simple degenerate cheek teeth covered with little if any enamel. In tree sloths the foremost tooth of the series on each side of the upper and lower jaws is a canine-like tusk, but in ground sloths the tusk may be present or absent. Palaeanodonts had similar tusks.

Zoologists of the late 18th and 19th centuries included the African aardvark and old world pangolins (scaly anteaters) in the Edentata. There is no evidence, however, that either group descended from the original edentate stock that gave rise to new-world forms. The resemblances between pangolins and edentates are the result of similarities in their diets. Even the scales of the armature of pangolins are quite different from those of armadillos. In pangolins the scales are overlapping, erectile and formed of cemented hairs. In armadillos the individual scales are rigid bony structures. The aardvark had been associated with new-world anteaters because of its feeding habits, long snout, extremely long tongue and degenerate dentition. But these characters alone prove no relationship. Pangolins are now placed in the order Pholidota, and the aardvark is in an order by itself, the Tubulidentata.

EARLIEST EDENTATES (PALAEANODONTA)

The suborder Palaeanodonta comprises the oldest and structurally the most primitive of known edentates. Their history extends from the Upper Paleocene to the Middle Oligocene (roughly, from 60,000,000 to 35,000,000 years ago). The known distribution is wholly North American, but the ancestral form may have come from Asia. A distinct branch of the old stock must already have entered South America during the earliest Paleocene and have given rise to the Xenarthra (true anteaters, sloths, etc.). Although armadillolike in form and possibly in habits, palaeanodonts differ from all other edentates in having a normal (nomarthrous) type of articulation between the vertebrae of the posterior dorsal and lumbar regions.

The genus *Palaeanodon* of the Lower Eocene and Upper Paleocene has a reduced number of armadillolike cylindrical teeth; a partially ossified auditory bulla; a small, simple brain; slender limbs not greatly modified for digging; and, judged by the uncomplicated vertebrae, no hardened shield (carapace) or bony dermal plates (scutes). *Palaeanodon* may well have been ancestral to *Metacheiromys,* which lived about 50,000,000 years ago, during the Eocene.

Metacheiromys was about 18-in. long, including the tail, or about the size and proportion of a half-grown nine-banded armadillo (see *Dasypodidae,* below). The limbs were short, the front ones having been armed with strong claws. The high processes of the dorsal and lumbar vertebrae may have served as support for a carapace. Such a covering, if present, might have been horny rather than bony because scutes have never been found with the remains of palaeanodonts. The teeth of *Metacheiromys* were reduced in number and, except for the tusklike canines, vestigial and nonfunctional.

SLOTHS, ANTEATERS AND ARMADILLOS (XENARTHRA)

General Features

The fundamental character of the suborder Xenarthra is the presence of one, two or three pairs of supplementary articular facets on the front and on the back part of each lower dorsal and lumbar vertebra. This condition is called xenarthrous ("strange jointed"), hence the subordinal name. In all other mammals, including palaeanodonts, each vertebra has the usual single pair of articular facets (the prezygapophyses) in front and a single pair (the postzygapophyses) in back. In the three-toed sloths the supplementary facets are poorly defined and do not articulate with the corresponding elements of the adjacent vertebrae. In

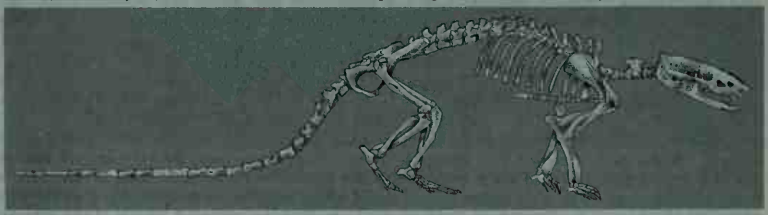

FIG. 1.—METACHEIROMYS, FOSSIL SKELETON OF AN ANCESTRAL EDENTATE OF THE SUBORDER PALAEANODONTA
Restored parts of skeleton are in outline, hypothetical parts are dotted

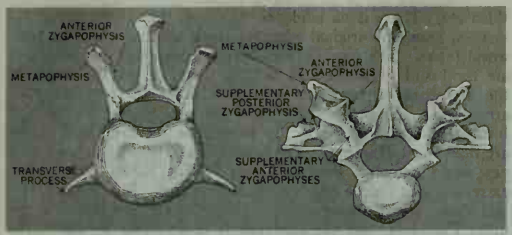

FIG. 2.—COMPARISON OF FIRST LUMBAR VERTEBRAE IN LION AND GREAT ANTEATER

(Left) Nomarthrous vertebra of a lion, with one pair of anterior zygapophyses that articulate with the posterior pair of zygapophyses of the adjacent vertebra; (right) xenarthrous vertebra of a great anteater, with supplementary pairs of anterior zygapophyses that articulate with the corresponding supplementary posterior zygapophyses of the adjacent vertebra. Figures are front views

two-toed sloths supplementary articular facets are vestigial or absent. In all Xenarthra the sacrum is attached to the hipbones at two points instead of one as in other mammals. Still another complication of the vertebral column is the presence of six cervical vertebrae in the two-toed sloth (incidentally, the same number as in the manatee) and eight to ten cervical vertebrae in the three-toed sloth. In all other mammals the normal number of cervical vertebrae is seven.

The body may be clothed with hair, or the greater part may be covered with a body armour. The forefeet are provided with strong claws adapted for digging, climbing or hanging. The tail, which may be short or long, is either covered with hair or scales or nearly naked; it is prehensile in the two smaller species of anteaters. The skull is globular in sloths, elongate in armadillos and almost tubular in the greater anteater; the interparietal bone is absent, and the tympanic bone annular and either partly free or completely fused with other elements in a well-developed auditory bulla. An entepicondylar foramen, or opening, is present in the humerus, and the third trochanter is absent in the femur. The placenta is deciduate, the uterus simple and the testes abdominal. Generally one young is produced at a birth, but in some armadillos the single fertilized egg secondarily develops into more than one embryo. The young are well developed at birth.

Hairy Edentates: Sloths and Anteaters

The infraorder Pilosa, or hairy edentates, comprises the ground sloths, tree sloths and anteaters, all South American in origin. Appearing about 40,000,000 years ago, during the Eocene, ground sloths were the dominant mammals from the Middle Eocene to the end of the Pleistocene, a span of about 25,000,000 years. Ground sloths spread into North America and the Greater Antilles about 10,000,000 years ago and persisted in forested areas until the very beginnings of the Recent epoch. Although ground sloths combine the characteristics of anteaters and true sloths, they have several features peculiar to themselves. All three groups were evidently derived from a common ancestor. Anteaters, as mentioned earlier, lack teeth. The dental formula for each upper and lower jaw in tree sloths is: incisors $\frac{0}{0}$, canines (caniniforms) $\frac{1}{1}$ premolars (molariforms) $\frac{4}{4}$; for ground sloths; I $\frac{0}{0}$, C $\frac{0}{0}$ or $\frac{1}{1}$, M $\frac{4}{4}$.

Megalonychidae.—The family of extinct ground sloths typified by *Megalonyx* originated in Patagonia about 40,000,000 years ago, but the genus in North America is known only from the Pleistocene. *Megalonyx* was about the size of an ox. Its head and teeth were similar to those of tree sloths but the lower jaw projected as a spout. The smaller *Nothrotherium* was common to the Pleistocene of North and South America and persisted into the Recent in southwestern United States. As in *Megalonyx* the structure of the pelvis, hind feet and tail indicates that *Nothrotherium* was capable of standing on its hind legs while browsing on trees. *Hapalops*, a more primitive ground sloth, was about the size of a large dog; it appeared about 25,000,000 years ago in the Patagonian Miocene. The West Indian ground sloths, which lived during the Pleistocene, may have been exterminated by early man. Ground sloths walked with the forefoot resting on the knuckles of the three middle digits, quite the same way as does the present-day giant anteater, *Myrmecophaga tridactyla*.

Megatheriidae.—The family of extinct ground sloths typified by *Megatherium* includes the largest and most massive of edentates. The genus, known from the Upper Pliocene and the Pleistocene of Argentina, was the first of the ground sloth group to be discovered. One species, *M. americana*, was larger than a modern elephant, and the hind limbs were of extraordinary bulk. The "hand" had four functional digits and a vestigial thumb. The three middle toes bore long sharp claws that may have been partly retractile. The hind foot had three functional digits, the middle one of which bore an enormous claw. *Megatherium* walked on the knuckles and the outside edge of his front feet and on the turned-in sides of its hind feet. As in the Megalonychidae, *Megatherium* assumed an erect posture when feeding on leaves and twigs of tall trees.

Mylodontidae.—Ground sloths typified by *Mylodon* were intermediate in size between megatheres and megalonids. They predominated in the Pliocene and Pleistocene of South America and were common in the Pleistocene of North America. The skull of *Mylodon* was short and broad without a sagittal crest, the orbit widely open behind, the muzzle broad and truncate and the lower jaw with lower border straight and without spout. A related genus, *Neomylodon*, which survived in Patagonia until the Recent epoch, had an internal layer of bony scales in the skin. The remains of the animal—consisting of the skull; large pieces of hide covered with coarse, yellow hair; and some dung—may have been but a few centuries old.

Myrmecophagidae.—Anteaters range throughout most of tropical America from northern Argentina to Guatemala and British Honduras. The head is prolonged into a tubular muzzle through the small gape of which extends the long, slender, worm-like tongue.

The giant anteater, *Myrmecophaga tridactyla*, is the largest of living edentates. It stands about two feet high and is about four feet long from the tip of the snout to the base of its bushy tail.

FIG. 3.—SKULL OF THE GREAT ANTEATER (MYRMECOPHAGA TRIDACTYLA)

The jugal and lower jaw bones, which serve for attachment of chewing muscles, are degenerate in anteaters

The tail itself adds about two feet more to the over-all length. Each hind foot has four or five toes; each forefoot has a strongly developed middle digit, the remaining digits being greatly reduced or vestigial. The claws of the front foot are hooked backward and serve the animal for ripping into ant and termite nests as well as for climbing and fighting. The enormously developed salivary glands of anteaters secrete the sticky substance that coats the tongue and traps the insects. The single young produced at a birth is carried for a time on the mother's back. The giant anteater walks clumsily on the soles and in-turned claws of its front feet. Though chiefly terrestrial, it can climb trees when necessary.

The lesser anteater, or tamandua, *Tamandua tetradactyla*, is about two feet long; the tail is nearly as long, sparsely haired and prehensile. The tamandua is mainly arboreal but frequently forages for ants on the ground. The two-toed or tiny silky anteater, *Cyclopes didactylus*, is about ten inches long, has a long, prehensile tail and is strictly arboreal.

Bradypodidae.—Tree sloths are the slowest moving and most arboreal of mammals. They inhabit the forested parts of tropical America from northern Argentina to Nicaragua. Although of undoubtedly very ancient lineage, tree sloths are unknown as fossils. The head is relatively small, short and rounded, and the eyes are placed low on the face. The tail may be either short or vestigial. Each of the extraordinarily long limbs, with the front ones longer than the hind, has two or three toes bound together in

BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

FIG. 4.—RECONSTRUCTION OF A GROUP OF GIANT ANTEATERS (MYRMECOPHAGA TRIDACTYLA)

The young individual in front has ripped open a termite mound with the powerful claws of his front feet

a common integument and ending in long hooked claws. There are two mammary glands, located on the chest. A caninelike tusk is present in each jaw, the upper tusk closing in front of the lower (the reverse of the canine-tooth relationship in other mammals).

Sloths sleep during most of the day and feed on leaves, fruits and young shoots during the night. They hang back downward from the branches to which they cling with their hooked claws, or they assume a vertical position by embracing the tree trunk or upright branch with their legs. Sloths often sleep in a sitting posture, with the head hidden between the legs. The gray or drab colour of the sloth's pelage renders the animal inconspicuous during the dry season. In rainy periods, however, algae lodged on the surface of the hairs of the sloth's coat turn green and make concealment even more effective against the lush green background.

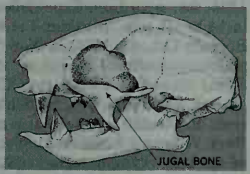

FIG. 5.—SKULL OF THE TWO-TOED SLOTH (CHOLOEPUS DIDACTYLUS)

This edentate is well provided with teeth but, unlike other mammels, its upper tusks close in front of the lower. The shape of the jugal bone in sloths is like that of extinct ground sloths and glyptodonts

The three-toed sloth (*Bradypus*) and the two-toed sloth (*Choloepus*) are the only members of the family. *Bradypus* has three toes on each front and hind foot. *Choloepus* has two toes on the front feet and three toes on the hind. *Bradypus* has 5 teeth in the upper jaw and 4 in the lower, 8–10 neck vertebrae, 14–16 thoracic vertebrae, 3–4 lumbar vertebrae and 11 tail vertebrae. The extra vertebrae in the neck permit the three-toed sloth to turn its head through three-quarters of a circle. *Bradypus* has little control over its body temperature; during a cold day its internal temperature may vary with the outside temperatures from 28° to 35° C. In extremely cold weather the body temperature of *Bradypus* may drop to as low as 20° C. and the animal becomes torpid. *Choloepus* has the same dental formula as *Bradypus* but has a different vertebral structure: 6–7 cervical vertebrae, 24–25 thoracic vertebrae, 3–4 lumbar vertebrae, 7–8 sacral vertebrae and 4–6 tail vertebrae.

The Indian names for *Bradypus* and *Choloepus*, *ai* and *unau*, respectively, are sometimes commonly used in other languages as well. Both animals are generally called *preguiça* in Brazil and *perezoso* (literally "lazy one") in other Latin-American countries.

Armoured Edentates

The infraorder Cingulata, or armoured edentates, contains the armadillos and glyptodonts, all of South American origin.

Dasypodidae.—All extant armadillos are characterized by shields of bony (ossified) dermal scutes which cover the head, back and sides of body and often the tail. The individual scutes are covered by a layer of horny epidermis.

Dasypodinae.—In typical armadillos, subfamily Dasypodinae, the head covering (cephalic shield) is separated from the body covering (carapace) by skin. The basketlike carapace is divided into an immovable shoulder (scapular) shield, an immovable rump (pelvic) shield and, between these, the dorsal field, consisting of a number of movable bands. Irregular bony scutes are scattered over the exposed parts of the limbs, whereas the face and inner sides of the body and limbs are soft and more or less clothed with hair. The tail and ears are usually well developed. Each forefoot has three to five toes and powerful, curved claws adapted for digging; the hind feet are plantigrade, each having five toes terminating in nails.

As in anteaters the tongue of armadillos is long, extensile and covered with sticky saliva secreted by the large submaxillary glands. Two or four cervical vertebrae are fused to form the mesocervical bone. With the exception of *Dasypus*, all existing armadillos have but a single set of functional teeth. In *Dasypus* all but the last of the nine permanent teeth have a two-rooted milk predecessor that remains in use until the animal is nearly full grown.

Armadillos escape from enemies by swift running or by burrowing with astonishing rapidity into the ground. They are omnivorous, feeding on insects, worms, roots, fruits, small vertebrates and carrion. Armadillo flesh is esteemed by the native hunters, and the carapace is sometimes used for making decorative baskets.

The nine-banded armadillo, *Dasypus novemcinctus*, is the best known and most widely distributed living member of the family. It has a continuous range from northern Argentina to Kansas and Florida and from sea level to 10,000 ft. high in the Andes. Though not so adept at burrowing as most other armadillos, *Dasypus* can nevertheless dig itself out of sight in hard ground in about two minutes.

The apar (apara), or three-banded armadillo, *Tolypeutes*, has rounded shoulder and pelvic shields and from two to four movable bands between the shields. This arrangement permits the animal to roll itself into a ball, with its armoured head and tail fitting snugly against each other. It lives in northern Argentina, Paraguay, eastern Bolivia and eastern Brazil.

Priodontes, the giant armadillo, measures about 3 feet in total length, the tail occupying about 20 in. It also has 11 to 13 movable bands and bears an extremely large middle claw on each front foot. From 20 to 25 teeth may be found in each upper and lower jaw. The giant armadillo is confined to South America east of the Andes, from the Caribbean coast to Argentina.

Cabassous, the large so-called eleven-banded armadillo, has 11 to 13 movable bands, a soft tail and powerful claws on its forefeet. It ranges from Argentina into Central America.

BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

FIG. 6.—(LEFT) GROUND SLOTHS (MEGATHERIUM) AND (RIGHT) GLYPTODONTS (DOEDICURUS) OF THE PAMPEAN FORMATION IN ARGENTINA, ABOUT 500,000 YEARS AGO

The ground sloths were leaf eaters the size of elephants. The armadillolike glyptodonts, also plant eaters, used their spiked tails for protection against predators. Restoration from fossil skeletons by Charles R. Knight

Euphractus, Chaetophractus and *Zaedyus* are armadillos characterized by long abundant hairs projecting between the movable bands. *Euphractus*, the six-banded armadillo, is 20 in. long from snout to base of tail; *Chaetophractus*, the hairy armadillo, is 13 in. long; and the *pichi, Zaedyus*, is only 10 in. long. All three genera are found in South America east of the Andes and south of the Amazon.

Chlamyphorinae.—The Chlamyphorinae is the second subfamily of living armadillos. It differs from the Dasypodinae by having less completely ossified scutes; continuity between the shields of the head and back; the carapace of the back completely movable; the pelvic shield vertical to the long axis of the body and entirely separated from the dorsal carapace; the remainder of body clothed with long silky white hair. One species, the lesser *pichiciego, Chlamyphorus truncatus*, is about five inches long, with its dorsal shield attached along the mid-line of the back. Another species, the greater *pichiciego, Burmeisteria retusa*, has the entire dorsal shield attached to the skin of the back. These armadillos, natives of eastern Bolivia and northern Argentina, are the smallest and the most capable burrowing members of the family.

Fossil Armadillos.—Armadillos first appeared in southern Argentina about 55,000,000 years ago, during the Paleocene. Only a few fossil dermal scutes represent these animals. *Utaetus buccatus*, one of the best preserved of fossil armadillos, lived in the same region but about 5,000,000 years later. It combines the basic xenarthran and armadillo characters with a close resemblance to palaeanodonts. *Utaetus* may well be regarded as a descendant of palaeanodonts and nearly or actually ancestral to modern armadillos.

Stegotherium was a highly evolved armadillo that appeared later, during the Miocene. The reduction of its teeth to virtual obsolescence, together with extreme elongation of the muzzle, surpasses anything found in modern armadillos.

Another highly specialized armadillo is the Pleistocene *Chlamytherium*, which was equal in bulk to a rhinoceros. This genus was the culmination of a line of herbivorous armadillos that began with *Proeutatus*, during the Miocene.

Peltephilidae.—The Patagonian horned armadillos appeared about 30,000,000 years ago, during the Upper Oligocene, and disappeared a few million years later, in the Lower Miocene. The most conspicuous character of this family, typified by the genus *Peltephilus*, is the pair of high, cone-shaped horn cores located on the nasal and maxillary bones. *Peltephilus* differed in many respects from true armadillos. The pattern of its head shield is unique: its muzzle was short and broad; the teeth were arranged in a continuous series, with one incisor on each side of the mid-line of each of the two jaws; and the middle digit of each of the hind feet had a hooflike claw.

Glyptodontidae.—Glyptodonts, or turtle armadillos, are among the most bizarre of all mammals. Most glyptodonts are characterized by large size, the largest being about 14 ft. long and over 15 ft. high; the solid, immovable single carapace; the usually present ventral shield, or plastron; the retractability of the head into the body armour; and the complete fusion of the dorsal, lumbar and sacral vertebrae into a solid tube. Glyptodonts appeared in the South American Eocene about 40,000,000 years ago and spread into North America during the Pliocene and Pleistocene.

Early glyptodonts were rather small and not too different from their ancestors. The greatest diversification, particularly of the tail, took place during the late Pliocene and Pleistocene. In *Glyptodon* the tail had about ten heavy rings of dermal plates, the edges of which bristled with long, pointed projections. In *Doedicurus* the basal half of the tail was covered with six overlapping rings; the terminal portion of the tail was smooth and the tip thickened into a huge club-shaped mass studded with long sharp horns.

CLASSIFICATION

The order Edentata, with old-world forms excluded, is a natural assemblage. The principal subdivisions, to the family level, are arranged as follows (extinct groups are prefaced with an asterisk):

*Suborder Palaeanodonta
  *Fam. Metacheiromyidae
  *Fam. Epoicotheriidae
Suborder Xenarthra
  Infraorder Pilosa, hairy edentates
    *Superfam. Megalonychoidea, ground sloths
      *Fam. Megalonychidae
      *Fam. Megatheriidae
      *Fam. Mylodontidae
    Superfam. Myrmecophagoidea, true anteaters
      Fam. Myrmecophagidae
    Superfam. Bradypodoidea, tree sloths, sloths
      Fam. Bradypodidae
  Infraorder Cingulata, armoured edentates
    Superfam. Dasypodoidea, armadillos
      Fam. Dasypodidae
      *Fam. Peltephilidae
    *Superfam. Glyptodontoidea, glyptodonts
      *Fam. Glyptodontidae

See also ANTEATER; ARMADILLO; MAMMAL; SLOTH.

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(PH. H.)

EDERLE, GERTRUDE CAROLINE (1906–), first woman to swim the English channel, was only 19 when on Aug. 6, 1926, she swam from Cape Gris-nez to Dover, a distance of 35 mi., in 14 hr. 31 min., breaking the world record by 1 hr. and 59 min. Born on Oct. 23, 1906, in New York city, "Trudy" won her first major international race at 14. She was a leading exponent of the 8 beat crawl (*see* SWIMMING: *Crawl Stroke*). In the early 1920s she set world and U.S. women's free style records for distances from 100 to 880 yd. and was a member of the championship New York Women's Swimming association free style relay teams and of the U.S. Olympic team in 1924, becoming a professional in the 1925–26 season. After her channel triumph she became a swimming instructor and fashion adviser. (J. D. McC.)

EDESSA, the chief city of the *nomos* (department) of Pella in Greek Macedonia, is the seat of the metropolitan bishop of Edessa and Pella. Pop. (1961) 15,534. The town is located 111 km. (69 mi.) W.N.W. of Salonika by railway and is on the main road from Salonika to Bitola, Yugos. It stands on a rocky height above the valley of the Loudhias river. The proliferation of its orchards and vineyards caused Edessa to be called in antiquity the "Garden of Midas," and the abundance of running water and streams, which pour down the rocks into the plain in a cascade on the eastern side of the town, gave it its medieval name of Vodena (Slav. *voda*, "water"). Rugs and carpets are manufactured there.

Under the name of Aegae, Edessa was the original capital of ancient Macedonia and remained the cult centre of the Macedonian kings even after the capital was moved to Pella at the end of the 5th century B.C. Philip II was assassinated there in 336 B.C. In Roman times it was one of the stages on the Via Egnatia. Later its possession was disputed between the Bulgarians and the Byzantines and, in the 13th century, between the rival Byzantine kingdoms of Thessalonica and Nicaea. In the 14th century it fell to the Serbians, but was recovered by John VI Cantacuzenus in 1349 before being conquered by the Turks. It passed into the kingdom of Greece in Oct. 1912, was occupied by German troops during World War II and was the scene of fighting during the subsequent civil war. (D. M. N.)

EDESSA, an ancient city on the northern fringe of the Syrian plateau, the site of which is now occupied by the town of Urfa in the Urfa *il* of Turkey. Its modern name is derived from its early Aramaic title, Urhai, which was officially replaced by the appellation of Edessa when it was refounded, probably early in the 3rd century B.C., by Seleucus I. Traditions of its earliest foundation refer to the legendary king Nimrod, and Muslim legend

BY COURTESY OF THE CONSULATE GENERAL OF TURKEY

MOSQUE OF IBRAHIM AL-KHALIL AND THE POOL OF SACRED FISH, EDESSA (URFA), TURKEY

associates the place with Abraham, whose birthplace is still shown there, in a cave under the citadel. It is certain that the city was a centre of the cult of the Syrian goddess Atergatis in pre-Seleucid times, for a pool of sacred carp of the kind associated with her worship is still to be seen there, and the fish are even now regarded as sacrosanct.

Remains.—The main remains of the ancient city are the castle, which stands on a steep bluff to the west of the site; the Romanesque tower in the precincts of the medieval mosque of Ibrahim al-Khalil; parts of the city walls, especially on the south side; and the dam and rock-cutting of Justinian.

The castle provides a commanding view of the modern city. Its medieval walls are still substantially intact, and rise sheer from steep hill slopes on the east side. On the west they are defended by an immense ditch cut from the solid rock. Two Corinthian columns that stand within the citadel are conspicuous from most parts of the city. They were associated in popular tradition with the cult of the Dioscuri, and according to Muslim legend they formed the arms of a catapult from which the tyrant Nimrod projected the prophet Abraham.

In the hillsides beyond the citadel are numerous grottoes, often with ornamental entrances, which penetrate deep into the rock, and are sometimes furnished with cisterns. In one cave is a fine mosaic of the 2nd or 3rd century A.D.

The handsome square tower set among trees in the confines of the mosque of Abraham, by the pool of sacred fish, just under the shadow of the citadel, is probably a relic from the crusader occupation. The city walls are in a decrepit condition, though there is a fairly continuous stretch and one quite complete gate on the south and southwest sides.

The most striking remains of ancient Edessa, however, are those of the flood-prevention works of the emperor Justinian. Edessa, like its modern successor, was watered by a stream, the ancient Scirtus (modern Daisan), which rises in a deep pool, under a rock with an Armenian inscription, about 4 mi. N. of the city. It was probably from this watercourse that Edessa received its alternative name of Antiocheia-Callirrhoes ("beautiful-flowing"). This stream, though normally of modest scale, is liable to sudden flooding, and it was responsible for several devastations of the place before Justinian undertook its control in the 6th century A.D. He constructed a low dam across its course, just before it enters the city, and, from there, an impressive channel, about 100 ft. deep, round the east side of the site, which was used to lead away the surplus water in time of flood.

To the south of Edessa stretches the wide valley of the river Belikh. This river rises in the springs of Ras al-Ain al-Arus about 30 mi. below Edessa, but doubtless before the city of Edessa drew off the waters of the Scirtus this stream formed a headwater of the Belikh and supplied the ancient city of Harran, the decline of which seems to have begun with the foundation of Edessa upstream.

History.—Edessa was called after the Macedonian city of the same name, whence according to tradition its first colonists arrived. It remained, however, incompletely Hellenized, and the principality of Osroene (*q.v.*), of which it was capital, was one of the main strongholds of Syriac culture in Roman imperial times. Lying on the main military highway from northern Mesopotamia to the Mediterranean, Edessa was continually involved in the conflicts between Parthia and Rome. Its deliverance from the siege by Khosrau I Anushirvan in A.D. 543 was attributed to its possession of a veronica of Christ, which henceforth became regarded as the palladium of the city. It fell, however, to Khosrau II in 608, and later in that century to the Arabs.

In 1098 Baldwin detached himself from the main body of the first crusade to capture the city of Edessa and founded a countship, which throve there until the place was recaptured in 1144, after a siege of 25 days, by the Muslims. This crusader principality held only local sway, its influence extending as far as Samsat and Seruj. But the discovery of a fine Norman arch built in a chamber of the Saracen castle of Harran has shown that this city, too, was held at this period by the crusaders. Edessa was captured by the Turks in 1637. For later history *see* URFA.

(WM. C. B.)

Edessene Christianity.—Christians in this small city-state saw three events never seen before: a king baptized, a church building erected and the Greek New Testament translated into another language. Eusebius in his ecclesiastical history records correspondence between King Abgar and Jesus. Abgar (*q.v.*) asked Jesus to come and heal him, adding, "I have heard that the Jews murmur against you and wish to harm you. The city I have is very small and stately. It would do for us both." Jesus replied sending his blessing. Eusebius adds that after the ascension "Judas Thomas sent Thaddaeus (Addai), one of the seventy," who healed the king and preached to all his people. This legend is an antedating and romanticizing of a real event. Christianity reached Edessa *c.* A.D. 150 and the missionary may have been called Addai. By 190 the Easter controversy reveals several bishoprics in the region. The king may have been baptized about this time. A cross appears on the headdress of Abgar VIII in coins issued within the period 180–192. The church building is mentioned in the 6th-century *Edessene Chronicle* as destroyed by flood in A.D. 201. The translation of the Greek New Testament was into Syriac, Edessa being the home of Syriac literature (*see* SYRIAC LITERATURE).

Tatian was born in Edessa in the 2nd century, as was Bardesanes (*q.v.*). Bardesanes was later considered a Gnostic heretic, but the reason for his unorthodoxy might be the fact that his was the first native expression of Edessene Christianity. Another product of Edessa at about this time (with a Gnostic taint) was the Syriac *Acts of Judas Thomas*, an imaginative account of St. Thomas' mission to India. It contains the "Hymn of the Soul," considered the gem of Syriac literature, and ends with the apostle's martyrdom and the bringing back of his bones. Edessa from *c.* 350 claimed his tomb. Ephraem Syrus (*q.v.*) lived his last ten years in Edessa.

The 4th-century *Doctrine of Addai* says that Palut was made bishop of Edessa by Serapion of Antioch (*c.* 190). This may represent an attempt to bring Edessene Christians into line with Greek. Bardesanites, however, long outnumbered "Palutians." Incorporation of Edessa into the Roman empire in A.D. 216 brought a share in persecutions. There were martyrs under Decius and Valerian in the mid-3rd century, most famous being Bishop Barsamya, and in the final persecutions (303–311), when Shamona, Guria and Habbib came to be commemorated.

Rabbula, bishop from 411 to 435, ended Edessene irregularities. He brought Bardesanites to conform, and ousted the *Diatessaron* (*q.v.*) of the heretical Tatian in favour of the Peshitta (Syriac) New Testament. The Christology of Nestorius was condemned by the Council of Ephesus (431). Ibas, head of Edessa's theological school and a leading Nestorian, succeeded Rabbula as bishop in 435, making Edessa for a time the centre of Nestorian-

ism. In 489, however, the school was closed on grounds of heresy and the Nestorians fled across the Persian frontier. The church in Persia, thus strengthened and freed from the restraints of its western connection, began to spread eastward and reached the capital of China in 635. Edessa, the real home of Syrian Christianity, had been brought to conform to the Greek west and was robbed of its share in this great missionary achievement.

See also references under "Edessa" in the Index volume.

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(J. Fr.)

EDFU (Idfu, Behdet; Egyptian Djeba, Coptic Atbo), a town in upper Egypt, 484 mi. S.S.E. of Cairo by rail. Once the capital of the second upper Egyptian nome, it lies on the west bank of the Nile. The chief god of the city of ancient times was Horus (*q.v.*) of the Winged Disk, called the Behdetite, whom the Greeks identified with Apollo, hence the classical name for the city, Apollinopolis Magna. His consort was Hathor of Dendera, whose statue during the late empire was brought to Edfu annually by boat on a ceremonial visit; Harsomtus, "Horus uniter of the Two Lands," was the child of their union and the third member of the triad of Dandarah and Edfu. The legend of the Winged Disk related the battle of Horus against the forces of evil symbolized by hippopotami and crocodiles; on certain feast days the priests of Edfu performed a symbolic harpooning ritual.

The chief monument of ancient Edfu is the great sandstone temple of Horus, 451 ft. long and 250 ft. wide. It stands on the site of an earlier temple of the Ramesside period, and there were probably yet earlier shrines of Horus on the same spot. The present building, the most perfectly preserved large Egyptian temple, was begun by Ptolemy III Euergetes I in 237 B.C. The main structure was completed by his successor, Ptolemy IV Philopator, in 212 B.C.; the portico, court, pylons and surrounding wall were added by succeeding Ptolemies. The decoration of the walls, comprising scenes in relief which form a unique collection of priestly lore and temple liturgy, was not finished until 57 B.C., in the reign of Ptolemy XII Auletes. Generations of craftsmen thus took part in the construction of this temple, yet it forms a harmonious whole, simply planned along one main axis, so that although late in date it serves as the classic example of an Egyptian temple.

Extensive mounds covering the ancient city and cemeteries of Edfu were excavated, largely between World Wars I and II, by members of the French Archaeological institute in Cairo and of the University of Warsaw. Mud-brick houses of the Greco-Roman, Coptic and Byzantine periods yielded a rich harvest of ostraka and papyri. In the necropolis west and north of the town were found mastaba-tombs of Old Kingdom officials and a number of Middle Kingdom burials.

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(M. S. Dr.)

EDGAR (Eadgar) (943 or 944–975), king of the Mercians and Northumbrians from 957 to 959, and king of the English from 959 to 975, was the son of Edmund I and Aelfgifu. The Mercians and Northumbrians rejected his elder brother Edwy in 957 and made Edgar their king. He recalled Dunstan (*q.v.*) from exile and made him bishop of Worcester and of London. When he became king of England he deposed Byrhthelm, since 958 archbishop of Canterbury, and intruded Dunstan in his place. Edgar was a keen supporter of the monastic revival, insisting on the return of many estates alienated from monasteries and granting to them some lands which should not have been alienated from royal possession. With his concurrence, secular priests were driven from several houses. He placed as bishop of Winchester the most violent of the reformers, Aethelwold, who refounded the fenland abbeys of Ely, Peterborough and Thorney, while Oswald, bishop of Worcester and archbishop of York, gradually replaced priests by monks at Worcester and founded the abbey of Ramsey. Edgar instigated the composition of the *Regularis concordia*, to ensure uniformity of observance in monasteries. His laws are the first to mention penalties for nonpayment of tithe and Peter's pence.

Monastic writers believed that Edgar's support of the monasteries won him divine favour and accounted for the peace of his reign. He maintained friendly relations with Scotland, ceding Lothian to King Kenneth II, and he received the allegiance of Welsh rulers. He allowed the Danish areas of England to preserve their laws, and won their loyalty. He was anxious for the proper administration of justice, and the reorganization of the hundred, borough and shire courts was completed in his reign. He encouraged trade and instituted an important reform of the coinage. He received embassies from foreign rulers, including the emperor Otto I. He left a reputation for efficient rule.

Edgar delayed his coronation until 973, when he was in his 30th year, probably because he saw a parallel between the royal and priestly offices and wished to be anointed at the age when priests were normally ordained. His splendid coronation at Bath was followed by a spectacular act of homage by foreign rulers of Britain at Chester. In the many panegyrics on him, there is only one criticism, in an 11th-century addition to the Anglo-Saxon Chronicle, that he favoured heathen customs and enticed foreigners to England. He died on July 8, 975, leaving two sons, Edward the Martyr and Aethelred (afterward Aethelred II), and an illegitimate daughter, Edith, who became abbess of Wilton and was venerated as a saint. Edgar's death was the signal for a reaction against his ecclesiastical policy.

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(D. Wk.)

EDGAR (*c.* 1075–1107), king of the Scots from 1097 to 1107, was probably the second son of Malcolm III and St. Margaret. He was given "the kingdom of *Scotia* and the land of Lothian" by William II of England in 1094 or 1095. As vassal to William he seized the kingdom from Donaldbane in 1097. He conferred on Durham cathedral extensive lands in Berwickshire, which were later the endowments of Coldingham priory, a cell of Durham. He revived the Benedictine priory of Dunfermline, but the see of St. Andrews was probably vacant throughout his reign. He ceded the Western Isles to the king of Norway in 1098. Edgar died unmarried at Edinburgh on Jan. 8, 1107.

(A. A. M. D.)

EDGAR (Eadgar), the Aetheling (d. *c.* 1125), English prince, was the son of Edward, a son of Edmund II Ironside, and Agatha, a kinswoman of the emperor Henry II. After the battle of Hastings, Aldred, archbishop of York, and the earls Edwin and Morcar wished to make him king, but he and his supporters submitted at Berkhamsted to William I, who took him to Normandy in 1067. He fled to Scotland in 1068, where his sister Margaret married King Malcolm III. By 1069 rebellions in his favour were crushed. When William and Malcolm made an agreement in 1072, he took refuge in Flanders. He returned to Scotland and in 1074 he was shipwrecked when on his way to France at the invitation of King Philip I, and sought William's protection. He led an expedition to Apulia in 1086. Deprived of his Norman lands in 1091, he went to Scotland, where he acted as intermediary between Malcolm (d. 1093) and William II, who sent him in 1097 to put Malcolm's son Edgar on the throne. He won honour on a crusade, probably in 1102. He was taken prisoner at the battle of Tinchebrai in Sept. 1106, fighting for Duke Robert of Normandy against King Henry I, but was released, and lived in obscurity until his death in about 1125.

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(D. Wk.)

EDGEWORTH, MARIA (1767–1849), Anglo-Irish novelist, is chiefly known for her children's stories and for her portrayal of Irish life and the general stimulus this gave to the handling of national and regional characteristics in fiction. She was born at the home of her maternal grandparents at Blackbourton, Oxford-

shire, on Jan. 1, 1767, the second child and eldest daughter of Richard Lovell Edgeworth (*q.v.*) and his first wife, Anna Maria Elers. Until she was 15 she lived and was educated in England but in 1782 the family went home to Edgeworthstown, about 60 mi. N.W. of Dublin, and there Maria acted as her father's chief assistant in the management of the estate. In this way she gained knowledge of the difficulties and triumphs of ordinary life, and of Irish peasant life in particular, that was to be the backbone of her novels. The Edgeworths had a wide acquaintance among the gentry; one of Maria's friends was Lord Longford's daughter, "Kitty" Pakenham, who subsequently became duchess of Wellington. Domestic life at Edgeworthstown was busy and happy. Maria helped to educate her young half-brothers and sisters who provided an eager audience for the stories she readily invented. In 1786 these stories were published as *The Parent's Assistant*. They moralize but are lively. The children who appear in them are the first living and breathing children in English literature since Shakespeare. Frequent appearances are made by the impetuous and delightful Rosamond, most memorably in *The Purple Jar*.

Maria's first publication, however, came out in the previous year. *Letters for Literary Ladies* (1795) is a somewhat tepid plea for reform in women's education, expressing views which were largely those of her father. Mr. Edgeworth's influence over Maria's work was enormous. It took the form of encouragement, collaboration, the providing of plots for novels and the inserting of lengthy passages. This influence is usually deplored. But for Mr. Edgeworth, it was argued, Maria's writing would have been free from the moralizing which undoubtedly mars it. Maria herself thought that but for her father she would never have written at all. There is no doubt that she loved him uncritically and adopted his utilitarian precepts on life and literature without question.

Castle Rackrent (1800) was Maria's first novel and, as it happens, Mr. Edgeworth had no hand in it. Thady, the steward, stands before us in his long greatcoat to tell the story of the estate and its owners, the Rackrents, who came to ruin. This short narrative was an immediate success. It is free from moralizing and since it launched her into the writing of her Irish stories may be counted among the most influential works of fiction written between the death of Tobias Smollett and the publication of *Waverley*. In his postscript to the original edition of *Waverley*, Scott described his aim as being "in some distant degree to emulate the admirable Irish portraits drawn by Miss Edgeworth." *Belinda* (1801) is a society novel particularly admired by Jane Austen whose heroines may owe something of their naturalness to Belinda, the type of sensible young lady that Mr. Edgeworth himself believed the right education would inevitably produce. *The Essay on Irish Bulls* (1802) is the happiest result of Maria's collaboration with her father as *Belinda* was the most unfortunate. He robbed the latter of greatness by urging a happy ending. In the same year (1801) appeared *Early Lessons* and *Moral Tales for Young People* which were expressly designed, after a theory of Mr. Edgeworth's, for the younger members of the upper classes. *Popular Tales* (1804) made a bid to corner the youth of less elegant society.

The peace of Amiens (1802) made it possible for the Edgeworths to visit first Brussels and then Paris where they were admitted to literary and scientific circles and Maria received an offer of marriage from M. Edelcrantz, a Swedish gentleman "of superior understanding and mild manners," which she refused. She never married. *Leonora* (1806) was reputedly written to please Edelcrantz but she never knew whether he read it. *The Modern Griselda* appeared in 1805. *Tales of Fashionable Life* were issued in six volumes, the first three in 1809 and the second three in 1812. The moral earnestness that lies behind them would have crippled a lesser writer but Maria's exuberance and inventiveness repeatedly rescue her from the most unpromising situations. The *Tales* were popular and for the first time she began drawing big royalties. The best of these novels is *The Absentee* which appeared in the second series. It sprang from a great contemporary abuse—that Irish landowners lived in London while their agents extracted from the peasantry rents that would eventually be thrown away in gaming—and together with *Castle Rackrent* is generally reckoned to be Maria's most enduring work. In 1813 Maria and the family spent some time in London where she enjoyed considerable social success and made a favourable impression on, among others, Byron. Before her father's death in 1817 she was to publish three more novels, two of them, *Patronage* (1814) and *Ormond* (1817), being of considerable power.

After 1817 she wrote less. She completed her father's *Memoirs* (1820) and, from 1826, largely ran the estate. For some years now she had enjoyed a European reputation and when she visited Paris in 1820 she received a particularly warm welcome. The great experience of her later years was Scott. She had at once recognized the authorship of *Waverley* when it was published anonymously in 1814 and their relations were always cordial. They exchanged visits. Her only considerable work after 1817 was *Helen* (1834), a distinguished novel in which Lady Davenant represents one of the first attempts to put a female politician into fiction.

The Irish famine clouded her last years and she worked strenuously for the relief of the stricken peasants. She died at Edgeworthstown on May 22, 1849.

Her literary reputation has suffered in the inevitable comparison with Jane Austen but her achievement was nevertheless considerable. In spite of the tedious moralizing much of her writing is as fresh as paint. Her humorous and well-balanced young women, her realistic children, her dignified and shrewd peasantry and her scenes of regional life were all new things in fiction and where she had shown the way others followed.

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EDGEWORTH, RICHARD LOVELL (1744–1817), made contributions to the theory of pedagogy and was the dominant influence on the writings of his daughter, Maria Edgeworth (*q.v.*). He was born at Bath on May 31, 1744, and was educated at Trinity college, Dublin, and Corpus Christi college, Oxford. While still at college he married Anna Maria Elers of Blackbourton, Oxfordshire. Scientific interests brought him the friendship of Erasmus Darwin whom he visited at Lichfield where he also met Anna Seward and her cousin, Honora Sneyd, whom he married in 1773 on the death of his wife. When Honora died in 1780, Edgeworth married her sister, Elizabeth. She died in 1797 and he married Frances Beaufort the following year. By his four wives he had 22 children.

Practical Education (1798), written in collaboration with Maria, is of value in the history of education. Inspired by Rousseau, Edgeworth argued that education should be based on an understanding of the child's mind and this could be obtained by treating the subject as an experimental science in which the conversation of children was noted down. This work had been initiated by Honora and continued by the authors after her death.

From 1782 onward Edgeworth lived on his estate at Edgeworthstown, Longford, Ireland, where he was an enterprising and enlightened landlord. In 1798, when the Defenders were roaming the countryside and the French landed an expeditionary force, he organized a troop of yeomanry. He took his family to Paris in 1802 and was received in literary and scientific circles. In 1806 he became a member of the board of commissioners to inquire into Irish education and from 1807 onward found time, in addition to his estate management, scientific experimenting and the encouraging of Maria's novel-writing, to work at his autobiography. He dictated three passages in Maria's novel *Ormond* during his last illness. He died at Edgeworthstown on June 13, 1817. His works include *Poetry explained for the Use of Young People* (1802), *Essays on Professional Education* (1809) and *Readings on Poetry* (1816).

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EDGEWORTH DE FIRMONT, HENRY ESSEX (1745–1807), last confessor to Louis XVI, was the son of Robert Edgeworth, rector of Edgeworthstown in Ireland, who emigrated to Toulouse, where the boy was brought up by the Jesuits. On taking orders he assumed the additional surname of De Firmont, from the family estate of Firmount near Edgeworthstown. In 1791 he became confessor to the princess Elizabeth, sister of Louis XVI, and then to Louis himself. After Louis's condemnation he obtained permission to celebrate Mass for him and attend him on the scaffold. The legend that at the moment of execution the *abbé* uttered the words, "Son of St. Louis, ascend to heaven," was denied by him. Edgeworth continued to correspond with Elizabeth. In 1795, his mother having meanwhile died in prison, where his sister was also confined, he escaped to England, carrying with him Elizabeth's last message to her brother, the future King Charles X. He later went with some papers to Monsieur (Louis XVIII), then at Blankenburg in Brunswick, and was induced to accompany him to Mittau, where, on May 22, 1807, he died.

EDINBURG, a city of Texas, U.S., and seat of Hidalgo county, is about 50 mi. W.N.W. of Brownsville. Originally located at the site of Hidalgo village, it was founded and named by John Young of Edinburgh, Scot. In 1908, by popular referendum, the county seat was moved to Chapin which was established in 1890 and named for D. B. Chapin. In 1911 the county commissioners' court changed the name of the county seat to Edinburg, and old Edinburg took the name of Hidalgo. The city-manager form of local government was adopted in 1946.

Edinburg, gateway to the irrigated section of the lower Rio Grande valley, is a citrus and vegetable packing-shipping centre. Other industries include a creamery, ironworks, planing mills and cotton gins. There are many oil and natural-gas fields in the vicinity, and Moore air force base is nearby. The city operates one of the nation's most scattered school districts embracing about 945 sq.mi. of grove, farm and ranch development. Pan American college, founded in 1927, is located there. For comparative population figures *see* table in TEXAS: *Population*.

(O. Mo.)

EDINBURGH, PRINCE PHILIP, DUKE OF (1921–), husband of Queen Elizabeth II of the United Kingdom of Great Britain and Northern Ireland, was born at Corfu on June 10, 1921, the youngest child and only son of Prince Andrew of Greece, who was a younger son of King George I of the Hellenes, and of Princess Alice, eldest daughter of Prince Louis of Battenberg. The monarchy in Greece was then in eclipse, and he was in consequence brought up abroad and educated in Great Britain—at Gordonstoun, under Kurt Hahn, and at the Royal Naval college, Dartmouth. He served with the Royal Navy from Jan. 1940 to the end of World War II, taking part in the sharp and victorious action at Cape Matapan (1941), the Sicily landings (1943) and the war in the Pacific. On Feb. 28, 1947, he renounced his right to the Greek throne (he was fifth in succession) and took British nationality, adopting his mother's name of Mountbatten. His engagement to Princess Elizabeth was announced on July 9, 1947, and their marriage took place in Westminster abbey on Nov. 20, 1947. On the eve of his wedding he was created a royal highness, with the titles Baron Greenwich, earl of Merioneth and duke of Edinburgh.

Soon after his marriage, the duke of Edinburgh continued his service with the Royal Navy, commanding the frigate "Magpie" in the Mediterranean in 1950–51. At the suggestion of King George VI he took the presidency of the National Playing Fields association in 1948, which brought him into contact with local affairs in all parts of the country. In 1951 he revealed the scientific and practical bent of his mind by his presidential address to the British association on the British contribution to science and technology. After the queen's accession to the throne on Feb. 6, 1952, he had to abandon his naval service to share her official and public life, accompanying her on numerous tours in Great Britain, the commonwealth and foreign countries. In the winter of 1956–57 he made an important world tour, after which the queen conferred on him the titular dignity of a prince of the United Kingdom.

Prince Philip went around the world again in 1959, rejoining the queen for their visit to Canada to open the St. Lawrence seaway on June 26. His concern with industry and national efficiency was shown by the conference on the human problems of industry which he organized at Oxford in 1956, inviting participants from both labour and management throughout the commonwealth. Prince Philip has met with some criticism from traditionalists because of his free and easy approach to the ceremonial side of his work and has had difficulties with the popular press, whose photographers annoyed him and whose owners tended to emphasize his foreign connections. However, the queen's personal decision in 1960 to link the name of Mountbatten with her dynasty was well received by public opinion, and revealed Prince Philip's widespread popularity. (R. T. B. F.)

EDINBURGH, the capital of Scotland, county of a city, royal burgh and county town of Midlothian, stands on the south side of the Firth of Forth, having its seaport at Leith, 2 mi. N.E. from the centre of the city. It is 44 mi. E.N.E. of Glasgow by road and 373 mi. N.N.W. of London, and is bounded north by the Forth, south by the Pentland hills, east by Edgebucklin brae, Musselburgh and west by the Almond river, West Lothian. Pop. (1961) 468,378. Seen from Arthur's Seat, a hill to the east, the Old town lies low in front of the castle. The "witch's hat" turrets give the Old town the impression of a medieval burgh, though most of the stone buildings are not earlier than the 16th century. Most houses in the Georgian New town north of Princes street, the main thoroughfare, are of gray Craigleith stone.

Edinburgh has long been the cultural centre of Scotland. In 1947 the annual Edinburgh international festival, comprising music, opera, ballet, drama and art exhibitions, was established. During the festival, which lasts for three weeks at the end of August and the beginning of September, a military tattoo is staged on the floodlit castle esplanade by the Scottish Command, whose headquarters are at Edinburgh.

Geology.—Quarries of limestone at Burdiehouse and of sandstone at Slateford, Hailes, Granton and Craigleith furnished many of the city's buildings. Earth movements caused upheaval of igneous rocks to form the Pentland hills (1,898 ft.), Braid hills (698 ft.), Blackford hill (400 ft.) and Salisbury crags. Volcanic eruptions produced Arthur's Seat (822 ft.) and Calton hill (355 ft.), which later, in the Great Ice Age, were smoothed by a glacier several thousand feet thick, moving from west to east to produce the crag and tail features conspicuous in the Castle rock (445 ft.) and Salisbury crags.

General Description.—From the castle, dominating the city, the Old town dips eastward down the narrow ridge of Castlehill, Lawnmarket, High street and Canongate to the abbey and palace of Holyroodhouse. From the deep valley south of the Castle rock, the ground rises steeply to Lauriston, then declines to the Meadows, and rises again to the Blackford, Braid and Pentland hills. North of the castle is the ravine where until 1816 lay the Nor' loch, now Princes Street gardens, with railway lines running east and west in the centre. Beyond them on the northern embankment the imposing Princes street has offices and shops on its northern side only. From Princes street the ground northward rises slightly to George street, then descends steeply to Canonmills and Inverleith row in stately Georgian streets, terraces and crescents. Beyond, streets and open spaces stretch to the shores of the Forth. Princes street is prolonged eastward by Waterloo place, built in 1815, and containing government offices, including St. Andrew's house (1937) opposite Calton hill, the Royal High school, and a magnificent terrace of houses high up on the left hand with the older houses of the Canongate deep in the valley on the right. Holyrood palace lies east of the Canongate beneath the majestic Salisbury crags. From the east end of Princes street a road runs south by the North bridge over the valley between Princes street and the High street of the Old town. There, at the point from which the town was first extended northward by the building of the bridge in 1764, another extension was made in 1786 by a bridge

over the valley of the Cowgate leading south to Newington, Grange, Craigmillar and Liberton. Southwest from Princes street lie Haymarket, Murrayfield, Dalry, Gorgie and Saughton; and west are Corstorphine and Turnhouse airport. Queensferry street, at Princes street, runs northwest over the Dean bridge, built by Thomas Telford in 1833, 106 ft. below which is the picturesque village of the Water of Leith, with the river flowing past toward its mouth at Port of Leith. In Queensferry road Daniel Stewart's college for boys looks across toward the fine buildings of Fettes college to the northeast. The road passes through Blackhall, Barnton and Cramond to South Queensferry and the south terminus of the Forth railway bridge, just west of which is the Forth road bridge. From the west end of Princes street, Lothian road leads south through Fountainbridge, Tollcross, Bruntsfield and Merchiston to Morningside and the foot of the Pentland hills. The "Royal Mile" is the popular name for the street that links the castle with Holyrood palace.

Open Spaces.—Public parks and gardens are in every region; the oldest, largest and most historic, Holyrood park (5 sq.mi.), contains Arthur's Seat, Salisbury crags and the lochs of St. Margaret's, Dunsapie and Duddingston. Other open spaces include Calton hill, Princes Street gardens, rich in flowers, the Saughton park, the Meadows, Bruntsfield links, Inverleith and Craigentinny. The Royal Botanic garden is at Inverleith row and the Zoological park on Corstorphine hill, a forest park of 100 ac.

(C. A. Mm.; X.)

History.—The name Edinburgh is derived from the Gaelic *Dun-eideann* ("hill fort of Eidin") and is not, as was once thought, connected with Edwin of Northumbria. Nothing is known of a settlement there during the Roman occupation, and, although there is evidence of a hill fort in the 6th century, the history of the town must be reckoned as beginning in the reign of Malcolm III (Canmore; 1058–93), who, with his queen, St. Margaret, seems to have resided occasionally on the castle rock. Certainly she died there, and the chapel dedicated to her in the castle probably dates at the latest from the early 12th century. It is thought that in the reign of David I (1124–53) the burgh rose, at a bowshot's distance from the castle walls, on the sloping ridge, bounded by streams to north and south. On the low ground farther east David founded the Augustinian abbey of Holyrood, granting it the right to erect the burgh called Canongate. Before the end of the century Edinburgh was one of the four burghs that in their court administered a special code of law for their burgesses. But the first extant charter to Edinburgh was granted as late as 1329 by Robert I the Bruce (*q.v.*), who gave to the burgesses the burgh with the port of Leith, mills, etc., for a yearly sum of 52 merks (a merk was worth 13*s.* 4*d.*). The Wars of Independence involved constant ravaging of southeast Scotland, and in 1341 Edinburgh was described in the exchequer rolls as totally devastated. There was some recovery under David II, who built a new tower in the castle and for whose ransom in 1357 the burgh pledged itself along with Perth, Dundee and Aberdeen. The town, however, was again laid waste in Richard II's invasion of 1385. Thereafter it prospered once more, though in the reign of James I (1406–37) Perth rather than Edinburgh was the chief town of the kingdom. It was in the reign of James II (1437–60), who was born and crowned at Holyrood, that Edinburgh emerged as the undoubted capital of Scotland. It was now the usual meeting place of parliament; it had a municipality of provost, bailies and council. A second street, known as the Cowgate, had been built to the south, and the earliest wall of which traces remain was begun by James II's orders, though this was superseded by another, of wider compass, after the battle of Flodden (1513). In 1482 James III rewarded the loyalty of the burgesses by granting the provost in perpetuity the office of sheriff with the appropriate jurisdiction. The years 1473–1517 saw the incorporation of ten craft guilds which throughout the 16th century strove with the merchants for control of the burgh council, until in 1583 the decree arbitral of James VI settled its composition and the method of its election for the next 250 years. The town's precedence was confirmed by the foundation of the College of Justice in 1532 and, after further destruction by the earl of Hertford's English army in 1544, by the inauguration of the General Assembly of the Church at the Reformation. For these bodies it has been the meeting place in normal times. The removal of the court to England at the union of the crowns (1603) involved some loss both of prestige and of prosperity, but in 1633 Charles I conferred on the town the dignity of a city and made St. Giles's church a cathedral. Soon afterward the town council, alarmed by his threat to move the law courts elsewhere, erected with the help of individual subscriptions the Parliament house to the south of the High street. Other buildings of the time included Heriot's hospital, for which an extension of the Flodden wall, known as Telfer's wall, was made. Beyond the ancient royalty three neighbouring burghs were acquired. In 1636 the Canongate with Broughton (including North Leith) became a burgh of barony under Edinburgh's superiority. South Leith having been acquired in 1605, the whole of Leith became a burgh of barony for Edinburgh also in 1636. The district outside the West and Bristo ports, known as Portsburgh, was added in 1649. In 1650 the town was besieged by Cromwell and was occupied after the battle of Dunbar. With the increase of mercantile prosperity after the Restoration there was much building, especially of the high tenements which are still a feature of the Old town. After a setback through the abolition of the Scottish parliament by the Union of 1707 with England, the town came near to losing its charter through the Porteous riots of 1736 (*see* Porteous, John), but it entered on its "Augustan Age" in the second half of the 18th century. This was not only the time of its eminence in art and literature, represented by such names as Allan Ramsay, Sir Henry Raeburn, Robert Adam, David Hume, Principal William Robertson and Henry Mackenzie (*qq.v.*) but of its extension south and north. To the south George square was begun in 1766 by a builder, James Brown, and some adjacent streets were added in the next few years. More important was the expansion to the north, where the New town was commenced, in accordance with an act of 1767, on the gridiron plan of James Craig (?–1795), with its main streets—George street, Queen street and Princes street—culminating in Charlotte square. Communications between the new districts and the Old town were made by the erection of the North and South bridges before 1800 and a little later by the Mound, built up, where the Nor' loch had been drained, with earth removed from the foundations of the Princes street houses. Further building followed in the 19th and the 20th centuries, sometimes well planned, as in the regions of Regent terrace and Moray place, sometimes less happily as in Dalry and Gorgie. Many new housing areas came into being after World Wars I and II.

(E. W. M. B.-M.)

The Castle.—Edinburgh owes much of its importance to its commanding position near the mouth of the Forth river. The medieval town grew upon the crest of the long massive rock which is dominated by the castle. The Castle rock has been a fortress from very early times, certainly from the 6th century A.D., but continual use of this strategic site has obliterated all material evidence of occupation before the 11th century. The principal surviving buildings have been altered to suit changing needs. They are of greater historical than architectural interest, and they date mainly from the 16th century and the reign of Mary, queen of Scots (1542–87). They are grouped as the restrictions of space have permitted and in architecture as varied as its date and purpose. The tiny chapel of St. Margaret, the queen of Malcolm III (Canmore), on the highest point of the rock, is the oldest surviving building. It dates from the 12th century but may incorporate within its walls some undefined masonry of the chapel she founded and in which she heard her dying mass in 1093. The chapel is a simple oblong, with a small nave and a semicircular chancel (square externally) entered through a Norman chancel arch. The building is complete and somewhat restored; occasional services are still held within it. During the middle ages the castle was frequently occupied by the English. Buildings erected before and during this stormy period, many of which in any case were probably of timber and clay, have almost entirely vanished.

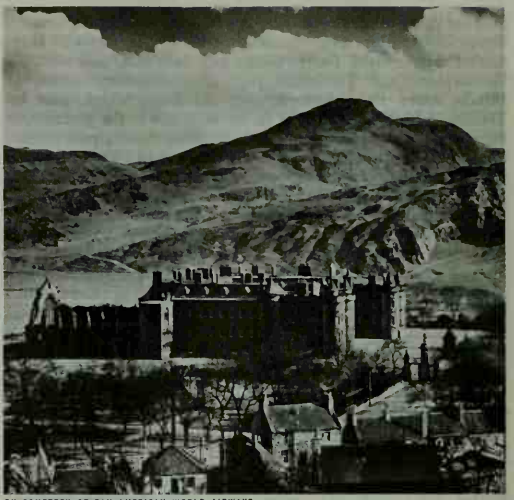
Near St. Margaret's chapel are substantial remains of an early example of the characteristic later medieval Scottish castle, the "tower-house." This example was erected in 1367–79 by David II and is known as David's tower. Its massive ruins are accessible,

although entirely engulfed by the Half-Moon battery of 1574. Outside St. Margaret's chapel is the famous bombard "Mons Meg," probably built before 1500, weighing five tons and of 19½ in. calibre, one of the most notable pieces of ordnance in Britain. Buildings are arranged in a quadrangle about Palace yard or Crown square which occupies much of the summit of the Castle rock. The range on the east is the Palace block or "king's lodging" and looks down the High street. It contains the Scottish regalia (the "Honours of Scotland") which consist of the crown, sceptre, sword of state, all of 16th-century date, and other treasures. In the same block are the apartments of Mary of Guise (Lorraine) and her daughter Mary, queen of Scots, and the small room in which James VI of Scotland (James I of Great Britain) was born in 1566. On the south side of Palace yard is an imposing early 16th-century banqueting hall. Although comprehensively restored in 1888 it presents the essential features of a great medieval hall, with hooded fireplace, minstrel's gallery and buffet hatches to the kitchens. The richly carved hammer-beam roof is original. On the north side, on the site of a 12th-century church, is the Scottish National War memorial (1927), designed by Sir Robert Lorimer. The Scottish United Services museum, with Jacobite relics, Highland weapons and uniforms, is also among the buildings of Palace yard. The descent from these buildings upon the summit of the Castle rock is by a winding road passing under the portcullis gate erected in 1574 by the regent, James Douglas, 4th earl of Morton, who built the Half-Moon battery. The exit to the spacious esplanade or parade ground in front of the castle precincts is by way of a dry ditch and other fortifications of the 18th century. At that time extensive ramparts with sentinel turrets were added, which, following the rise and fall of the precipitous rock, invest the castle with picturesque profiles.

Holyrood Abbey.—An abbey for Augustinian canons from Merton in Surrey, Eng., was founded near the castle by David I in 1128 and rebuilt in about 1220. This work, of which much remains, must be numbered among the most imaginative and successful exercises in early 13th-century composition in Britain. The west front is a particularly imposing façade, with a deeply recessed doorway originally flanked by boldly projecting towers of which only one remains. The nave incorporates substantial parts of its 12th-century predecessor and stands complete to the wallhead, but the transepts and east end have been reduced to their foundations, and of the cloistral buildings nothing remains.

The Palace of Holyroodhouse.—The destruction of much of the abbey was due to the erection of royal palaces upon the site. The earliest surviving palace, associated closely with Mary, queen of Scots, is a great square tower with a projecting round tower at each corner. It was built for James IV and was completed about 1505. Extensive additions which encroached into the abbey were made in 1671 for Charles II; these were designed on a quadrangular plan by Sir William Bruce (d. 1710), the first Scottish architect in the modern professional sense. The old palace (the northwestern tower of the present complex) contains the Historical apartments with furnishings and other features particularly associated with Mary, queen of Scots, and her times. This old tower is truly medieval, but the new palace of the Restoration period conforms to the more sophisticated style then popular. This is evident in the interiors and in the refined use of superimposed classical orders on the courtyard façades. The palace is still a royal residence, but is normally open to the public.

Buildings of the Old Town.—Between the castle and the abbey the houses of the medieval burghers rose to great heights upon the high and narrow spine of rock. They had narrow frontages facing the street and even narrower closes or vennels (gaps) between them, and long gardens falling away to the rear. Originally those buildings, or "lands" as they are called, were heavily timbered, with overhanging galleries and gables. There is little left that is earlier than the 17th century, but much of that period remains, and the more modern buildings are lofty and cliffike and preserve the ancient canyonlike aspect of this renowned thoroughfare. Opening off it are picturesque closes leading to unsuspected courtyards with towering buildings behind the main frontages. Many lands and closes retain their descriptive names, such as



BY COURTESY OF PAN AMERICAN WORLD AIRWAYS

PALACE OF HOLYROODHOUSE, EARLY 16TH–17TH CENTURIES, WITH HOLYROOD ABBEY (112B) ON THE LEFT, IN HOLYROOD PARK AT THE FOOT OF THE ROYAL MILE OF EDINBURGH

Shoemakers' land, Bible land, Playhouse close, Advocates' close, World's End close (at the city gate); and names such as Lawnmarket, Grassmarket, Cowgate and Canongate indicate the original function of these areas. In several of the late 16th- and 17th-century dwellings are painted timber ceilings, profusely decorated with foliage, biblical scenes and inscriptions and heraldic and mythical subject matter. Good examples exist in Gladstone's land and in John Knox's house.

The early town, close against the protection of the Castle rock, was further defended by a wall. Parts of the Flodden wall of the early 16th century survive; it crossed the long incline of the Royal Mile about halfway down, and the site of the eastern gatehouse, called the Netherbow port, is marked in the roadway just below Knox's house. East of this, outside the wall, lay the Canongate, between the gatehouse and the abbey, and so-called because it was the "gate," or way, of the canons between their abbey and the town and castle.

Within the medieval precincts the historic church of St. Giles' dominated the old town for *c.* 800 years. In its eventful history it has been a parish church, a collegiate church and for two short periods (1633–38, 1661–89) an Episcopal cathedral. It is in use for Protestant worship. It is notable for its magnificent lantern tower (*c.* 1500), an open spire with a high central feature supported by eight flying buttresses which impart a crownlike effect. It contains many chapels of late medieval dates, and a modern one of great distinction (opened in 1911) designed by Sir Robert Lorimer for the Order of the Thistle. Nearby is the Tron church, begun about 1637 by John Mylne (1611–67), master mason to the crown, and farther down the High street is the Trinity College chapel, founded about 1460 by Mary of Gueldres in memory of her husband James II of Scotland. Its site being threatened in 1848 by the construction of the Waverley railway station, it was taken down and partly rebuilt on its present site behind John Knox's house. It consists of the choir without the aisles, and, with an unusually lofty stone vault and much excellent carving, is one of the most accomplished examples of late medieval architecture in Scotland. Two panels of its large altarpiece in the National Gallery of Scotland, Princes street, are attributed to the Flemish painter Hugo van der Goes (*c.* 1470). In Holyrood park is a small 15th-century well with miniature stone vaulting. It was removed from the district of Restalrig nearby and rebuilt in the park in the 19th century when threatened by railway construction.

The Canongate until 1856 remained a separate burgh and the parishioners worshiped in the nave of the abbey church until this was appropriated by James VII of Scotland (James II of Great Britain) for the Order of the Thistle in 1686. Two years later a new parish church of considerable merit was designed by James Smith; it is still in use. Immediately adjacent to the old Canongate tolbooth (1591) was the civic hall and prison on the Canongate; the tolbooth is now a museum. Opposite are Huntly house (1570), Moray house (1630), with fine plaster ceilings and period details, and Acheson house (1633) in Bakehouse close, all notable buildings. Farther down the Canongate is White Horse close, a unique survival of a 17th-century coaching inn with overhanging timber gables and outside stairs, which has been converted into dwellings. At the foot of the Canongate the Royal Mile (which comprises the Lawnmarket at the top, the High street in the middle and the Canongate at the bottom) widens into an open space before the gates of Holyroodhouse. This space was the sanctuary area of the abbey in medieval times, and within it debtors and delinquents could seek refuge from civil law for a time. The 16th-century abbey sanctuary house, also called the abbey strand, stands within the sanctuary precincts. Summer exhibitions illustrating Scottish ancient monuments are held within it. Incorporated in the walls of the building opposite are the remains of the abbey gatehouse. The Greyfriars church (1614), in which the National Covenant of Scotland was signed in 1638 by men and women resolved to worship God after the established custom and not in the manner laid down by the English archbishop William Laud, has a historic churchyard with many notable tombs, including that of the Adam family of architects.

Buildings of the New Town.—By the mid-17th century the old town was overcrowded; moreover, there were no civic buildings of fitting importance for a capital city. The Royal exchange on the north side of the High street, opposite St. Giles's, was erected from the plans of the brothers John and Robert Adam in 1753; but it was not until access by bridge and road across the valley and loch north of the castle hill was begun in the 1760s that a comprehensive new town was planned for the open ground beyond the valley. The loch was drained and the valley now forms an extensive open public garden at the foot of the Castle rock, separating the Old town from the New. Thus the skyline of the medieval town, with castle, ramparts, spires and lofty houses perched upon the crest of the rock, affords a striking view across the valley from the boulevard of Princes street. Most of the New town was built between 1768 and 1850; its showpiece is Charlotte square at the west end laid out by Robert Adam in 1791. The layout is simple—in spacious squares, terraces and crescents, with wide roads serving houses of characteristic Georgian urbanity. It is seen at its sophisticated best in Charlotte square (especially the north side), Moray place and vicinity, Great King street (1820) and the monumental St. Bernard's crescent of 1828. Melville street, Queen street and Heriot row are notable examples of residential thoroughfares with buildings on a smaller and more domestic scale. The New town forms a grid whose three parallel main thoroughfares (Princes street, George street and Queen street) are regularly linked by crossroads at right angles. George street in the middle was planned as the chief axis, with large garden squares at each end, but Princes street, a terrace with open outlook to the south, is the principal promenade. At the east end of it the General Register house (1772–90), by Robert Adam, is the public record office of Scotland. St. Andrew square at the east end is distinguished by the headquarters of the Royal Bank of Scotland, originally built (1772) as a private residence by Sir William Chambers (1726–96). The New town was residential and much remains so, its Georgian buildings having characteristic railings, doorways, fireplaces, plaster ceilings and the like.

Later Buildings.—In Edinburgh the Greek and Gothic revival of the 19th century was particularly active in church and public buildings. Of Greek Revival civic architecture the Royal Scottish academy off Princes street and the adjoining Scottish National gallery by William Henry Playfair (1789–1857), the Royal High school by Thomas Hamilton (1784–1858) and the Surgeons' hall by Playfair are notable exercises in the Doric and Ionic styles. The classical style is also well represented on the summit of another of the many hills upon which Edinburgh stands (the appellation "the Modern Athens" derives from this predominance of hills and classical architecture). The City observatory (1818) on the Calton hill is by Playfair in the Roman Doric manner. The National monument nearby is correct Greek Doric, like the splendid Royal High school which it overlooks. The National monument is all that was built of a church originally intended to be an exact copy of the Parthenon and a national memorial of the Napoleonic Wars. By 1830 only 12 columns had been erected, when funds ran out.

Among many churches in the classical style are St. Andrew's, George street (1782–89); St. Mary's, Bellevue crescent (1824); St. George's, Charlotte square (1814); and St. Bernard's, Claremont street (1823). Among neo-Gothic churches St. John's at the west end of Princes street is outstanding, with a fine fan vault. It was designed in 1816 by William Burn (1789–1870), who demonstrated characteristic versatility in John Watson's school (1828), a severe but impressive Greek Doric building. St. Paul's, York place (1816), by Archibald Elliot, is late Gothic, but his Regent bridge (1815) is classical, as is Regent road itself, a remarkable example of street façade designing caused by a civic desire to dignify the formal exit from Edinburgh at the east end of Princes street. The pseudo-castellated Governor's house (1815) at the old Calton jail is also by Elliot. The old University building by Robert Adam was begun in 1789, completed in 1834 and received its dome in 1884. The noble University library in the classical style, by Playfair, is about 200 ft. long and covered with a coffered barrel-vault. Even better is the library of the Writers to the Signet, by William Stark (1813). About 140 ft. long, the building is lined with lofty Corinthian columns supporting a shallow barrel-vault, whose length is interrupted by a saucer dome. This library was ingeniously heated by hot air rising through the legs of cast-iron tables which are still in place. Adjoining is the old Parliament house (1632–39), whose hall retains its hammer beam roof. St. Mary's Episcopal cathedral in Palmerston place (1879) is by Sir George Gilbert Scott with western towers of 1917. The National Portrait Gallery and Museum of Antiquities of Scotland (1889) in Queen street is a four-storied building in the Gothic style. Niches in the façade contain statuettes of famous Scots.

Monuments.—Erected in honour of kings, queens and distinguished subjects, monuments are conspicuous in George street, Princes Street gardens and sundry streets and public buildings. The oldest, a leaden statue of Charles II astride his horse ("Bandy-legged Charles on his tun-bellied charger"), has been in Parliament square by St. Giles's church since 1685; the largest is the Sir Walter Scott monument in East Princes Street gardens (1846). Its Gothic spire is 200 ft. high with successive tiers of finials and niches; in each niche is a statuette of a character in the works of Scott, while a marble statue of the author by Sir John Steell is in the open base. In the centre of St. Andrew Square gardens is a Trojan column 136 ft. high surmounted by a 14-ft. figure of Henry Dundas, 1st Viscount Melville, friend of Pitt and "uncrowned king of Scotland." The statue of the statesman W. E. Gladstone by Pittendreich Macgillivray was removed to Coates gardens in 1955.

In Parliament house are statues of Sir Walter Scott, Lord President Robert Blair, Henry Dundas, Lord Cockburn and Lord President Duncan Forbes of Culloden by L. Roubillac, considered one of the finest pieces of statuary in Scotland. St. Giles's church has a large number of memorials, including a statue of John Knox, recumbent effigies in marble of the marquesses of Argyll and Montrose and mural effigies of the novelist R. L. Stevenson and other famous men. Outside, a few yards west of the church, is the statue of the 5th duke of Buccleuch by Sir J. E. Boehm, with sculptured sketches of episodes of the Buccleuch family history.

On the Calton hill the monuments include the unfinished memorial to the Scots sailors and soldiers who fell in the Napoleonic wars, the 102-ft.-high Nelson tower and the small Greek temple commemorating the philosopher Dugald Stewart (1753–1828). East of the hill, in Regent road, is a Robert Burns memorial in the shape of a Greek temple. In the cemetery of the Old Calton are

memorials to the philosopher David Hume and to the political "martyrs" of 1793, together with the fine monument (1893) to Abraham Lincoln, which is also dedicated to the Scottish-American soldiers who fell in the American Civil War. Of memorials of World Wars I and II—in addition to that in the castle—the two best known are in Princes Street gardens, one erected in 1927 to the American-Scottish soldiers and the other to The Royal Scots, the oldest "line" regiment of the British army. The most extraordinary monument is the marble sarcophagus at Craigentinny, showing the "Overthrow of Pharaoh and his Egyptians at the Red Sea" and the "Song of Moses and Miriam." The monument stands over ground 40 ft. below which was buried William H. Miller (1789–1848), famous bibliophile, who left £300,000 and £20,000 to be set aside for burying him at that depth with a suitable monument. (S. H. C.)

The University.—Edinburgh university, the youngest of the Scottish universities, was founded by a royal charter dated 1582, granted by James VI. Although the college in the past was occasionally referred to as the College of King James, and James VI considered himself its founder, it really originated in the liberality of the town council of Edinburgh. William Little of Craigmillar and his brother Clement Little, advocate, along with James Lawson, the colleague and successor of John Knox, may justly be regarded as the true founders. In 1580 Clement Little gave all his books, 300 volumes, for the beginning of a library, and this was augmented by other valuable benefactions which included the 16th-century library of the poet William Drummond of Hawthornden.

The old buildings of the university occupied the site of the ancient collegiate church of St. Mary in the Fields (the "Kirk o' Field"), the scene of the murder of Lord Darnley. The present Old college on the same site, designed by Robert Adam, dates from 1789. The Royal Scottish museum is structurally united to the university, and nearby are the Heriot-Watt college, affiliated to the university since 1933, and the dental school. The renowned medical school stands in Teviot row, adjoining George square and the Meadows. Beside the University Union and the Reid School of Music stands the magnificent McEwan hall (1897), which is used for academic and public functions. Closely associated with the medical school, and separated from it by the Middle Meadow walk, is the Royal infirmary, designed by David Bryce (1803–76). Its wards are lodged in a series of turreted pavilions and cover a large space of ground on the margin of the Meadows, from which, to make room for it, George Watson's college—the largest of the Merchant Company schools—was removed to a site farther west, while the Sick Children's hospital was moved to the southern side of the meadows. George Watson's college was moved again (to Colinton road) in 1932 to make room for a further large extension (a maternity wing) to the Royal infirmary, one of the largest hospitals in Great Britain. In 1951 the Royal (Dick) Veterinary college was embodied in the university, and the university is associated in greater or lesser degree also with the Moray House College of Education, the Edinburgh College of Agriculture and the Edinburgh College of Art. Most of the faculty of science is housed in the King's buildings at Liberton. Adam house, the examination halls in Chambers street, is equipped as a university theatre.

Scientific Institutions.—The old observatory (1774) stands on Calton hill; nearby is the city observatory (likewise disused), and on Blackford hill is the Royal observatory (1896). The Royal College of Surgeons, which occupies a classical building in Nicolson street, is an ancient corporate body, with a charter of the year 1505. The Royal College of Physicians, with a charter granted by Charles II in 1681, has in its hall (1844) in Queen street a valuable library and a museum of *materia medica*. The school of medicine of these two Royal colleges was incorporated in the faculty of medicine of Edinburgh University, and undergraduate medical instruction is now given only by the university. The Royal colleges, however, continue to be closely associated with the faculty in the work of the postgraduate board for medicine.

Other Educational Facilities.—After the disruption in 1843 and the formation of the Free Church, New college was founded in connection with it for training students in theology. After the amalgamation of the United Presbyterian and the Free Churches, as the United Free Church of Scotland, New college was utilized by both bodies and now houses the faculty of divinity.

The Royal High school, among whose pupils were James Boswell and Alexander Graham Bell, is an ancient foundation, and the Grecian buildings (1829) south of Calton hill are its third habitation. Edinburgh academy was opened in 1824. Fettes college and Merchiston Castle school (now at Colinton) are organized on the model of the great English public schools. Foremost among the city's charitable foundations was George Heriot's hospital (1628–50), now a boys' school, founded for the maintenance and teaching of poor fatherless sons of freemen by George Heriot (1563–1624), the goldsmith and banker of James VI. This quadrangular building in Lauriston is one of the noblest in the city. The Mary Erskine School for Girls (until 1944, the Edinburgh Ladies' college) was founded in 1694 by the Company of Merchants and Mary Erskine to give daughters of merchant burgesses similar advantages to those which Heriot's secured for burgesses' sons. George Watson's college for boys was opened in 1738. The Trades' Maiden hospital for craftsmen's daughters, John Watson's, Daniel Stewart's, the Orphans', Gillespie's and Donaldson's hospitals, and other institutions, in which poor children of various classes were lodged, boarded and educated, were founded by successful merchants. George Watson's and Daniel Stewart's hospitals were converted to day schools. George Watson's Ladies' college was founded in 1871. The Edinburgh College of Domestic Science (1889) is in Atholl crescent.

By the 1960s the Education authority administered more than 80 primary and 20 secondary day schools, including the Royal High school and James Gillespie's High School for Girls. The authority also provides educational facilities for adults and young persons over school age—formally in day and evening classes and informally through youth and community groups. A wide range of playing fields is available to the public schools of the city. (J. Sr.; X.)

Environs.—On the shores of the Forth lie pleasant suburbs: Cramond, farthest west and once a Roman station, has some old historic houses and has literary associations with R. L. Stevenson. Granton, with a large harbour used by fishing and pleasure craft, lies farther east. Newhaven still has 16th-century fishermen's houses with wooden outside stairs, and its fishwives in voluminous blue-and-white-striped petticoats were for many years familiar spectacles on the streets of Edinburgh where they cried their "caller herrin!" (fresh herring). The village adjoins Port of Leith, which, though now a busy district of Edinburgh (which absorbed it in 1920), had in 18th-century days wide stretches of sand where horse racing took place and a reputation as a fashionable seaside bathing resort. The latter distinction passed to its eastern neighbour, Portobello, while the horse races were transferred to Musselburgh, 2 mi. E. of Portobello. Musselburgh, long famed for its mussels and the distich

> Musselburgh was a burgh when Edinburgh was nane
> Musselburgh'll be a burgh when Edinburgh's gane,

has been misunderstood. The "burgh" of Musselburgh meant mussel *bank*, not burgh in the sense of "town."

Southeast of the city are Duddingston with its 12th-century church and its old manse and garden frequented by the poet and novelist Sir Walter Scott; Craigmillar with its fine 14th-century castle, once the county seat of Scottish sovereigns; and Liberton and Gilmerton, once medieval sergeanty lands and now suburban townships. Colinton, in the southwest, is picturesquely situated with woods and a popular dell and has intimate associations with R. L. Stevenson. There also were the snuff mill and the mansion of James Gillespie, 18th-century founder of Gillespie's hospital and school. Merchiston castle (15th century onward), in Colinton road, a towerlike, thick-walled house, was the birthplace of John Napier (*q.v.*), the inventor of logarithms. At Restalrig, a northeastern suburb, are substantial remains of the vaulted octagonal King's chapel of the collegiate church, founded by James III in the 15th century. In Corstorphine to the west the 15th-century collegiate church is a fine example of its type. (C. A. Mm.; X.)

Population.—In 1801 the population was 67,288; in 1881 it

was 228,357; in 1931, 439,010; and in 1961, 468,378. In 1896 portions of the parishes of Liberton and Duddingston and the police burgh of Portobello were incorporated, and in 1900 a further addition was made including Granton, Restalrig and parts of South Leith and Duddingston. In 1920 the burgh of Leith was amalgamated with the city, and the parishes of Corstorphine, Cramond, Liberton and Colinton were incorporated. In 1955 a further small extension of the city was effected by incorporating parts of the county of Midlothian at Moredun and at Corstorphine.

Government and Administration.—For parliamentary purposes Edinburgh includes Musselburgh and Port of Leith and is divided into seven divisions, each returning one member. The departments of the secretary of state for Scotland are housed chiefly in St. Andrew's house. The town council, which meets in the City chambers, consists of 71 members, 69 of whom are popularly elected; the remaining two (the lord dean of guild and the convener of trades) are ex officio members elected by the guildry and convenery, respectively. The lord provost, ten bailies and the honorary treasurer are elected by members of council from among their number. By the Burgh Reform act of 1833, passed at a time when the city was bankrupt, the method of appointing the town council in force since 1583 gave place to election of one-third each year by owners and occupiers. The town council exercises all the functions of a local authority within the city. The corporation has a water committee to administer a water supply plan covering city and county, and is represented on the regional committee controlling the fire service and on the joint board responsible for the Forth road bridge. The probation committee is also regional in character.

Industries and Communications.—Long-established industrial activities include brewing and distilling, printing, bookbinding, rubber manufacture, biscuit baking and confectionery and the manufacture of glassware, drugs and fine chemicals. Mention should also be made of shipbuilding and repairing, marine engineering, steel constructional work, wire drawing and wire rope manufacture, the making of paper, glue and gelatin, printing ink, rope and sailcloth. A more recent development is the electronics industry. By the early 1960s Edinburgh had developed rapidly as a tourist centre, its annual total of about 750,000 visitors exceeding that of any other city in the United Kingdom except London. About 90,000 visitors are attracted to the annual international festival. Edinburgh is also popular as a conference centre for international and other congresses.

The city is served by British railways; of the two large railway stations, Waverley served the former London and North Eastern railway, and Princes street formed a terminal point of the former London, Midland and Scottish railway. Scottish Omnibuses Limited operates passenger services from the city linking up with most parts of Scotland, as well as with London and the south. Edinburgh's civil airport is 6 mi. W. at Turnhouse. (J. Sr.; X.)

Port of Leith.—The harbour and docks of Leith form one of the largest ports on the east coast of Scotland and are situated in the sheltered waters of the Firth of Forth, approximately 30 mi. from the open sea. The undertaking is vested in a body of commissioners set up by act of parliament. The port consists of an outer and inner harbour (used by coasting vessels), six enclosed docks and a modern western harbour of 203 ac. All classes of goods are handled, but grain, cement, timber, iron and steel, fertilizers and foodstuffs are the principal imports and coal, paper, beer, spirits and wines the principal exports.

A vessel of more than 13,000 tons gross register has entered the docks, and cargoes of more than 10,000 tons have been loaded and discharged. The entrance to the harbour is 400 ft. wide and that to the Imperial (the largest) dock 70 ft. wide. The depth of water on the sill of the Imperial dock is 30½ ft. at mean high-water springs and 27 ft. at neaps. The dock gates are normally opened three hours before high water and closed at high water, but there are facilities for locking in and out. In the tidal Western harbour, vessels drawing up to 30 ft. can remain afloat at the deep-water quay. Four dry docks are available, the largest, the Imperial, being 550 ft. long. Excellent facilities are available for the loading and discharging, the docks being liberally equipped with cranes ranging from 1½ to 120 tons' capacity. All the discharging berths have shed accommodation, and there are special facilities for the handling of grain in bulk. Reclamation undertaken just north of the Imperial and Edinburgh docks in the 1960s provided land for additional industrial sites.

See also references under "Edinburgh" in the Index volume.

(Jn. R. P.; A. B. K.)

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EDIRNE (formerly ADRIANOPLE), a town and capital of the *il* (province) of Edirne in west European Turkey, is situated near the Greek frontier on both banks of the Tunca (Tundzha) river, at its confluence with the Maritsa (Meriç) 234 km. (145 mi.) W.N.W. by road of Istanbul. Pop. (1960) 31,865.

The site of Edirne was probably determined by its bridgehead location, and a historic road from Europe via the Balkan countries to Istanbul which crossed the Maritsa at Edirne. The largest and oldest part of the town occupies a meander of the Tunca around an old citadel. Its plan is irregular except for the south-central part which was replanned after a fire in the 19th century. The centre of the town has many beautiful mosques, including that of Selim II, built by Sinan and completed in 1574, and those of Ucserefeli and Murad. Other historic buildings include Dar el Hadis (a religious college) and caravansaries. There are many fine bridges over the rivers.

Edirne is on the railway from Belgrade (Yugoslavia) and Sofia (Bulgaria) to Istanbul and is also linked with Salonika in Greece. Main roads connect it with central Europe and with the rest of European Turkey. A bus service runs to Istanbul. The town manufactures cheese, soap, leather, tapestry, woolens, linens and cotton but the once-important raw silk industry has declined. The chief products of the *il* are cereals (principally wheat) and fruits. Rice is cultivated in the Maritsa plain. Stock-raising is an important activity and Edirne produces its well-known white cheese and meat for the Istanbul market.

Adrianople or Hadrianopolis, originally known as Uskadama or Uskodama, was renamed and enlarged by the Roman emperor Hadrian (117–138). It was the scene in 378 of the Roman defeat by the Goths (*see* below). Conquered successively by the Avars, Bulgars and crusaders, the town was captured by Murad I in 1362 and from 1365 became the residence of the Turkish sultans until the fall of Constantinople in 1453. Under Turkish rule the town flourished as an administrative, commercial and cultural centre, attaining a population of about 100,000 in the 19th century, but the foreign occupations and devastation brought its decline. It was occupied by the Russians in 1829 and 1878 (*see* RUSSO-TURKISH WARS).

During the first Balkan War, Adrianople was taken from the Turks by the Bulgars, with Serbian assistance, in 1913 after a siege of 155 days. The Turks reoccupied it during the second Balkan War and by the treaty of Bucharest (Aug. 10, 1913) it was returned to Turkey. The Greek army, sent to restore order in Thrace, entered Adrianople in July 1920 and the town was ceded to Greece on Aug. 10 by the treaty of Sèvres. The town was again restored to Turkey by the Mudanya convention of Oct. 1922, confirmed by the treaty of Lausanne, July 24, 1923.

(N. Tu.; S. Er.; E. Tu.)

Battle of Adrianople.—Adrianople was the site of two battles. In the first, in A.D. 323, Constantine the Great defeated Licinius (*see* CONSTANTINE). The second and more famous engagement, in 378, was the crushing defeat by the Goths of the Roman imperial forces under the emperor Valens (*q.v.*).

The Visigoths had been allowed, in 376, to move inside the

Roman frontier to escape the pressure of the Huns. A year later they revolted, and in 378 Valens determined to subdue them. When the attack was made (Aug. 9) the Gothic cavalry was away foraging. To gain time to recall them, Fritigern, the Gothic leader, made offers of surrender, and, while Valens negotiated, the Roman troops remained stationary without water for several hours under a blazing sun. After some of the Roman officers began to fight without orders, the Gothic cavalry returned and the Romans, exhausted and dispirited, were forced into a disordered mass too dense to allow them to use their weapons. Their main body was massacred: two-thirds of the army fell, including the emperor; his corpse was never found.

This Gothic victory was one of the milestones of history: the Roman empire's barriers were breached so gravely that they could be restored only temporarily, by taking the barbarian tribes inside the imperial frontiers and charging the new settlers with defending the provinces against other barbarians. According to the traditional view the battle also marks the changing relative values of infantry and cavalry in that henceforth cavalry was to have increasing predominance; but the account of the battle by the 4th-century historian Ammianus Marcellinus hardly supports the conclusion that it was a great cavalry victory.

See Ammianus Marcellinus, *Res Gestae*, xxxi, 12–13. (E. A. T.)

EDISON, THOMAS ALVA (1847–1931), U.S. inventor best known for his development of the phonograph and the incandescent lamp, was even more notable for the wide range of his interests. Born at Milan, O., Feb. 11, 1847, Edison's education was limited to three months in the public school of Port Huron, Mich. At 12 he became a railroad newsboy and after 15 earned his living as a telegraph operator in various cities, always studying and experimenting in his spare time. In 1868 he took out his first patent, for an electrical vote recorder. During the next few years he devised stock tickers, duplex, quadruplex and automatic telegraph systems and the electric pen, which was the forerunner of the modern office duplicating machine. His invention (1877–78) of the carbon transmitter, in which compressed lampblack buttons were used to translate sound into a varying electrical signal and back again, marked a real advance in the science of telephony and aided materially in bringing the Bell telephone into practical use.

Most modern inventions result from the contributions of many minds, and it is often difficult for the courts to determine priority, but when Edison made application in 1877 for a "phonograph or speaking machine," the U.S. patent office could discover no previous record of this sort. The original model, costing $18, recorded on a cylinder covered with tin foil and turned with a hand crank. Ten years afterward Edison developed a motor-driven machine with cylindrical wax records, and this speedily became popular. Later he invented a disc form for reproducing music with a diamond point as well as the "Ediphone" for office dictation.

On Oct. 21, 1879, after expending more than $40,000 in fruitless experiments, he succeeded in making an incandescent lamp in which a loop of carbonized cotton thread glowed in a vacuum for more than 40 hours. The following decade was devoted to the invention and exploitation of methods for the generation and distribution of electricity, including the three-wire system, underground mains, improved dynamos and motors and an electric railway for carrying freight and passengers. From 1891 to 1900 he was chiefly engaged in the advancement of a magnetic method of concentrating iron ores and from 1900 to 1910, in the development of a new kind of storage battery, using an alkaline solution with nickel hydrate as the positive material and iron oxide as the negative. In 1891 he applied for a patent on a "kinetescopic camera" for taking motion pictures on a band of film to be viewed by peeping into a box; this was later improved to project the pictures on a screen.

In the *Scientific American*, Dec. 25, 1875, he described an unknown "etheric force," which manifested itself by sparks passing between carbon points at a distance from an interrupted current. In 1883 he patented what became known as "the Edison effect," the passage of electricity from a filament to a plate of metal inside an incandescent lamp globe (a forerunner of the electron tube), and in 1885 a method of transmitting telegraphic signals from moving trains or between ships by induction. During World War I he worked on naval problems for the government and on the production of phenol and other chemicals. In 1927 he was admitted to the National Academy of Sciences.

In his combined workshop and laboratory at Menlo Park, N.J., and later at West Orange, N.J., Edison was incessantly engaged in various forms of invention for more than 50 years and took out 1,033 patents up to April 1928. He died at West Orange, Oct. 18, 1931.

See also references under "Edison, Thomas Alva" in the Index volume.

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EDMER (EADMER) (*c.* 1064–*c.* 1141), English historian and biographer of St. Anselm, was of English parentage, probably a native of east Kent. He was placed when a boy in the convent of Christ church, Canterbury, and in due course became a monk there and eventually precentor. When Anselm was made archbishop of Canterbury in 1093, Edmer became his chaplain, and as the archbishop's intimate friend and adviser wrote an authoritative biography of him (*De vita et conversatione Anselmi*), about 1124. Edmer was also closely associated with Anselm's successor Ralph d'Escures, and was active in the prolonged dispute between Canterbury and York over ecclesiastical supremacy in Britain. In 1120, with Henry I's permission, he was appointed bishop of St. Andrews by King Alexander I of Scotland, but returned unconsecrated the next year because Alexander refused to recognize Canterbury's claims to ecclesiastical supremacy over Scotland. Edmer's chief work was his history of England, the *Historia Novorum in Anglia*, and in addition to that of Anselm he wrote biographies of several English saints. Edmer's account of the Canterbury-York controversy is partisan to the point of being disingenuous and even dishonest, but although Archbishops Lanfranc and Anselm are his heroes, his work remains a first-class source for the history of England and the English church between 1066 and 1122. Edmer died probably about 1141.

See M. Rule (ed.), *Eadmeri historia novorum in Anglia* and *De vita et conversatione Anselmi* (1884); A. Wilmart, "Edmeri Cantuariensis cantoris nova opuscula," *Revue des sciences réligieuses*, vol. xv (1935). (G. W. S. B.)

EDMONTON, a city and capital of the province of Alberta, Can., and a trade and transportation centre for much of northwestern Canada, is in the meadow and aspen-grove country of central Alberta at an altitude of 2,182 ft.; the city is located 150 mi. E. of the Rocky mountains, on the wide, impressive valley of the North Saskatchewan river. It is named after Fort Edmonton, a Hudson's Bay company trading post built in 1795, 20 mi. downstream, opposite a North West Fur company post built the previous year. After 1807 the trade of the far northwest was conducted from the present site; the furs were shipped out via the North Saskatchewan river. A few Métis settled in the area, but it did not grow appreciably until the 1870s, when pioneers arrived in anticipation that the transcontinental railway then being built would follow the wooded park belt. That did not happen, but steady agricultural settlement began when a railway connection with Calgary was secured in 1891. In 1905 the transcontinental Canadian Northern railway reached Edmonton on its route to Yellowhead pass in the Rockies. That same year Edmonton was selected as the capital of the newly organized province of Alberta, and in 1906 the University of Alberta was founded there; the city quickly became the undisputed centre of northern Alberta. Edmonton is the wholesaling and retailing centre of a rich mixed farming area that includes the Peace river country 175 mi. N.W.

Some of Canada's largest meat-packing plants were established

in Edmonton, and they comprised its most important industry in the early 1960s. Fuel is obtained relatively inexpensively from nearby coal deposits and natural gas reserves. The whole development of Edmonton was changed in 1947 with the discovery of one of the world's great oil fields at Leduc, 20 mi. S. Thereafter a number of other important fields, including Redwater and Pembina, were discovered within 75 mi. of Edmonton, and the city experienced a sustained boom. Its population more than doubled after 1941, when it was just under 100,000. The population was 281,027 in 1961 (metropolitan area, 337,568).

Edmonton became the leading oil refining centre of western Canada, with three large oil refineries. An important petrochemical industry was developed in the second half of the 20th century, and there were plants producing polyethylene, cellulose acetate and various industrial chemicals. Other industries such as pipe mills and steel-fabricating plants also serve the oil industry. Near Edmonton a large nickel refinery utilizes natural gas as a fuel; commercial fertilizers are an important by-product. Only 235 mi. N.W. in the valley of the Athabasca river, are the famous oil-saturated tar sands, a great potential source of petroleum.

Edmonton is served by two transcontinental railway lines; railways radiate from Edmonton to the Peace river country, where the Alaska highway continues northward, and to the town of Fort McMurray in the northeast, which is on the Mackenzie water system that serves the area to the Arctic ocean. Thus the city functions as the distributing and collecting centre for the rapidly developing north.

Edmonton is in a strategic position for international flights in the northern hemisphere; there are daily transcontinental flights, as well as flights to Alaska and the rest of the United States, and to the Canadian Arctic. (JN. H. W.)

EDMONTON, a municipal borough (1937) and parliamentary constituency of Middlesex, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Enfield and Southgate to form the new London borough of Enfield (*see* LONDON). Edmonton municipal borough, 9 mi. N. of London bridge, has the River Lea Navigation and the William Curling reservoir in the east and the New river in the northwest. It is crossed, north-south, by the old North road (Ermine street) and the Great Cambridge road, and east-west by the North Circular road. Pop. (1961) 92,062. Area 6 sq.mi. Timber wharves on the Lea Navigation supply a furniture industry; the oldest factory is a gasworks (1845) and the biggest industry the manufacture of gas equipment. Textiles and clothing are also made. Edmonton (Eadhelm's tun) was a Saxon township and the Edmonton hundred has existed for 1,000 years. Near the centre of the town is Pymmes park (53½ ac.). Salisbury house (16th–17th century) is an art centre and there is a continuous art exhibition in the town hall. The memorial of Charles Lamb, who lived and died (1834) at Edmonton, and his sister Mary lies in All Saints' churchyard. Lamb cottage and the house where John Keats lived (1810–14) is in Church street. William Cowper was also a resident of Edmonton and the Bell inn is famed through his poem "John Gilpin." Other literary allusions include the play *The Merry Devill of Edmonton* (1608) and the joint play of William Rowley, Thomas Dekker, John Ford, etc., *The Witch of Edmonton* (1658). The public library (1897) is a Lamb and Keats memorial.

EDMUND, SAINT (EDMUND RICH) (*c.* 1175–1240), archbishop of Canterbury and a distinguished scholar, was born at Abingdon, near Oxford, on Nov. 20, probably in 1175. His father, Reginald of Abingdon, a fairly prosperous merchant earned for himself the nickname of "the Rich," which apparently became hereditary in the family. Edmund began his education in a grammar school at Oxford, and at the age of 12 took a vow of perpetual chastity in the Virgin's church at Oxford. After graduating at Paris, he lectured for six years in the liberal arts, partly in Paris and partly in Oxford, where he was the first to lecture on Aristotle. He returned to Paris to study theology, on which subject he then lectured at Oxford. In 1222 he accepted the treasureship of Salisbury cathedral, and little is known of his life for the next ten years. But he attracted the notice of the Roman court and during 1227 he preached the crusade in England.

In 1233 Edmund was elected archbishop of Canterbury at the express suggestion of Pope Gregory IX, after the monks of Canterbury had in vain suggested three other candidates for the pope's approval. Edmund at once leaped into prominence by the outspoken manner in which he rebuked the king for following the advice of foreign favourites. In common with the baronial opposition he treated Henry III as responsible for the tragic fate of Richard Marshal, earl of Pembroke (*see* PEMBROKE, EARLS OF), and threatened the king with excommunication. The king bowed before the storm, dismissed the foreign counselors, made peace with Marshal's adherents and was publicly reconciled with the barons. But it was in part at least in the hope of emancipating himself from Edmund's control that the king asked the pope to send him a legate (1236).

Matthew Paris, who heartily disliked the pope's envoy, paints a picture which was accepted as true until modern research showed it to be grossly exaggerated. According to him, on the arrival (1237) of the legate, Cardinal Otto, the archbishop felt himself thwarted at every point: the marriage between Simon de Montfort and the princess Eleanor, which Edmund had pronounced invalid, was ratified at Rome upon appeal; the king upheld the monks of Canterbury in their opposition to the archbishop's authority, a common occurrence at the time, and the legate, if he did not actually favour the king's moves, kept silent. In fact, however, there are several indications that the two prelates remained on good terms and trusted each other. Nevertheless, Edmund duly laid a protest before the king and excommunicated in general terms all who had infringed the liberties of Canterbury. These measures, the least he was expected to do, led to no result; he possibly had anticipated this. In 1240 the English clergy were required to pay the pope a subsidy for the war against Frederick II, and simultaneously 300 Romans were "provided" with English benefices.

In Aug. 1240 the pope, Gregory IX, summoned a general council. Edmund, who in any case was bound to his triennial visit to Rome, seems to have anticipated the normal date in order to discuss personally with the pope the affairs of Canterbury and of England in general. He crossed the channel and stayed for a little rest at Pontigny, but the state of his health drove him later to Soisy (near Provins), where he died on Nov. 16, which is his feast day. His canonization, demanded at once by his admirers, was delayed (till 1247) through the opposition of Henry III.

Edmund is one of the most saintly and attractive figures of the English church. It was his misfortune to be placed at the head of the national hierarchy in a crisis for which he had not been prepared by practical training or experience. As archbishop he showed no great capacity or force of character, but the purity of his motives and the loftiness of his ideals commanded universal respect.

Some scholastic treatises are claimed as the work of Edmund. Assuredly authentic is the once widely known *Speculum ecclesiae*, a devotional treatise which belongs to the end of his career; it appeared in *Bibliotheca*, vol. v (1609), edited by M. de la Bigne (Eng. trans. by F. M. Steele, 1905).

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(H. W. C. D.; PL. GN.)

EDMUND (EADMUND), **SAINT,** THE MARTYR (d. 869), king of East Anglia, was killed by the Danes on Nov. 20, 869. The Annals of St. Neots date his accession 855, but contemporary authorities record only his death. The Anglo-Saxon Chronicle says that he fought the Danes and was defeated and killed. The belief that he was killed, not in battle, but unresisting, must have arisen early, for the St. Edmund pennies afford evidence of his cult before the end of the 9th century. The oldest life, written by Abbo of Fleury about 985, claims to repeat the story as Dunstan had heard it told to King Aethelstan by Edmund's sword-bearer. It tells how he was shot at with arrows and eventually beheaded by the command of the Dane Ingwar for refusing to desert Chris-

tianity. He was ultimately buried at Beadoricesworth (now Bury St. Edmund's; *q.v.*), where his shrine became famous. Later, fictitious, versions make him a continental Saxon, born at Nürnberg, and adopted by Offa, king of East Anglia, when on his way to Rome. They also invent names for his parents, Alkmund and Scivare. His feast is celebrated on Nov. 20.

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EDMUND (Eadmund) **I** (921–946), king of the English from 939 to 946, was the son of Eadgifu, third wife of Edward the Elder, and was half brother of King Aethelstan, alongside whom he had fought at the battle of Brunanburh in 937. On Aethelstan's death in 939, Olaf Guthfrithson, the Norse king of Dublin, occupied Northumbria, and in 940 raided the midlands as far as Tamworth. A peace made at Leicester left him in possession of Northumbria and of the territory of the Five Boroughs of Lincoln, Stamford, Nottingham, Derby and Leicester, but Edmund recovered all except Northumbria in 942 after Olaf's death, and in 944 regained Northumbria, driving out the Norse kings Olaf Sihtricson and Raegnald. He captured Strathclyde in 945 and entrusted it to Malcolm I of Scotland in return for a promise of his support on sea and land. He thus inaugurated a policy of establishing a secure frontier and peaceful relations with Scotland, which was followed by his son Edgar also. Early in his reign he received an embassy from Germany, and just before his death he intervened in Frankish politics in support of King Louis IV, who had been foster son of Aethelstan.

His short reign produced three law codes, apart from the Hundred ordinance which may be his or Edgar's. The hundred is first mentioned in his laws. He aimed at curtailing the practice of the blood feud and at suppressing cattle thieving. One code enjoins celibacy on the clergy, perhaps at the instance of Dunstan, whom he made abbot of Glastonbury.

Edmund was killed on May 26, 946, in his royal hall at Pucklechurch, Gloucestershire, by Leofa, an exiled robber, and he was buried at Glastonbury. By his first wife, Aelfgifu, he left two sons, Edwy and Edgar, and he was succeeded by his brother Edred.

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EDMUND (Eadmund) **II** Ironside (*c.* 993–1016), king of the English from April 23 to Nov. 30, 1016, was a son of Aethelred II and his first wife, Aelfgifu. When, in 1015, after the murder of two leading thegns of the northern Danelaw, Sigeferth and Morcar, King Aethelred confiscated their estates and imprisoned Sigeferth's widow, Edmund seized and married her against his father's will, took possession of the estates of Sigeferth and Morcar and was accepted as ruler by the people of the Five Boroughs (Lincoln, Stamford, Nottingham, Derby and Leicester). When Canute invaded later in 1015, Edmund raised the northern forces, while Ealdorman Eadric of Mercia collected an army in the south, but then deserted Edmund for Canute. Edmund assembled the English army late in the year, and again early in 1016, but on both occasions it disbanded because it would not fight without King Aethelred being present. Then Edmund and Earl Uhtred of Northumbria laid waste the northwest midlands which would not come out against the Danes. Meanwhile Canute ravaged in the east and finally reached York, thus causing Uhtred to return north and submit. Edmund joined his father in London, and after Aethelred's death some councilors with the citizens of London elected him as king, while a fuller gathering of the witan at Southampton chose Canute. From then until Oct. 18, Edmund led a strong resistance against the Danes. He recovered Wessex, relieved the siege of London and forced the Danes, who had been raiding Mercia, to take shelter in Sheppey. Ealdorman Eadric now rejoined Edmund; but when, on Oct. 18, Edmund intercepted the Danish army at Ashingdon, Essex, Eadric again deserted and Canute was victorious. Peace was made at Alney, Gloucestershire, Edmund retaining Wessex and Canute the lands north of the river Thames. When Edmund died on Nov. 30, 1016 (probably from natural causes, since only late authorities say he was murdered), Canute became king of all England. Edmund was buried at Glastonbury. His stout defense against Canute earned him the epithet "Ironside," recorded from the late 11th century. His infant sons were brought up in Hungary, and one of them, Edward, became the father of Edgar the Aetheling and of his sisters Margaret (afterward queen of Scotland) and Christina.

Bibliography.—*Anglo-Saxon Chronicle;* B. Thorpe (ed.), *Florentii Wigorniensis . . . chronicon* (1848–49); F. M. Stenton, *Anglo-Saxon England,* 2nd ed. (1947); *English Historical Documents,* vol. i, ed. by D. Whitelock, pp. 50 ff., 224–227, 284 ff. (1955). (D. Wk.)

EDMUNDS, GEORGE FRANKLIN (1828–1919), U.S. senator and noted constitutional lawyer, was born in Richmond, Vt., on Feb. 1, 1828. He had little formal schooling but studied law and was admitted to the bar in 1849. He served as a Republican member of the Vermont house of representatives (1854–59) and the Vermont senate (1861–62). He was appointed to a vacancy in the U.S. senate in 1866 and served until 1891 when he resigned to devote full time to the legal profession. He was chairman of the senate judiciary committee from 1872 to 1891 except for one two-year period, and was president *pro tem.,* 1883–85. He took an active part in the impeachment proceedings against Pres. Andrew Johnson and supported the Tenure of Office act limiting the president's power to make removals. Edmunds was influential in establishing the electoral commission to decide the disputed presidential election of 1876 and became one of its members. He was a candidate for the presidential nomination in 1880 and 1884, receiving 93 votes in the Republican convention in the latter year. The act for the suppression of polygamy (1882) bears his name and he was responsible for the final form of the Sherman Anti-Trust act (1890). He was admired for his legal acumen, independence and inflexible integrity but feared for his barbed wit. He died in Pasadena, Calif., on Feb. 27, 1919.

See W. H. Crockett, *Vermont: the Green Mountain State* (1923), *A Book of Biographies* (1932). (E. H. Ro.)

EDO, the vernacular name for the city of Benin (*q.v.*), is used to designate those Negro peoples in Southern Nigeria who speak dialects of Bini, one of the Kwa group of Western Sudanic languages. Their territory, a little west of the Niger river, extends from hilly country in the north to swamps in the Niger delta about 150 mi. southward and makes up the four administrative divisions, Kukuruku, Ishan, Benin and Urhobo (Sobo). Altogether the Edo in Nigeria number just over 500,000 (1952 census). Benin Division (pop. 292,081) was once the nucleus of the former Benin empire; the other divisions do not correspond to indigenous political units, the latter being far smaller, mostly petty kingdoms or chiefdoms of one or more villages and a few single autonomous villages without chiefs.

Today many Edo are Christians or Muslims, but traditionally they believe in a rather remote high god, the Creator. Lesser gods have cults everywhere; local heroes and the spirits of parents are also worshiped, and witchcraft beliefs are distinctive. The village is the basis of political organization. The men are associated in age grades, and patrilineal descent is combined with primogeniture in the inheritance of offices. These customs are modified by other features—*e.g.,* titled political, military and priestly offices, title societies and, in the south, women's age grades—which differ in complexity and relative importance from place to place. *See* also Nigeria.

Bibliography.—R. E. Bradbury, "The Benin Kingdom and the Edo-speaking Peoples of South-western Nigeria," *Ethnographic Survey of Africa, Western Africa,* pt. xiii (1957); *Population Census of the Western Region of Nigeria, 1952* (Government of Nigeria) (1953); J. W. Hubbard, *The Sobo of the Niger Delta* (1948); J. W. Welch, "The Isoko Tribe," *Africa,* vol. 7 (1934); N. W. Thomas, *Anthropological Report on the Edo-speaking Peoples of Nigeria,* 2 vol. (1910). (P. M.-W.)

EDO (Yedo), the ancient name for Tokyo, the capital city of Japan. Edo was a small fishing village at the end of the 16th century but soon thereafter became important under the shogun Tokugawa Ieyasu, who made it his capital. In less than a century the population of Edo exceeded 1,000,000. In 1868 it was pro-

claimed the residence of the emperor and official capital of Japan, and was renamed Tokyo. In the 20th century it continued to grow in spite of fires, earthquakes and air raids during World War II. By 1960 the population of Tokyo had reached 8,310,027, and the city had become known as one of the most modern in the world. *See* also Tokyo.

EDOM refers variously to a land (Gen. xxxvi, 31, 32), equated at times with Seir (Gen. xxxii, 4); a person, identified with Esau (*q.v.*); and a people (Num. xx, 21).

In the pre-exilic period, the territory of Edom lay solely east of the Dead sea and the (Wadi) Araba, the great rift extending between the south end of the Dead sea and the Gulf of Aqaba, the east arm of the Red sea. It consisted mainly of the southern continuation of the high, rolling, fertile plateau, of which Moab (*q.v.*), immediately north of it, formed one segment. Oriented north-south, it measured 82 by 35 mi. The two lands were separated by the wide and deep canyon of the Zered river (Wadi Hesa) (Num. xxi, 12) which, rising in the reaches of the desert to the east, flowed westward, emptying into the southeast end of the Dead sea.

Edom was bounded on the north by the Zered, on the west by the Araba and on the east by the desert; the southern boundary was formed by the edge of the tableland which drops suddenly to meet the Wadi Hismeh, a part of the great Arabian desert. On this high plateau, rising in places to above 3,500 ft., with its temperate climate, abundant natural resources and strategic position astride the trade routes between Arabia and Syria, numerous civilizations arose and fell from earliest historical times onward, with sometimes fallow periods lasting as long as 500 years intervening between the destruction or collapse of one and the development of another. The historical memory contained in the account in Gen. xiv of the destruction wrought by the kings of the east has been corroborated by the discovery of a whole series of Bronze Age sites which were destroyed no later than the 19th century B.C. and were never again reoccupied. Thereafter, for more than five centuries, till the establishment of the kingdoms of Edom and Moab and the related kingdoms of eastern Palestine in the 13th century B.C., nomads roamed the land. In the Negev and Sinai the gap in sedentary, agricultural civilization lasted between the 19th and the beginning of the 10th century B.C. It is significant in connection with this particular gap in the history of permanent, sedentary civilization in Edom, as in Moab, that neither the Egyptian lists of towns nor the Tell el-Amarna letters refer to them or to eastern Palestine in this period between the 20th and 13th centuries B.C. Edom and Seir, for instance, are first mentioned in the records of Merneptah (*c.* 1234 B.C.) and of Ramses III (1198–67 B.C.). There are no archaeological traces of Horites (Deut. ii, 12, 22) in either the hill country of Edom or in the Araba or in the Negev. It may be that under the Horites are to be understood purely nomadic groups such as the Edomites must have found and conquered when they seized the territory to which they gave their name. They may originally have been descended from the Hurrians (*q.v.*) who, to judge from archaeological finds at Nuzi, played an important role in the ancient near east during the 2nd millennium B.C.

The heyday of the Edomite kingdom extended from the 13th to the 8th centuries B.C., although it continued to exist several centuries longer. Its civilization was of a high order. Agriculture, animal husbandry, mining and metallurgy, architecture, pottery making and commerce were among the sophisticated activities. The land was dotted with well-built stone villages and towns and fortresses. The literature of Edom, like that of Moab, was in all probability of no mean order, if inferences may be drawn from the related Moabite inscription of Mesha. Edomite pottery, like Moabite pottery of the 13th to 6th centuries B.C., was possessed in part of outstanding and distinctive excellence. Archaeological investigation has revealed pottery figurines indicative of the worship of fertility gods, which prevailed throughout the entire ancient near east.

The beginning of Edomite as of Moabite pottery antedates that of the closely related Israelite pottery. This precedence has a direct relationship to the account in Gen. xxxvi, 31–39, which lists "eight" Edomite kings who reigned in the land of Edom before the Israelites had a king. This archaeological fact harmonizes with the biblical information that the Edomite and Moabite kingdoms were established before the advent of the Israelites, who begged in vain for permission to travel through these kingdoms via the "king's highway" en route to the Promised Land (Num. xx, 14–21; Judg. xi, 17). These well-established kingdoms with their strongly fortified frontiers refused permission, and the Israelites were compelled to go east around their territories, and finally succeeded in forcing their way westward on the north side of the Arnon, through what at that time was part of the territory of Sihon, king of the Amorites. Had this particular Exodus of the Israelites taken place before the 13th century B.C., they would have found neither Edomite nor Moabite kingdoms whose rulers could have given or refused them transit permission through their territories.

Throughout most of their history, Edom and Judah were engaged in war with each other, primarily to determine which was to control the Araba rift that stretched between them and that was of great importance because of the trade route which followed its length and especially because of its copper and iron deposits (Deut. viii, 9). Long before the outbreak of Judaeo-Edomite hostilities, the copper and iron in the Araba were mined by the Kenites and then by the Edomites, to whom they were related through the Kenizzites (Gen. xv, 19). David defeated Edom and enslaved many of the Edomites (II Sam. viii, 13–14). Solomon was able to capitalize on David's gain and organized the copper-mining industry on a large scale. He probably compelled many Edomites to work for him in the copper mines in Araba. When the tables were reversed, the Edomites probably did the same with Judaean prisoners. They are known to have engaged in the slave trade (Amos i, 6, 9), and whenever opportunity offered took slaves from Judah (II Chron. xxviii, 17). Solomon, although he had to contend with the Edomite prince Hadad (I Kings xi, 14 ff.), held undisputed control over the Araba itself. He exploited its mines and exported copper on his Tarshish ships sailing from his port city Ezion-geber to Ophir (I Kings ix, 26–28; x, 11, 22; II Chron. xx, 36–37). When next heard of, Edom was ruled by Jehoshaphat through a deputy governor (I Kings xxii, 47). Jehoshaphat attempted but failed to revive the sea trade from Ezion-geber (I Kings xxii, 48). During the reign of his son Joram, Edom regained its independence (II Kings viii, 20–22).

For somewhat more than half a century, Edom was undisturbed. Then Amaziah of Judah in 800 B.C. captured Sela, the main stronghold of Edom, and renamed it Joktheel (II Kings xiv, 7). His son Uzziah (Azariah) completed the reconquest of Edom, recovering Ezion-geber (which had become known as Eloth or Elath) from Edom and establishing it as a port (II Kings xiv, 21–22; II Chron. xxvi, 1–2). Edom then remained subject to Judah till the time of Uzziah's grandson, Ahaz, when it regained control of the Araba and of Elath by taking advantage of Ahaz' distress during the Syro-Ephraimitic war in 734 B.C.

To the first part of this final period of Edomite control over Elath belong pottery jars discovered in excavations there, stamped with a royal seal in ancient Edomite (Hebrew) characters reading: "Belonging to Qosanal, the Servant of the King." Qosanal is a typical Edomite name, the first part of which, Qos, is the name of a well-known Edomite and then Nabataean deity.

Following its recovery of Elath, Edom, like Judah, experienced a progressive decline. The long struggle with Judah, plus the extended period of aggrandizement by Assyrian and Babylonian armies against Edom and Moab, in addition to whatever events may have transpired during the very first part of the rise of the Persians to power, coupled with the growing strength of the Nabataeans who had appeared upon the scene, resulted in the weakening and destruction of the Edomite state. By the 4th century B.C. the Nabataeans dominated the former territory of Edom as they did that of Moab.

Many of the Edomites, pushed out of their former territory by the Nabataeans, drifted westward across the Araba and established themselves in southernmost Judah. There, during the Hellenistic period, they became known as Idumaeans. The possibility that

Edomite territory once extended into parts of southern Palestine is suggested by a number of biblical verses which definitely locate Edom-Seir on the west side of the Araba. All of these verses, however, in their present form must be dated to the exilic period or later, after the collapse of the Edomite kingdom on the east side of the Araba. They reflect the Idumaean settlement in southernmost Judah, which the author of Deut. xxiii, 7 probably had in mind when he said: "You shall not abhor an Edomite, for he is your brother," meaning those Idumaeans who had been Judaized and had become worshipers of Yahweh. The close relationship of the Idumaeans and Judaeans in Judah and the Nabataeans in the former territory of Edom and Moab as well as in the Negev and Sinai can be no better illustrated than by the marriage of Herod Antipas, the son of the Idumaean Herod the Great, king of Judaea, to the daughter of the Nabataean king Aretas IV.

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EDRED (EADRED) (d. 955), king of the English from 946 to 955, was the son of Edward the Elder and his wife Eadgifu. He succeeded his brother Edmund in 946, and received the submission of Northumbria and took oaths from the Scots. In the next year, Archbishop Wulfstan I of York and the Northumbrians pledged themselves to him at Tanshelf, Yorkshire, but soon afterward accepted as king Eric Bloodaxe, a son of Harald I Fair-hair of Norway. Edred ravaged all Northumbria in revenge (948), burning the minster at Ripon. His rear guard was overtaken and defeated at Castleford, and Edred was prevented from utterly destroying the land only by the Northumbrians' desertion of Eric and payment of compensation. Yet they accepted in 949 another Scandinavian, Olaf Sihtricson, as king; they drove him out in 952 in favour of Eric Bloodaxe, who was expelled and killed in 954. Henceforward the West Saxon kings ruled Northumbria. Archbishop Wulfstan was suspected of disloyalty and imprisoned in 952; he was restored in 954, but apparently not allowed to return to Northumbria. Edred was a close friend of Dunstan and a supporter of monastic revival. He gave Abingdon to Aethelwold (afterward bishop of Winchester) for him to refound the monastery there. Edred suffered from continuous ill-health. He died at Frome on Nov. 23, 955, and was buried at Winchester. His will sheds light on the constitution of a king's household. He left a large sum of money for his people to buy off heathen armies if required.

See F. M. Stenton, *Anglo-Saxon England*, 2nd ed. (1947); *English Historical Documents*, vol. i, ed. by D. Whitelock, pp. 44 ff., 68, 203–205, 257, 508–512, 828 ff., 833 ff. (1955). (D. WK.)

EDUCATION (ARTICLES ON). Educational methods are presented in the context of the cultures from which they arose, from those of ancient India, China, Greece and Rome to the world of today, in EDUCATION, HISTORY OF. This article outlines the concepts of the great leaders of educational thought, and the rise and development of national school systems. A supplementary article, WOMEN, EDUCATION OF, deals with the traditional prejudice against academic and professional training for women, its social sources and its conquest.

Theories as to the purpose of education, both in democratic and nondemocratic societies, are analyzed in EDUCATION, PHILOSOPHY OF; various kinds of control, management and direction of matters related to schools are discussed in SCHOOL ADMINISTRATION. Practical applications of educational philosophy are treated in TEACHING, METHODS OF and TEACHERS, TRAINING OF. The educational pioneers whose contributions are described in articles of this type are represented also by biographical articles.

Current methods of education on various age levels in Great Britain and the United States are the subject of a series of articles: PRE-ELEMENTARY EDUCATION; ELEMENTARY EDUCATION, which is supplemented by PAROCHIAL EDUCATION, U.S.; SECONDARY EDUCATION; and HIGHER EDUCATION. Also, sections on educational administration are included in articles on nations and states—*e.g.*, FRANCE: *Education;* OHIO: *Education;* etc.

The overall objectives of education are discussed in EDUCATION, PHILOSOPHY OF; PROGRESSIVE EDUCATION; and biographies of educational leaders including J. A. COMENIUS, JOHN DEWEY, FRIEDRICH FROEBEL, BENJAMIN JOWETT, HORACE MANN, MARIA MONTESSORI, J. H. PESTALOZZI, and BOOKER T. WASHINGTON. Articles on specific types of subject matter include ART EDUCATION; CLASSICAL EDUCATION; FOREIGN LANGUAGES, TEACHING OF; HUMANITIES; MUSIC, TEACHING OF; PHYSICAL EDUCATION; READING; and SCIENCE, TEACHING OF. Techniques that have contributed to teaching effectiveness are described in AUDIO-VISUAL EDUCATION; PROGRAMMED LEARNING and TELEVISION: *Closed-Circuit Television.* Discussions of testing methods include EXAMINATIONS and PSYCHOLOGICAL TESTS AND MEASUREMENTS.

Problems of special groups of students are treated in BLIND, TRAINING AND WELFARE OF and DEAF AND HARD OF HEARING, TRAINING AND WELFARE OF.

UNIVERSITIES outlines the development of the first universities from the centres of instruction known as *studia generale;* the rise of the University of Paris, Oxford and Cambridge and the spread of centres of higher education in Europe; and the establishment of modern universities in various parts of the world. This article is supplemented by COLLEGE; LAND-GRANT COLLEGES AND UNIVERSITIES; UNIVERSITY COLLEGES; and individual articles on many colleges and universities. Also, information on colleges and universities is included in many articles on the cities in which they are located.

Education for professional careers is discussed in ARCHITECTURAL EDUCATION; ENGINEERING EDUCATION; LEGAL EDUCATION; MEDICAL EDUCATION; etc. Education for the armed services is treated in MILITARY, NAVAL AND AIR ACADEMIES. Among the articles dealing with specialized fields are AGRICULTURAL EDUCATION AND RESEARCH; TECHNICAL EDUCATION; and VOCATIONAL EDUCATION. Also, articles on various careers—for example, ACCOUNTING; JOURNALISM; and PHARMACY—contain sections on education in these areas.

Articles dealing with institutions and methods adapted to special needs include ADULT EDUCATION; CORRESPONDENCE INSTRUCTION; EMPLOYEE TRAINING; EDUCATION, HISTORY OF; SUMMER SCHOOL; and UNIVERSITY EXTENSION.

Among the articles concerned with the professional interests of teachers are ACADEMIC FREEDOM; EDUCATION, SOCIETIES OF; EDUCATIONAL ARCHITECTURE; PARENTS AND TEACHERS, NATIONAL CONGRESS OF; SCHOOL ADMINISTRATION; and TEXTBOOKS.

Scholarships, fellowships and other forms of financial aid to students are discussed in STUDENT AID. Additional articles of general interest include COEDUCATION; DEGREE, ACADEMIC; FRATERNITY AND SORORITY.

In many cases, articles in related fields will be found helpful in setting educational problems in perspective—for example, ART; BOOK; the articles cited in CHILDREN (ARTICLES ON); CIVILIZATION AND CULTURE; INTELLIGENCE; PHILOSOPHY; PSYCHOLOGY (ARTICLES ON); SCIENCE; and SOCIOLOGY. For a comprehensive view of *Encyclopædia Britannica's* resources on any topic, the Index should be consulted.

While some of the articles referred to in the above paragraphs are of special importance to the teaching profession, all are essentially nontechnical and within the grasp of the intelligent layman. The following articles are recommended as a minimal reading program for those who wish an introduction to the aims and methods of the educational world: CIVILIZATION AND CULTURE; SCHOOL ADMINISTRATION; EDUCATION, HISTORY OF; EDUCATION, PHILOSOPHY OF; HUMANITIES; SCIENCE.

EDUCATION, HISTORY OF. This article deals with the history of educational thought and practice from early historical times to the present day. Emphasis is placed on the history of elementary education rather than on that of secondary, technical and university education (*see* SECONDARY EDUCATION; TECHNICAL EDUCATION; UNIVERSITY). Descriptions of modern educational systems are in general to be found in the educational sections of the country articles, and there are also articles treating the different aspects of education (*see* COEDUCATION; ELEMENTARY EDUCATION; SCHOOL ADMINISTRATION; etc.).

The educational programs of underdeveloped countries and of countries achieving independence after World War II have been primarily concerned with the pressing problems of illiteracy and of providing elementary education for children and functional education and technical training for adults. Programs to meet these problems are discussed in the country articles. (*See* also ADULT EDUCATION; AGRICULTURAL EDUCATION AND RESEARCH; AUDIO-VISUAL EDUCATION; ELEMENTARY EDUCATION; ILLITERACY; READING.)

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I. THE WESTERN WORLD

It is usual to regard ancient Greece as the cradle of western education and as the starting place of its history. Earlier cultures —Mycenaean, Minoan and Egyptian—contributed to Greek development, but all too little is known about them, whereas the Greeks have handed down a rich store of knowledge about their educational thought and practice during the 5th and 4th centuries B.C., the great days of their civilization. Ever since, this remarkable heritage has been a formative and creative influence in the shaping of educational policy, especially in western countries.

1. Ancient Greece.—Living in city-states, the Greeks regarded education as a major service of the state and an essential instrument for the training of citizens. Frequently engaged in life-and-death struggles against powerful enemies and, in addition, often in peril from within the city-state itself, they looked to education to provide citizens capable of defending the city in any crisis. But theirs was an exclusive citizenship, for Greek civilization rested on a basis of slavery, the slaves outnumbering the citizens. Trade and manual work, regarded as degrading, were left to slaves and Greek education did not, therefore, include technical and commercial studies.

Each city-state had its distinctive character and its own conception of good citizenship, with consequent differences in educational aims, a characteristic well illustrated by the contrast between Spartan and Athenian ways of educating children and young people. The Spartans were always a minority in their territory and to retain their position as the dominant race had to be strong enough to enforce their authority over the subject majority. They had also to be able to garrison their frontiers effectively against possible invaders. Their principal aim, therefore, was military efficiency and their education was designed to promote soldierly qualities such as courage and obedience. Xenophon and other Greek writers have described the system in some detail, revealing the ruthlessness with which young people were conditioned to make them brave soldiers. Physical fitness was the paramount objective. Babies with weak constitutions or physical defects were killed by exposure and those allowed to live were, at the age of seven, taken from their mothers for a course of rigorous training. This training continued with increasing severity for the next 11 years. Grim austerity was the keynote of their lives during this long apprenticeship, the memory of which survives in our use of the word "Spartan." They were organized in "packs," each under the leadership of a boy picked for his ability and courage. Corporal punishment was an important feature of the discipline and it was imposed not only as a penalty but also as a test of endurance. Boxing and other pastimes calculated to foster fighting instincts were encouraged, and boys were kept fully occupied by an exacting round of activities. At the age of 18 they became ephebi (cadets) and for two years were trained in garrison duty. When they were 30 they became full citizens, but their military education did not cease until they were too old to fight.

Whether in the course of their training they learned to read is uncertain. Unlike other Greek states Sparta cared little for poetry and the arts. It made an exception, however, of the works of Homer and poems of war, especially those "in praise of the men who had died for their country." And the Spartans loved dancing, particularly when it reproduced movements of battle or of gymnastic exercises like wrestling. A notable feature of Spartan education was the care taken in the upbringing of girls. In other Greek states girls were given no education other than the domestic training that home life provided. But in Sparta girls were also taught to be active out-of-doors and to regard physical fitness as a main objective. They were allowed to live at home but in other respects their training was similar to that of the boys. Motherhood and the careful rearing of children were set before them as the highest ideals, and the women of Sparta were renowned for their excellence as mothers and nurses. Within its narrow range, education in Sparta was certainly efficient and fulfilled the main task assigned to it. But it was a poor training for political leadership.

Although as concerned as Sparta about defense, the Athenians had a very different attitude toward life and this was reflected in their education. Their boys were prepared for peace as well as for war, and more was expected of them than of their Spartan contemporaries—wisdom no less than courage. Their aim in education was to rear well-balanced individuals, physically sound and

intellectually alert with a moderate outlook on affairs—"nothing in excess" was a maxim to which they attached much importance. Education in Athens had no clear-cut political aim and was much less a state enterprise than in Sparta. The educative process was divided into two stages which, using modern terminology, may be described as: (1) primary, with an age range from 6 to 14; and (2) secondary, from 14 to 18. At the age of 18 boys began a period of two years' compulsory service as an ephebos, or cadet, taking the customary oath to defend the city and the gods. Later, when Athens fell under the power of Macedonia, the need for military training ceased and the ephebic years were devoted to courses in philosophy and literature. In the primary and secondary stages a principal study was music which included much that we should call literature and art. Gymnastics also had a wide connotation and was designed not only to secure physical fitness but also to promote poise and graceful movement. We have no sure knowledge of the detail of the curriculum but it generally included reading, writing, simple arithmetic, poetry repetition, music and physical exercises. Girls did not share in this education; they were trained at home mainly in housekeeping. This was because women were not of great account in Athenian society; Pericles suggests their modest role in the saying: "Great is the glory of the woman whose name is not in the mouths of men for either good or evil."

As Athenian culture developed, more attention was paid to intellectual studies, especially by students during their ephebic years. There was a corresponding decrease of attention to physical pursuits, hence the complaints of satirists like Aristophanes about growing luxury and the corruption of youth. Such complaints were apparently based on a comparison of the worst features of the present with an idealized picture of the past. But some criticism was well justified, especially when directed against the influence of the less reputable Sophists, itinerant pay-receiving lecturers who helped to gratify the Athenian's appetite for discussion. They have given the word "sophistry" to our vocabulary, and it furnishes a clue to the type of adult education they provided. Often repudiating the claims of citizenship they were a disintegrating force harmful to the morale of the state. Some Sophists, however, were great teachers and one of them, Socrates, as we see him through the eyes of his disciple Plato, stands out as one of the noblest and wisest men of all time. Although a Sophist he was a fierce enemy of the shallow and pretentious rhetoric with which some of these lecturers misled their hearers.

The Athens and Sparta of their day provided Plato and Aristotle with a useful background for their discussion of educational principles. But the quality of their thought transcends limits of time or place, and some of the problems that they examine belong as much to the 20th century A.D. as to their own. While Plato discusses education in several of his dialogues, his major pronouncements about it are in his *Republic* and in his *Laws*. "If you want to know what is meant by public education," said Rousseau in his *Émile* (Eng. trans., Everyman ed., 1955), "read Plato's *Republic*. Those who merely judge books by their titles take this for a treatise on politics, but it is the finest treatise on education ever written." Both Plato and Aristotle regarded politics and education as inseparable: for in their view education, with its main purpose the training of good citizens, should be the basis of any political structure. But the emphasis on citizenship did not involve disregard of the individual, for to be a good citizen it was necessary to be a good man. "If you ask what is the good in general of education," Plato observed in his *Laws*, "the answer is easy; education produces good men and good men act nobly. . . ."

But Plato distrusted democracy—the trial and death of his master, Socrates, was one reason for this, and he taught at a time when some brake upon excessive individualism was necessary. So he advocated a kind of communism that has been likened to that of a monastery, with education as the main creative force in the community life. But this community life involved the destruction of the family as a social unit and the elimination of parental control in the upbringing of children. This feature of Plato's utopia has had many critics including several in general sympathy with his views—Aristotle, for example, and Rousseau who asks in his *Émile:* (Eng. trans., Everyman ed., 1955): "Can devotion to the state exist apart from the love of those near and dear to us? Can patriotism thrive except in that miniature fatherland, the home? Is it not the good son, the good husband, the good father who makes the good citizen?"

Another much-criticized feature of Plato's educational scheme was that it confined the benefits to a governing class neglecting the industrial, artisan elements. Members of the governing class were to be sorted into two categories during their educational course. Those who showed practical ability but lacked philosophical insight would be given a training to fit them for military service or for subordinate positions in the task of government. But those who were outstanding in wisdom would be given a prolonged training to equip them for the highest service to the state, namely that of ruler or guardian. At the age of 20 those who showed promise of this kind were to undergo, for approximately ten years, an advanced course of study in which the mathematical sciences were an important element. At 30 there was a further selection and those chosen would be called upon to study dialectic or philosophy for five years and at the end of that period would be assigned various duties to enable them to gain experience as leaders in military and civil affairs. Finally, at 50 they would be required to spend their lives in contemplation of "the good," and to be ready "when their time comes to toil also at politics and in ruling for the public good." These guardians were the elite of Plato's utopian state, the finest products of an elaborate education designed to promote as its principal aim human goodness "intimate with the eternal order."

While it is quality of thought and vision that makes Plato's plan for education remarkable, some of the details are interesting and important. His view that women should receive the same education as men did not gain general acceptance in Great Britain until late in the 19th century, and his insistence upon it is the more surprising because in the Athens of his time women were treated as inferior beings to be educated only in household affairs. Similarly advanced was his appreciation of the role of adult education and his belief that some studies, such as philosophy, need a background of experience and maturity. Plato's conception of education was concerned to impart values, taking as a guiding principle in their selection the view that all education should conduce to the promotion of goodness. Sir Richard Livingstone has described this notion of education as a training for goodness as the most important truth that can be learned from Plato. It has had a profound influence on educational thought in the western world, and many great teachers have consciously or unconsciously based their philosophy of education upon it. Thomas Arnold, for example, was echoing Plato when he defined education as "teaching our understandings to know the highest truth, teaching our affections to love the highest good. . . . The great work of education is to make us love what is good, and therefore not only know it but do it."

Aristotle was one of Plato's pupils and shared many of his opinions about education. Like his master he believed that education should be controlled by the state and that it should have as a main objective the training of citizens. The last chapter of his *Politics* (B. Jowett's trans., 1905) opens with these words: "No one will doubt that the legislator should direct his attention above all to the education of youth. . . . The citizen should be moulded to suit the form of government under which he lives." He shared some of Plato's misgivings about democracy, but after discussing various forms of government he declared his preference for limited democracy. He recognized, however, that it could only succeed if the citizens were of high quality and contended that education should have two principal aims—training for citizenship and the development of personality. His conclusion about the purpose of education is, therefore, not unlike the twofold British aim as expressed in the Hadow report (1926) on the *Education of the Adolescent*, namely, to attain "social individuality." Aristotle anticipates another modern trend when stressing the emotional factor in education: discussing the training of citizens he urges the importance of developing a sense of "affection" for the state and the community.

2. Hellenization of the Western World.—Although on many issues Aristotle's views resemble those of his master, there are some features of Plato's ideal commonwealth of which he strongly disapproved, especially the disruption of family life. In his *Ethics* he describes the family as a centre of friendship and a powerful force for good. He was no recluse but a man of the world acquainted with public affairs; as a tutor to the young prince who became Alexander the Great he had an opportunity of influencing one who later wielded immense power. History does not record what impression he made on his famous pupil, but in due course Alexander by his conquests and his policy of planting Greek cities and towns in conquered territories succeeded during his short reign in bringing Hellenic civilization to the countries bordering the Mediterranean and farther afield. Within ten years (334–324 B.C.) he brought under his sway Asia Minor, Syria, Egypt, Babylonia and Persia, and his vast empire stretched as far as the northern territories of India. Education was encouraged throughout the Hellenic world and new centres of learning rivaling Athens developed in Alexandria, Pergamum, Antioch, Rhodes and other places.

Of the cities founded by Alexander the most famous for its learning was the one which bore his name, Alexandria. It continued to flourish under the Ptolemies, the dynasty that ruled Egypt after Alexander's death in 323, until its conquest by Rome in 30 B.C. Alexandria had a famous library founded by the first of the Ptolemies which was reputed to house 700,000 manuscripts, and there was a museum provided by his son with a residence for scholars and research workers. Researches carried out in Alexandria covered a wide field; the pioneer work done in mathematics and science was outstanding, Euclid and Archimedes being two of Alexandria's famous students. "Euclid's *Elements*," observes Lord Russell in his *History of Western Philosophy* (1946), "is certainly one of the greatest books ever written, and one of the most perfect monuments of the Greek intellect." Hellenic civilization continued to expand its influence in a variety of ways and eventually, in Cicero's words, it "poured in a great flood from Greece to Rome."

3. Ancient Rome.—During the early centuries of the republic, before coming under the influence of Greek culture, Rome relied upon parents to provide what were regarded as the essentials of education, namely character training, healthy upbringing and a grounding in civic traditions. Fathers were expected to ensure, as far as possible, that their sons grew up healthy in mind and body, that they revered the gods, knew how to conduct public business competently, and were capable of serving their country in the field in time of war. On the mothers rested the responsibility of training their daughters to be modest, virtuous, industrious and skilled in household duties. In training his sons the Roman father contrived to combine a fairly grim severity with a large measure of paternal affection. No attempt was made to arouse cultural interests or to cater to them; it was essentially a practical training, civic and moral, but its intellectual outlook was extremely narrow. It was, however, remarkably effective in producing in its youth a devotion both to the family and to Rome.

It is uncertain when Greek culture began to penetrate into Italy beyond the early southern colonies, but by about 250 B.C. Hellenism was flowing in like a rising tide. Teachers (*grammatici*) set up schools in which they taught their pupils to read and write Greek, basing their instruction on the works of great authors, especially Homer. These authors were soon being translated into Latin, and knowledge of Greek literature increased rapidly. In time, schools of rhetoric and philosophy were established, attracting students preparing for a career in public life or the law. This higher education in rhetoric, characteristic of hellenized Roman education, was not without its critics who feared that it would widen the gulf between the social classes. Theodor Mommsen (*Roman History*, Eng. trans., Everyman ed., 1911), describing it as "an exclusive humanitas," maintains that it "eradicated the last remnants of the old social equality." Cicero deals at length with the training of the orator in his *De Oratore*, contending that the well-educated citizen should be versed in both philosophy and rhetoric. In the next century Quintilian (born about A.D. 35), the most famous of Rome's teachers of rhetoric, wrote his *Institutio oratoria*, in which the conception of rhetorical culture is seen at its best. His ideal was "the good man skilled in speech."

His *Institutio* is not just a monograph on the teaching of oratory, but a comprehensive treatise covering many aspects of education. It came rather late to have a significant effect on Roman education but had a great vogue during the Renaissance, influencing especially the development of the grammar school. Although its education was so much affected by Greek thought, Rome never took kindly to the intervention of the state in educational affairs. It was not until the later phases of the empire that the central government attempted to systematize education. Vespasian (A.D. 9–79) was the first emperor to subsidize it, and eventually subsidizing led to control. Later emperors intervened over the appointment and remuneration of teachers, and Diocletian (A.D. 245–313) fixed the rate of payment for the teaching of various subjects. In A.D. 425 an imperial edict made the government the controlling education authority and, subsequently, persons wishing to keep a school had to obtain consent. From the subsequent passing of the schools from secular to ecclesiastical control until comparatively modern times—certainly for well over 1,000 years—the idea of the state as the seat of authority in education was dormant.

As Alexander the Great had done, the Romans usually planted their culture and their institutions wherever they established their rule. They installed their system of education throughout their empire and, although the subject population included people of several races with wide differences in degrees of civilization, the education provided followed much the same pattern everywhere. Grammar schools were to be found in most areas, giving pupils between the ages of about 7 and 14 an education in language and literature, while in towns of any size there were also schools of rhetoric.

In the western parts of the empire the grammar schools usually taught Latin and Greek but eastward Greek was generally the only language. Ambitious and wealthy students wanting a university type of education went to Athens, Alexandria, Rome or Constantinople; but higher education, as understood by the great majority, meant the grammar and the rhetoric schools. While Roman education was spreading, Christianity was also gaining such strength that its relationship to the schools with their pagan culture became an issue of growing importance.

4. The Beginnings of Christian Education.—At first Christianity found most of its adherents among the poor and illiterate, making little headway, as St. Paul observes (I Cor. i, 26), among the worldly wise, the mighty and those of high rank. But during the 2nd century and afterward it appealed more and more to the educated class and to leading citizens. These naturally wanted their children to have at least as good an education as they themselves had had, but the only schools available were the grammar and rhetorical schools with their Greco-Roman, non-Christian culture. There were different opinions among Christian leaders about the right attitude to this dilemma that confronted all Christians who sought a good education for their children. The Greek fathers, especially the Christian Platonists Clement of Alexandria (*c.* 160–*c.* 215) and Origen (*c.* 185–*c.* 254), regarded Christianity as the culmination of philosophy, to which the way must be sought through liberal studies. Without a liberal education the Christian could live a life of faith and obedience but could not expect to attain an intellectual understanding of the mysteries of the faith nor to appreciate the significance of the gospel as the meeting ground of Hellenism and Judaism. St. Augustine (354–430) and St. Jerome (*c.* 340–420) also encouraged the use of the secular schools by Christians, maintaining that literary and rhetorical culture is valuable so long as it is kept subservient to the Christian life. Tertullian (*c.* 155–*c.* 222), on the other hand, was suspicious of pagan culture, but he admitted the necessity, though deploring it, of making use of the educational facilities available. Most Christians who wanted their children to have a good education appear to have sent their children to these secular schools; this practice seems to have continued even after 313 when Constantine stopped the persecution of Christians, giving them the same rights as other citizens. Christians also set up catechetical

schools for the religious instruction of adults who wished to be baptized. Of these schools the most famous was the one at Alexandria which had a succession of outstanding heads, including Clement and Origen. Under their scholarly guidance it developed a much wider curriculum than was usual in catechetical schools, including the best in Greek science and philosophy in addition to Christian studies. Other schools modeled on that at Alexandria developed in some parts of the near east, notably in Syria, and continued for some time after the collapse of the empire in the west. The gradual subjugation of the western empire by the barbarian invaders during the 5th century led to the breakup of the educational system that the Romans had built up. Among the ruins of this great civilization the Christian Church survived, and one of its most important tasks was to build, when this became possible, a new educational order.

For about four centuries the western world was plunged in intellectual darkness. The church, however, was able to provide some teaching of a religious character, especially for its clergy; and on those modest foundations a new educational system took shape gradually and fitfully. Learning that had no religious significance was rarely encouraged, and monastic and other teachers were directed to avoid what Pope Gregory the Great (*c.* 540–604) stigmatized as "the vanities of worldly learning." But even during the darkest days there were exponents of wider conceptions of education and among them were such scholars as Boethius, Cassiodorus, Isidore and Bede. There were, too, monasteries in which the lamps of learning burned brightly. "We may," says Spencer Leeson in his *Christian Education* (1947), "remember with special thankfulness Bede, the monk of Jarrow, *praeceptor Angliae*, ... Not only did Bede by teaching and translation spread the knowledge of his faith: he also in his great *Ecclesiastical History of the English Nation* gave us, as it were, the first consciousness of our nationhood." But it was in Ireland that monasticism made its greatest contribution to the preservation and enrichment of culture during the 6th, 7th and 8th centuries. In pre-Christian times there had been an educational tradition in Ireland, as in other Celtic regions, which the Irish monks took advantage of by developing schools open to the laity as well as to the clergy. They were keen students of the classics as well as of their native language and literature, and, when they crossed to the continent as missionaries, they carried with them their knowledge of the literature of Greece and Rome, establishing monasteries like St. Gall and Reichenau, which won renown for their scholarship.

The monastic schools are, however, not as significant in the history of education as the schools founded by bishops, usually in connection with a cathedral. These bishops' schools are sometimes looked upon as successors of the grammar schools of the Roman empire, and they are also often regarded as the parents of the grammar school of modern times. In their efforts to provide education the bishops sometimes had the support of the new rulers. Learning had no more ardent friend than Charlemagne (*q.v.;* 742– or 743–814), who attracted scholars from many quarters to help him in his plans to bring about a cultural revival. He was distressed to find such poor standards of Latin in his correspondence, the offenders including even bishops and abbots from all parts of his empire who, he complained, were in their letters often very correct in sentiment but very incorrect in grammar. He was fortunate to secure as master of his palace school and educational adviser so great a person as Alcuin (732–804) who brought with him from York high standards of scholarship. Alfred the Great also stands out as a royal patron of learning. When he came to the throne in 871 cultural standards had fallen to a low level, partly because of the Danish invasions. He was grieved to find so few who could understand their church services in English or translate a letter from Latin into English. He himself translated into English some great books of that age, including Boethius' *De consolatione philosophiae, Cura pastoralis* by Gregory the Great and Bede's *Ecclesiastical History;* he sought in other ways, by precept and example, the spiritual and intellectual regeneration of his people. We know little of what Alfred actually accomplished for education but, like Charlemagne, he helped to ensure the survival of scholarly traditions in a bleak and uncouth age. There was, however, nothing like a general advance in education until after the moral and cultural awakening during the 11th and 12th centuries.

5. Medieval Education.—By the 11th century Europe was reaching a condition of comparative political stability and social tranquility. The barbarians had been converted to Christianity, and there was general acceptance of the authority of the church in matters of belief, conduct and education. Soon contact with the east, by trade and in the crusades, and with the highly cultivated Moors in Spain further stimulated intellectual life. Arabic renderings of some of the works of Aristotle together with commentaries were translated into Latin, exercising a profound influence on the trend of culture. Other translations of Aristotle followed, notably those by the Dominican, William of Moerbeke, archbishop of Corinth. In the Christian world scholasticism (*q.v.*) became the dominant mode of thought with Peter Abelard (1079–1142) and St. Thomas Aquinas (1225–74) its dominant figures. The widespread intellectual ferment, the zeal in disputation characteristic of scholasticism and the growth of towns all contributed to the creation and development of universities (*see* UNIVERSITY). They met a great need of the western world at that time and by 1500 as many as 79 universities had been founded in Europe. While modern universities may seem very unlike their medieval prototypes, the essence of a university has not changed since its beginning more than 700 years ago.

The founding of universities was naturally accompanied by a corresponding increase in schools of various kinds. In most parts of western Europe there were soon grammar schools of some type available for boys. Not only were there grammar schools at cathedrals and collegiate churches but many others were founded in connection with chantries and guilds and a few in connection with hospitals. It has been estimated that toward the close of the middle ages there were in England and Wales for a population of about 2,500,000 approximately 400 grammar schools, rather better provision than in Victorian days. Knowledge of the teaching provided in the grammar schools at this period is too slight to justify an attempt at a description. No doubt the curriculum varied, but religion was all-important, with Latin as a written and spoken language the other major element in the timetable. There might have been instruction in reading and writing in the vernacular, but in addition to the grammar schools there were writing and song schools and other schools of an elementary type. Elementary teaching was given in many churches and priests' houses, and children who did not receive formal scholastic instruction were given oral teaching by parish priests in the doctrines and duties of the faith. The evidence of accounts, bills, inventories and the like suggests that there was some careful teaching of writing and of an arithmetic that covered the practical calculations required in ordinary life.

Girls were sometimes taught in nunneries, but usually in the home, and those of the upper classes, at least, generally learned to read, write and keep accounts, to perform household duties and to obtain such elementary medical knowledge as might be helpful when called on to treat minor accidents or ailments. For young and grown-up alike there was much that was educative in medieval society, and the influence of the community life of church, guild and village was an important factor. "Every village has its painter," wrote William Morris of the middle ages in his *Gothic Architecture* (1893), "its carvers, its actors even . . . . The few pieces of household goods left of its wreckage are marvels of beauty; its woven cloths and embroideries are worthy of its loveliest building; its pictured and ornamented books would be enough in themselves to make a great period of art." Medieval education had many shortcomings, and its benefits were too often confined to a few; but on the whole the mass of the people were by no means sunk in brutish ignorance. The number of people who could read the vernacular, as evidenced by the demand for books in the vulgar tongue as soon as printing made them available, is proof that the latter part of the middle ages was certainly not a time of general illiteracy.

In fulfillment of its responsibility for education, the church from the 11th century onward made the establishment of an effec-

tive educational system a central feature of ecclesiastical policy. During the papacy of Gregory VII all bishops were asked to see that the art of grammar was taught in their churches, and a Lateran council in 1215 decreed that grammar school masters should be appointed not only in the cathedral church but also in others that could afford it. Solicitude at the centre for the advancement of education did not, however, result in centralized administration. It was the duty of bishops to carry out approved policy but it was left to them to administer it and they in turn allowed schools a large measure of autonomy. Such freedom as medieval schools enjoyed was, however, always subject to the absolute authority of the church, and the right to teach was restricted to those who held a bishop's licence. This device was used to ensure that all teachers were loyal to the doctrines of the church, and the power to issue or withhold the licence was often delegated to an officer of the cathedral, the scholasticus or chancellor.

In medieval society there was an entirely different training for boys of high rank, and this created a cultural cleavage. Instead of attending the grammar school and proceeding to a university, these boys served as pages and then as squires in the halls and castles of the nobility, there receiving prolonged instruction in chivalry. The training was designed to fit the noble youth to become a worthy knight, a just and prudent master and a sensible manager of an estate. Much of this knowledge was gained from daily experience in the household, but in addition the page received direct instruction in reading and writing, courtly pastimes such as chess and playing the lute, singing and making verses, the rules and usages of courtesy and the knightly conception of duty. As a squire he practised more assiduously the knightly exercises of war and peace and acquired useful experience in leadership by managing large and small bodies of men. But this was a type of education that could only flourish in a feudal society and, while some of its ideals survived, it was outmoded when feudalism was undermined by the growth of national feeling.

6. The Renaissance.—The Renaissance was a landmark in the history of western education. One of its principal characteristics was a revival of the learning of ancient times but no less strong was the yearning for a new world with a fuller and more interesting way of life. In schools and universities the first of these two trends predominated, and educators of the period turned eagerly to the literature inherited from Greece and Rome. It was in the cities of northern Italy that this revival of learning began and from Italy it spread gradually to countries north of the Alps. But for about two centuries Italy stood in the van of European culture.

The educational ideals of the Renaissance were first expounded by Paulus Vergerius (1349–1420), who in one of his treatises advocates a liberal education, describing it as one that calls forth, trains, and develops the highest gifts of body and mind. He wrote a commentary on Quintilian's *Institutio oratoria* that helped to secure for that work a vogue much greater than it enjoyed in its own day. Vergerius' ideals found practical expression in the teaching of Vittorino da Feltre (1378–1446), the great humanist schoolmaster who taught the family of Gianfrancesco Gonzaga, lord of Mantua. Naming his school *La Giocosa* (the house of joy), he had about 60 pupils including the sons and daughters of his patron and boys of other noble families as well as some poor boys chosen for their ability. The language and literature of Rome and Greece were the central features of the curriculum, but other subjects such as arithmetic, geometry and music were taught as well as games and physical exercises, following the Greek ideal of development of body and mind. An important omission was the teaching of the vernacular. By precept and example Vittorino strove to make his school a Christian community, and there were daily devotions. For him classical studies were not the end and sum of education but a means of implanting ideas, developing taste and acquiring knowledge, all as helps and ornaments of a Christian life.

When the Renaissance reached northern Europe, there were still no signs of antagonism between the new humanism and Catholic faith and practice. It made its first advances in the Netherlands where, in the free cities ruled by a powerful and wealthy burgher element, conditions bore some resemblance to those of the Italian cities. There the Brethren of the Common Life (*q.v.*) introduced humanistic studies into their schools side-by-side with definite religious teaching and observances. The earlier German humanists such as Nicholas de Cusa, Alexander Hegius, Johann Agricola and Jacob Wimpheling adopted the same attitude, and Erasmus (1466–1536) himself, bitterly as he attacked the practical abuses of the church, remained in communion with it and aimed at harmonizing classical culture with the Christian life. He outlined his educational aims as: to sow the seeds of piety; to create a love of liberal studies; to prepare for the duties of life; and to promote good manners. In England the same love of classical culture combined with devotion to the church was seen in the leading humanists, most of whom were Erasmus' friends such as Thomas Linacre, John Colet and Sir Thomas More, whose enthusiasm for the new learning was as undoubted as their loyalty to Catholicism. Both Oxford and Cambridge welcomed the new learning, and in France even the conservative University of Paris—the headquarters of scholastic philosophical theology—permitted the teaching of Greek as early as 1458. One of the most interesting of the humanist educators was the Spaniard, Juan Luis Vives (1492–1540). He spent a few years in England under the patronage of Catherine of Aragon, tutored her daughter Princess Mary, and wrote at Catherine's request a treatise, *The Instruction of a Christian Woman.* His most influential work, however, was a comprehensive treatise on the curriculum and methods of study, *De tradendas disciplinas* (*On Education*).

It looked then, at first, as if the classical revival would result in a deepening of literary culture and the substitution of real inquiry for dialectical subtleties in the courses of schools and universities without any break with established religious teaching. It is true that when the religious revolt in Germany under the leadership of Luther (1483–1546) threw Europe into two hostile camps the majority of the schools had not been much affected by the Renaissance, and many universities had given but a half-hearted welcome to humanistic studies. Even so, the new learning had already won some notable victories and the prospect for further advance was promising, when education became enmeshed in the complex religious struggle that shattered the unity of Christendom.

7. Some Consequences of the Reformation.—The Reformation had a disruptive, disintegrating influence on education. The secularization of ecclesiastical property too often absorbed the endowments of the schools so that, both in Germany and in England, the majority of grammar schools either disappeared or continued a starved existence with depleted funds. Education was also profoundly affected by decisions in some countries to support one particular form of Christianity in pursuance of the principle that the religion of the people must be the religion of their ruler. Several of the German states adopted Lutheranism, their schools and universities being remodeled on Protestant lines. In this work Philipp Melanchthon (1497–1560), who came to be known as *Praeceptor Germaniae,* was pre-eminent and under his influence a number of universities were founded or reorganized and many schools set up or re-established. He also, by his own teaching and writing, did much to promote a combination of humanism and protestantism in the education of northern Europe and exercised a far-reaching influence through his many disciples and friends. One of these was John Sturm (1507–89), whose Latin *Gymnasium* at Strasbourg became a model for the grammar schools of the Protestant countries. John Calvin (1509–64) taught for a time in Sturm's *Gymnasium,* and he drew on his experience there when framing the curriculum of the college he founded in Geneva. Because of Calvin's eminence as a religious leader, the educational principles observed at his Geneva college were adopted in countries where his religious doctrines took root. The Huguenots in France, the Reformed Church in Holland, the Puritans in England and Wales and the Presbyterians in Scotland were in varying degrees influenced by Calvin's educational thought and practice.

In countries that remained Catholic the Roman Church retained control of education. The practical reform of abuses by the Council of Trent and the energy and skill of the Society of Jesus,

founded by St. Ignatius of Loyola in 1534 and recognized by the pope in 1540, brought most of south Germany back into the fold of the Catholic Church. In the Catholic universities, mainly staffed by Jesuit fathers, scholasticism, purged from the formalistic excesses that had degraded it, was fully restored. "They are so good," said Francis Bacon of the Jesuit teachers in his *Advancement of Learning* (Everyman ed., 1954), "that I wish they were on our side." By their successful teaching and comparatively mild discipline the Jesuit schools attracted thousands of pupils. The curriculum was purely classical, but importance was attached to spacious, well-adapted buildings and amenities designed to make school life interesting. In general, however, the religious conflict did great harm to education, which suffered much because contestants who gained power used the schools to propagate their cause, discarding teachers not of the approved persuasion. Moreover, apart from religion, the schools continued to ignore the new directions of men's minds, and the classical languages and literature, especially Latin, remained the only essential elements of secondary education. In the 17th century grammar-school teaching became more and more remote from the needs of life, and the absurdity of it was accentuated as Latin gradually ceased to be the language of the world of learning. In vain Bacon deplored the obsession with "words, not matter" and, foreseeing the necessity of laboratories and apparatus, urged that "other helps are required besides books" (*Advancement of Learning*, Everyman ed., 1954). The universities like the schools declined for the most part to contemplate any enlargement of the frontiers of knowledge and were too often deeply involved in the religious conflicts of the time. Toward the close of the 17th century there was a revival of mathematical studies at Cambridge, largely as a result of the work of Sir Isaac Newton, and a new academic era opened in Germany with the foundation of the universities of Halle (1694) and Göttingen (1737). But in general the main current of intellectual life tended to drift away from the orthodox centres of learning. The formation of the Berlin academy in Germany, the Royal society in England and the Académie des Sciences in France reflected this tendency.

There were, however, some interesting attempts to relate education to the needs of the time. One of the most ardent reformers was Johann Comenius (1592–1670), the great Czech educationist who, driven from his home by the severities of the Thirty Years' War, was invited to England for conversations about education when the Puritans were in power. His *Great Didactic*, in which he expounds his principles, brought a new note of realism into educational thought and, urging the claims of experimental science, was an important influence in shaping the curriculum of the Dissenters' academies established in England and Wales during this period. Another influence was John Milton's tractate *Of Education* (1644) in which he condemned the pedantic teaching of the classics in grammar schools. In France, and later in Germany, it became unusual for children of rank to attend such schools, and some of the best writing about education was concerned with teaching in aristocratic academies or at home. Two books written in the 16th century had a considerable vogue: Baldassare Castiglione's treatise on courtly manners *Il Cortegiano* ("The Courtier," 1528); and Sir Thomas Elyot's *The Boke Named the Governour* (1531) in which, recalling Plato's guardians, Elyot expounds an education designed as a preparation for public life. Such ideals found expression in the courtly academies which flourished in France in the 17th century and were soon imitated in the *Ritterakademien* of Germany.

8. The 18th Century.—There could not, however, be any general advance in education until religious animosities had died down. Happily the storms abated during the 18th century and the approach to educational problems became more tolerant. While John Locke's educational writings are important, probably his greatest services to education were his advocacy of a more liberal spirit in his *Letters concerning Toleration* (1689–92) and his widespread influence as a protagonist of civil liberty. But toleration came slowly, and meanwhile education went through a bleak period in which many universities and grammar schools stagnated at a low level. Schools providing education of an elementary kind were few and grossly inadequate, and there was mass illiteracy. The plight of poor children led to some notable philanthropic enterprises on their behalf, among which were the Christian schools that had been instituted in France by St. Jean Baptiste de la Salle toward the end of the 17th century and the charity schools provided in Britain by the Society for the Promotion of Christian Knowledge. Other ventures in the same cause were August Francke's charity school at Halle (1695) and, a later effort, the Sunday School movement initiated in England by Robert Raikes (1780).

It was, however, a period of great activity in reformulating educational principles, and there was a ferment of new ideas, some of which in time wrought a transformation in school and classroom. Of those who thought and wrote about education no one has had so great an influence as Rousseau (1712–78), whose *Émile* has often been called the charter of childhood. "The first thing," he wrote in his preface, "is to study your pupils more, for it is very certain that you do not know them." By stressing the importance of helping children to grow and develop naturally Rousseau started a revolution in educational theory which in time completely changed the relationship of teacher and pupil. His insistence that child nature is wholly good helped to destroy the harsh systems of discipline widely prevalent in his day, but it should be noted that it is a view at variance with Christian doctrine and with the findings of modern psychoanalysis. His version of education, so different from the artificial, conventional, formal teaching then usual, inspired others to continue the revolution that he initiated. He had many illustrious followers who if they did not adhere strictly to his creed were nonetheless of his fold; among them were such great educators as Johann Pestalozzi (1746–1827), Friedrich Froebel (1782–1852), John Dewey (1859–1952) and Maria Montessori (1870–1952).

9. The 19th Century.—Educational systems are strongly rooted in their nation's history and, therefore, differ in structure and scope even when, as in the western world, they share a similar cultural inheritance. But there were in the 19th century several general trends that were still influencing education in all western countries in the second half of the 20th century. Of these the most significant was the gradual acceptance of the view that education ought to be a responsibility of the state. In a sense the idea of a controlling state was a return to the Greek conception with which the history of western education opens, but its modern history began when Prussia set about its task of regeneration after its crushing defeat at Jena. Inspired by Johann Gottlieb Fichte (1762–1814) and Wilhelm von Humboldt (1767–1835) the Prussian educational system became the mainspring of recovery. In 1808 a department of public instruction was established and educational reforms soon followed. In the next year the University of Berlin was established, and then secondary education was reconstructed. First *Gymnasiums* were provided, several of the old grammar schools being reformed for this purpose. Their curriculum was mainly classical and, with an age range of 9 to 18, they were designed for boys who intended to proceed to the university or enter one of the professions. There was an officially prescribed school-leaving examination, and to maintain a good standard of teaching and raise the status of the teachers a special qualifying examination was instituted for men who proposed to teach in these schools. Gradually an alternative modern type of secondary education evolved, the *Realschule*, and succeeded so well that it became the envy of educational reformers in other countries. Although von Humboldt, Fichte and other progressive leaders also wished to see a good system of primary education established, advance in that field proved more difficult owing to reactionary obstruction: but Prussia gradually succeeded in building up a comprehensive system of education of a two-class type with the *Volksschule* providing an elementary education for the great majority of children. Attendance was compulsory, and before the end of the century it was made free. To maintain a supply of suitable teachers for the *Volksschulen* training colleges were established, and although the school curriculum was in many respects narrow, there were progressive influences at work. Among those who staffed the colleges were several disciples of Pestalozzi

and there were exponents of the educational ideas of Johann Friedrich Herbart (1776–1841), which had a considerable vogue. Froebel's doctrines were also becoming popular when in 1851 the minister of education dealt the movement a severe blow by prohibiting kindergartens. In the second half of the century continuation schools were developed and there were important advances in technical education. Victory in the Franco-German War, the unification of Germany and the creation of the German empire greatly enhanced the prestige of the system of education established by Prussia: education in Germany continued to develop until the outbreak of World War I, its statesmen recognizing the importance of education to their policy of industrial and commercial expansion and as a means of promoting national unity and an ardent patriotism.

It was in France, however, that the idea that the state would control education was first revived. Louis René de la Chalotais (1701–85) expounded the doctrine in his *Essay on National Education* (Eng. trans., 1934), criticizing at the same time the education given by the Jesuits. "I venture to claim for the nation," he urged, "an education which depends only on the state, because it is essentially a matter for the state. . . ." His *Essay* had a considerable influence, and during the 19th century France developed its highly centralized educational system. Napoleon initiated it, creating in 1808 the "Université de France," which was not so much a university as a government department under a rector responsible for the administration of education. Napoleon wished to ensure that the state was well provided with military officers and civil servants and he therefore encouraged the establishment of *lycées* and colleges. He paid relatively little attention to primary education, leaving it to the church and the communes. François Guizot, when minister of education, first organized primary schools under his law of 1833. Each commune had to maintain such a school: each town with more than 6,000 inhabitants had to provide a senior primary school, and each *département* a training college for primary teachers. There were several crises about the powers of church and state, and after France's catastrophic defeat in the Franco-German War there was much political controversy about the future of education. With the knowledge of what education had accomplished in Prussia it was realized that it could be an important asset in the Third Republic's efforts to revitalize the nation, but proposals for educational reform encountered much opposition. Eventually, at the instance of Jules Ferry, a strong education minister, primary education became in the 1880s secular, compulsory and free. New *lycées* were established, and provision was made for secondary education for girls, which had hitherto been mainly undertaken by the church. Technical education was developed and, between 1885 and 1896, 15 universities were reestablished as state universities. In the course of the century there were many attempts to modify the curriculum of the *lycées* but there was great reluctance to depart from the classical tradition, for much importance was attached to *culture générale* as the hallmark of an educated Frenchman. The relationship of church and state in educational affairs continues to be a source of controversy. A committee set up to find an acceptable solution produced a conciliatory report in 1959 only to provoke a renewal of bitter argument in which the question of state aid for church schools was the main issue.

England under the spell of laissez faire hesitated a long time before allowing the state to intervene in educational affairs. At the beginning of the 19th century education was regarded as entirely the concern of voluntary or private enterprise, and there was much unsystematic philanthropy. Attempts were made to canalize and concentrate it, and many hoped that the Church of England and the dissenting churches would join in a concerted effort to provide a national system of elementary education on a voluntary basis. But discordant views prevented such co-operation, and two voluntary societies were founded, one representative of the Church of England and the other of dissent. In 1829 the Catholics were emancipated by law from disabilities they had long suffered, and so they also were able to provide voluntary schools. Other religious bodies joined in the effort to meet the growing need for elementary schools but it was soon evident that voluntary finance would not be equal to this formidable task. In 1833 the government made a small building grant to these societies, and in this modest way state intervention began. Six years later a committee of the privy council was established to administer the state grants, now made annually, and to arrange for the inspection of voluntary schools aided from public funds. The work involved led to the establishment of a small central education department which was the beginning of the ministry of education.

England paid heavily for its prolonged reliance on voluntary initiative; for year after year population increased and with the growing industrialization people crowded in increasing numbers into the new towns. At last in 1870 parliament after long acrimonious debates passed an Elementary Education act, the foundation upon which the English educational system has been built. Religious teaching and worship were the crucial issues in the debates, and the essentials of the settlement agreed upon were: (1) a dual system of voluntary and local authority schools; and (2) careful safeguards about conscience to ensure as far as possible that no child would receive religious teaching at variance with his parent's wishes. It was left to the school boards—as these first local education authorities were called—to decide whether to make elementary education compulsory in their districts. In 1880, however, it was made compulsory throughout England and Wales, and in 1891 fees were abolished in all but a few elementary schools.

Secondary education, however, was still left to voluntary and private enterprise, and attention was focused on the "public" schools (independent secondary schools, usually for boarders from upper and well-to-do middle-class homes), which under the leadership of outstanding headmasters like Thomas Arnold (1795–1842) were thoroughly reformed. Several new universities were founded during the century, and during the latter half of it a number of girls' high schools and boarding schools were founded in which an education was given comparable to that in boys' public schools and grammar schools. Several training colleges for teachers were established by voluntary agencies, and universities and university colleges toward the end of the century undertook the training of postgraduates as teachers in departments of education created for this purpose. At the same time much thought was given to the secondary curriculum not only in England but throughout the western world. It was considered by such various bodies as the Imperial conference in Berlin (1890), the Ribot commission in France (1892), the Committee of Ten appointed by the National Education association in the United States (1892) and the Bryce commission in England (1895). In England the Education act of 1902 abolished school boards and made county and county borough councils the local education authorities; it empowered them to provide secondary and technical as well as elementary education. In the secondary schools that the local education authorities founded, the curriculum, while academic, was more broadly based than that which had been customary in the endowed grammar schools, and there were also interesting developments in postprimary education, providing an alternative education of a more practical type.

10. The 20th Century.—During the 20th century educational advance was halted by World Wars I and II and the ensuing economic dislocations. In preparation for World War II education was exploited in Germany and Italy to serve the ends of the dictators, but the general effect of both wars was to stimulate a yearning for social improvements and for educational reforms. Chiefly there was a desire for more equality in educational opportunity and for an education more appropriate to the interests and abilities of individual pupils. Such aspirations led to a more democratic attitude toward the organization of schools. The traditional British and European system of elementary schools for the masses and secondary schools for only a limited number of fee payers and scholarship holders became outmoded and the pattern emerging in the 1960s was one in which all pupils passed from the primary to the secondary stage. While this conception was largely because of the growth of a more egalitarian society, its adoption was stimulated by the spread of industrialization, which not only created a demand for better educated workers but also resulted in improved standards of living and an increase in the number of parents who

wanted their children to have a good education. The demand for secondary education led to extensions of the school-leaving age and to proposals to extend it still farther; there were important changes in the scope of secondary education and new types of schools were created to bring secondary education more in line with the needs of contemporary society. With a view to meeting the requirements of a scientific and technological age there were substantial developments in technical education and a remarkable expansion of universities, both as regards number of students and range of studies. While educational reform has usually come gradually in response to popular demands for social justice, it has in modern times had the vigorous support of statesmen, who have recognized the importance of education as an essential of national survival in a competitive and troubled world. In a wartime talk on the radio in 1943 Winston Churchill expressed the modern statesman's view: "The future of the world is to the highly educated races, who alone can handle the scientific apparatus necessary for pre-eminence in peace or survival in war."

In England the reports of the consultative committee, especially those known as the Hadow reports and the Spens report, paved the way for the reconstruction of the educational system provided for in the Education act of 1944; and the 1959 report of the central advisory council for education in England, the Crowther report, made important recommendations. In France the Langevin-Wallon recommendations made after World War II provided a comprehensive program of reform; the times were not propitious for its implementation but it had a formative influence in the schools and some of the proposals were carried out. Child study and the influence of psychologists not only transformed the teaching of infants and juniors but also brought about a growing realization of the significance of the pre-school stage and the value of co-operation between schools and home. In Italy first the sisters Rosa and Carolina Agazzi and then Maria Montessori, who opened the first of her children's homes in Rome in 1907, showed how much can be accomplished by education in early childhood. In France *écoles maternelles* have a long history and in the early 1960s there were about 4,000 of these institutions in which the children grow and learn in a happy environment. In England interest in the upbringing of very young children was roused by the work of Rachel and Margaret Macmillan, who established a nursery school at Deptford, London, in 1914. (*See* also ELEMENTARY EDUCATION; PRE-ELEMENTARY EDUCATION.)

By the second half of the 20th century it had become increasingly recognized that progress depends on an adequate supply of suitably qualified teachers. When teachers have not been forthcoming, classes have been large, making it difficult for teachers to give the pupils individual attention. But the problem has not been just one of recruiting teachers in sufficient numbers; modern methods of teaching require teachers of ability, well-prepared for their vocation. The staffing requirements of the schools have become more and more diversified as a result of the widening scope of education and the proliferation of subjects; it is not easy, especially where there are strong traditions of freedom, to organize the recruitment and training of teachers in such a way that the various staffing needs of schools are met satisfactorily. There was, for example, in the 1950s a shortage, both in the United States and Britain, of teachers of mathematics and science. Industry was attracting potential teachers qualified in these subjects, and at the same time by its demands for more and more scientists, technologists and technicians was adding to the number of students and pupils wanting to study these subjects in technical colleges and schools. In the U.S.S.R. the demand for teachers of these subjects was even greater, for in their specialist institutes and technicums the Russians were training more engineers than any other country both in terms of actual figures and per head of the population. But by central direction they were fairly successful in producing an adequate supply of suitably qualified teachers and in maintaining a high standard of scientific and technological education.

Much attention has been given in modern times to the preparation of teachers for their vocation. For a long time it was assumed that teachers in primary or elementary schools did not require a university education, and instead a training largely on apprenticeship lines was provided for them. On the other hand, secondary-school teachers were expected to have acquired at the university a knowledge of the subject they were going to teach but, except in Germany, they did not receive training of a vocational character. During the 20th century opinion about the preparation of teachers has been gradually changing, mainly as a consequence of new conceptions of education of primary and secondary teachers that were not easy to justify, but if much remains to be done in this field, it is no less true that there has been substantial progress. No country in the 20th century has done more for teacher education than the United States and some of its institutions, like the Teachers' college of Columbia university, are among the best of their kind. One great advance there has been the evolution of the normal schools, for training teachers, into teacher colleges, offering degrees to students completing a four-year course. In England the two-year training college course was extended to three years in 1960, and the regular co-operation of training colleges with university education departments in what are known as area training organizations had helped to created a liaison between the non-graduates and the university systems of teacher education.

See also ACADEMIES; CLASSICAL EDUCATION; COEDUCATION; ELEMENTARY EDUCATION; EXAMINATIONS; TEACHER TRAINING; TECHNICAL EDUCATION; WOMEN, EDUCATION OF; etc.

(W. O. L. S.)

II. NATIONAL SYSTEMS

The history of national systems of education providing public schools controlled and financed by the state and with attendance required by law is traced to the rebuilding of Prussia after the defeat at Jena (see *The 19th Century,* above). The following descriptions of national systems illustrate various aspects of this history. The United States was the first country to provide universal education through a common (one-track) school system, with separation of church and state. The history of the development of education in England traces the long conflict between voluntary and religious groups and the state, while Scotland's system has been free and independent and the commonwealth countries represent various adaptations of British institutions to local conditions. France and Germany illustrate highly organized educational systems established by centralized states. The U.S.S.R. has, in the 20th century, reduced illiteracy from about 70% (1920) to less than 2% (1960) and established ten years of universal compulsory schooling. (For a discussion of various types of school administration, control, management and direction *see* SCHOOL ADMINISTRATION.)

A. UNITED STATES

1. Control of Education in Colonial America.—During the colonial period, from the founding of the colonies in the 17th century to the Revolutionary War in the later 18th century, American schools generally reflected European educational ideas but they also began to reveal some distinctive characteristics of their own. Education was one of the powers of government transferred to the new world by delegation from the British crown to stock companies, proprietors, royal governors and colonial legislatures. From the very beginning of the colonies, therefore, power over schools was held by governmental authorities. Inasmuch as established churches were closely allied with civil governments in the 17th century, religion played a large part in most colonial schools and colleges. Although feudalism did not gain a strong hold on American life, certain definite distinctions between upper and lower classes were reflected in a dual system of schools, with elementary schools designed for the lower classes and secondary schools for the upper classes.

In the course of the 18th century colonial governments continued to maintain authority over education but began to delegate to private individuals and religious groups the right to establish and support their own schools. This shift from governmental to private control arose when a number of religious sects began to demand greater religious freedom, a fact that eventually contributed to the separation of church and state. Where religious

diversity was honoured and where religious groups had freedom of conscience and worship, the schools founded by public authorities could not continue to teach everyone the same religious doctrines. The early 18th-century solution to this problem was to permit the several religious denominations to conduct their own schools as private institutions.

The growth of towns and commerce, the rise of a strong middle class and the consequent economic development of the country led to the demand for new types of educational institutions and instruction that would meet the practical needs of the populace. These trends began to threaten the academic traditions that had produced the dual system of schools based upon distinctions of economic and social class, and served to create more flexible and democratic types of education from the middle of the 18th century onward.

Government Control of Schools.—During the 17th century the New England colonies exercised more direct public control over and support of schools than did the other colonies. Their relatively compact forms of town life, their Calvinist zeal for education and their strongly established Puritan forms of church control (except in Rhode Island) led to public initiative in this respect. In the 1630s several New England towns took steps to establish schools under the authority and supervision of the town meetings. In 1642 the general court (colonial legislature) of Massachusetts passed a law requiring all parents and masters of children to see that their charges were taught reading, the capital laws, the religious catechism and apprenticeship in a trade. Although no schools were established by this law, the colonial legislature exerted its authority to require compulsory education for the good of the commonwealth. Other New England colonies soon followed suit.

In 1647 Massachusetts again took the lead by passing a law requiring all towns of 50 or more families to appoint a teacher of reading and writing and making it possible for the teacher to be paid out of tax funds if the people so ordered. The law of 1647 also required all towns of 100 or more families to provide a teacher of Latin grammar as a means of preparing boys to enter college. Again, the other New England colonies followed Massachusetts and helped to formulate the New England conception of a public school which included the following principles: the state had authority to require parents to educate their children; the state could require the towns to establish schools; public moneys could be used to support schools; and the public authorities had the right to establish, control, supervise and directly manage and administer public schools.

In the 18th century two further developments took place. With respect to public schools the units of governmental control became smaller. As people moved into the back country, away from the populated places, the small local districts gained the right to set up their own schools apart from the jurisdiction of the larger town. This process of decentralization of control was a response to the frontier conditions of life and reflected the agrarian interests of the districts in contrast with the growing commercial interests of the central towns. The second development was an increase in the number of nonconformist religious groups that resisted the authority of the established churches. Stimulated by the religious revivals, they wanted their own forms of religious worship free from the control of the state church, and they wanted their own schools in which they could teach their own religious doctrines. Gradually, therefore, the colonies began to authorize different religious groups and private incorporated bodies to establish and maintain their own schools.

Public interest in education was not so extensive in the southern colonies as it was in New England. There it was assumed that education was rather a function of the church and of parents who could afford to educate their children, as had been the practice in England. But even so, the colonies' public concern with education was exerted in two principal ways. The southern colonial legislatures passed many laws requiring apprenticeship and education in literacy and religion for poor children, orphans and illegitimate children. The southern colonies thus exerted their authority over children who had no parents or whose parents could not properly care for them. In addition, the parish authorities (boards of vestrymen), which were civil as well as religious in nature, sometimes made provision for education. Beyond these efforts, several sporadic attempts were made to establish colony-wide systems of public education in Maryland, South Carolina and especially in Virginia, where Thomas Jefferson in 1779 proposed a complete system of public schools; but his proposals were not accepted by the legislature.

In the middle colonies the Dutch in New Netherland and the Quakers led by William Penn in Pennsylvania made early attempts to establish public control over education. But religious diversity in both colonies prevented the culmination of these plans in the 18th century, and the typical arrangement came to be denominational control of education.

Private Control of Schools.—In the 18th century several types of private schools came to characterize education in the colonies. Some of these were endowed schools whose support came largely from gifts or bequests of land, livestock or other goods of value. Such schools had a difficult time until control was vested in corporate bodies of men who were authorized to act as continuing trustees for the lands, buildings and endowments. The incorporated school under the control of a self-perpetuating board of trustees and created by charter by the state became an important type of private school toward the end of the 18th century.

Thus was born the academy, which soon replaced the Latin grammar school as the typical form of American secondary school. Many private elementary schools were also established by the several religious denominations. Some of these were conducted by individual congregations, others by groups of neighbouring churches and still others by large religious bodies, notably the Society for the Propagation of the Gospel in Foreign Parts. Still another type of private school was exemplified by the private-venture schools that arose in the seacoast towns in the early 18th century. These schools, set up by enterprising teachers for their own profit, were designed to make available a more practical type of education for young men and women.

2. Colonial Types of Instruction.—The curriculums and methods of instruction of colonial schools reflected the currents of religious thought of the Protestant Reformation, the humanist emphasis upon the classical liberal arts, the aristocratic ideal of an education for a gentlemanly class and the practical needs of vocational training for a rising middle class.

Elementary Education.—The dominant concerns in elementary schools were literacy and religion. This meant that children were taught reading and writing and often some elements of arithmetic. The materials of instruction were likely to be simple and usually religious in nature. These usually consisted simply of the alphabet, easy syllables, the Lord's Prayer, some hymns and Bible stories. The most famous of colonial schoolbooks was the *New England Primer*. Methods of instruction emphasized memory work, and punishment was often severe. For poor children and orphans, education was likely to consist of a form of apprenticeship whereby the child was taught a trade by his master and incidentally may have acquired some reading, writing and knowledge of the catechism. In general a child was fortunate if he had as much as two or three years of formal schooling, and the majority probably never attended any school at all.

Secondary Education.—Throughout most of the colonial period the dominant type of secondary instruction was carried on in Latin grammar schools in which the focus of attention, as the name indicates, was upon the study of Latin. In general the Latin grammar school was attended by the children of the more privileged families of the upper classes and was looked upon as providing the preparation necessary for college education and for positions of leadership in church and state. It thus reflected not only the aristocratic tradition of a gentleman's education but also the traditions of Renaissance humanism, according to which an educated person must be accomplished in knowledge of the classics.

In the 18th century the aristocratic and classical character of secondary education was modified and broadened somewhat by the appearance of new types of secondary schools. "English" schools were set up to provide instruction in a much wider range of studies,

including English, modern languages, mathematics, navigation, surveying, commercial arithmetic, bookkeeping, geography, history, music and the arts. These schools gave a more practical type of education to middle-class youth who were going into trade and commerce rather than to college. They also widened the opportunity for education of girls.

More permanently a part of American education were the academies which arose not only to meet such practical needs as mentioned above but also to provide a religious setting for the education of young men and women. The curriculums of the academies included languages, the social studies, the sciences, mathematics, the arts and music as well as the classics. They thus combined the religious, humanistic and practical concerns of the later 18th century.

Higher Education.—One of the most remarkable features of American colonial education was the fact that nine degree-granting colleges were established prior to the American Revolution. In general their programs were modeled after the colleges of the English universities. They were designed primarily to give education in the traditional liberal arts of Latin and Greek grammar, rhetoric, mathematics and philosophy. Even though the colonial colleges were not exclusively training schools for ministers, most of them were sponsored by the several religious denominations and thus combined religious and humanistic qualities. To a greater or lesser degree they adapted themselves to the new science and mathematics that were being developed during the 18th-century Enlightenment. Although they revealed varying elements of public control, they set the pattern for private higher education which prevailed in America until the 19th century. Harvard (1636), Yale (1701) and Dartmouth (1769) were established by the Congregationalists; William and Mary (1693) and Columbia (1754) were established by the Anglicans; Princeton (1746) by the Presbyterians; Brown (1764) by the Baptists; Rutgers (1766) by the Dutch Reformed; and the University of Pennsylvania (College at Philadelphia, 1755) was nondenominational.

3. Public Education in Early National Period.—During the years between the American Revolution (1775–81) and the Civil War (1861–65) Americans developed educational policies dedicated to the new national ideals of democracy, equality and freedom. If the new republic was to rest upon the consent of the governed, then all people would need to be educated for their responsibilities as citizens of a democracy. If the republic was to be strong and secure despite the differences of language and culture brought by immigrants from many lands, then all people must acquire the common language and values of U.S. citizenship. If talents were to be rewarded on the basis of ability and not upon class, economic privilege or place of national origin, all must have equal educational opportunity. If religious freedom and separation of church and state were to become realities in a country of divided religious loyalties, then education must be divorced from sectarian control.

To achieve these ideals the U.S. turned away from private systems of education based upon economic, class, national and religious distinctions and turned toward a system of common schools that would be free, universal and open to all. Despite vast difficulties and vigorous opposition, it was gradually decided that such values could be achieved only through the establishment of a free system of public education, publicly controlled and supported. The main outlines of such a system were achieved by the middle of the 19th century.

State Systems of Common Schools.—The ideal of public education was achieved under the leadership of a determined band of educational statesmen who acquired the support of increasing numbers of middle-class liberals, reformers, humanitarians and labouring and farm groups. Notable among them were James G. Carter and Horace Mann in Massachusetts, Henry Barnard in Connecticut, Calvin Wiley in North Carolina, Charles F. Mercer in Virginia, Robert Breckinridge in Kentucky, Calvin Stowe in Ohio, Caleb Mills in Indiana, Ninian Edwards in Illinois and John D. Pierce in Michigan. They worked through scores of organized groups, school societies, conventions and meetings; they utilized periodicals, journals, reports and pamphlets; and they occupied strategic posts in state governments and school systems. They had three main objectives: public support, state control and freedom from religious sectarianism.

Public Support.—If public schools were to become effectively free for all children, the schools must be supported by general taxation in order to overcome the inequalities of ability to pay for education. Traditionally, schools had been supported in a wide variety of ways: endowments, gifts, bequests, land grants, tuition, lotteries, licence fees and sometimes taxes. To these had been added rate bills whereby parents with children in the schools paid special rates depending upon the number of their children attending school.

Also, several states had set up common-school funds, the principal of which was largely derived from grants of public land bestowed by the federal government under the Land ordinances of 1785 and 1787 and a number of other federal laws. But none of these sources could provide the amounts of money necessary for a vast system of public schools.

The school reformers had to combat the prevailing notion that "free schools" were to be provided only for pauper children, and they had to convince state legislatures and the people of the states that direct and general taxation upon the whole community was the only adequate way to provide education for all the children of all the people. This was usually done in several steps. The state legislatures passed bills permitting local districts to tax themselves for schools if they elected to do so; then the states prodded the local districts by offering state aid to those districts that taxed themselves; and finally the states required the local districts to tax themselves for public schools. In this process major legislative victories were won in 1827 in Massachusetts, in 1834 in Pennsylvania, in 1867 in New York, in 1868 in Connecticut and in the 1850s in the middle western states.

State Control.—The second main objective was to widen the scope of educational control. So long as each local district could determine school policies for itself, great inequalities were bound to appear. Therefore the authority of the state had to be reasserted in order to assure adequate schooling for all the children of a state. Colonial precedents of the 17th century had established state authority, but decentralized control had gained headway in the late 18th century. The Massachusetts law of 1789, for example, recognized the local town school committees as agencies for supervising schools and appointing teachers. By 1820 the smaller districts had gained still more power. Then ensued a period of 20 to 30 years during which the power was gradually transferred from the local districts back to the towns and eventually back to the state governments themselves.

The principal means by which state authority was reasserted was the establishment of the office of state superintendent of schools and the appointment of state boards of education. New York created a state superintendent of schools in 1812, and virtually every northern state had done likewise by 1850. New York created its board of regents as early as 1784, and the movement toward state boards of education was accelerated when Massachusetts set up its board in 1837 with Horace Mann as secretary. Connecticut followed in 1839 with Henry Barnard as secretary. By 1860 several other states had used this means to raise educational standards and equalize opportunity within the states. Inasmuch as the U.S. constitution did not mention education, the states moved to reassert their colonial prerogatives and extend them, establishing a trend toward greater centralization of educational control and support despite a large degree of local and decentralized management of schools.

Freedom From Sectarianism.—The third critical problem in the struggle for free common schools was the religious issue. The U.S. had become a country of many tongues, peoples and religious sects. The tendency of new immigrants was to seek schools of familiar religious and nationality associations. The necessity for a common language and widespread agreement concerning democratic processes in political affairs pointed to the public school as a primary agency in creating unity in U.S. culture and in preventing permanent divisions in political, economic or social life. But the federal and state constitutions had agreed that there

must not be religious conformity imposed by government or by established religions.

Therefore it was soon realized that the drive for unity could not encompass religion and that the public schools could not impose religious conformity. On the other hand the religious groups wished to maintain their schools as a means of promoting their distinctive modes of worship and belief. Some Roman Catholics fought the establishment of public schools; some Protestants wanted the public schools to teach nonsectarian Protestantism; others wanted them to be sectarian. The conclusion was that public schools should be secular. Especially vitriolic were the struggles in New York, Massachusetts and Pennsylvania in the period from 1820 to 1860. The result was the general decision that sectarian religious instruction should not be given in public schools and that public funds should not be diverted from the public schools to private schools under sectarian control. New York settled the issue for the time being by legislation in 1842, Massachusetts by constitutional amendment in 1855.

4. Expansion of the Educational Program.—U.S. elementary schools in the early national period were called upon to broaden their aims and curriculums. They were expected not only to promote literacy, mental discipline and good moral character but also to help prepare children for citizenship, for jobs and for individual development and success. As a result, the elementary school curriculum not only maintained its earlier emphasis upon reading, spelling, writing and arithmetic, but added to these English grammar, geography, history and often bookkeeping and music.

Methods remained dominantly oriented to textbook memorizing, strict discipline and severe punishment; but a more sympathetic attitude toward children began to appear in the early 19th century. As the numbers of pupils expanded rapidly, individual methods of "hearing recitations" by children ranging in age from 5 to 15 began to give way to group methods. The monitorial or Lancasterian system became popular because it enabled one teacher to use older children to act as monitors in teaching specific lessons to younger children in groups. Similarly, the practice of dividing children into grades or classes according to their age began to spread as schools grew larger.

It soon became apparent that special training for elementary school teaching was needed if the common schools were to be adequately staffed, especially in view of the fact that increasing numbers of unskilled women were serving as teachers. New ground was broken in the 1820s when Samuel R. Hall established a private normal school at Concord, Vt., and James G. Carter did likewise at Lancaster, Mass. The movement for training elementary teachers in special schools outside the colleges gained further headway when the first public normal school was opened in 1839 in Lexington, Mass. By the outbreak of the Civil War, 12 such schools had been established in eight states.

Appearance of the Public High School.—During most of the 19th century the private academies were the dominant secondary schools in the U.S. They were typically controlled by self-perpetuating boards of trustees, often incorporated by charter from the state. They were supported by tuition and by gifts and endowments. They were often controlled by religious institutions and often open to girls either as coeducational institutions or as girls' schools.

Despite the popularity of the academies, however, the feeling grew that there were large numbers of children who should be able to continue their education but could not afford the fees of the academies. It was also felt that the private academies might impose a highly selective system of schools on top of the common schools and thus prevent genuine equality of educational opportunity. Some states took steps to open wider the doors of the academies by giving them grants of state funds or by trying to integrate them into the state educational systems. But the more popular move was to establish free public high schools under the control of local boards of education and supported by public funds as an extension upward of the common-school system. The first such high school was established in Boston in 1821, and although the growth was slow there were several hundred in several states by the time of the Civil War. Originally designed to offer a curriculum for boys and girls who were not going to college, the high school eventually provided a curriculum even broader than that of the academies, including college preparatory studies as well as terminal education for those who did not go to college.

State University Movement.—Higher education in the pre-Civil War period expanded rapidly. Whereas there had been nine colonial colleges at the time of the Revolutionary War, there were about 200 such institutions by 1860. Most of these were private colleges founded by the several religious denominations; the most active were Presbyterians, Methodists, Congregationalists, Baptists, Episcopalians and Roman Catholics. As might be expected from the growth of the idea of public education, the movement to make higher education free and available under public control and public support also gained headway.

Some of the states first thought that they could transform the private colleges into public universities. This was attempted in various ways in Virginia (William and Mary), New York (Columbia), Pennsylvania (University of Pennsylvania), Connecticut (Yale) and Massachusetts (Harvard). The decisive attempt was made in New Hampshire when the legislature tried to make Dartmouth college a state university. However, the U.S. supreme court in 1819 decided that the charter of Dartmouth college was a contract constituting it a private corporation which could not be impaired by the state under the U.S. constitution.

Thereafter the private colleges expanded rapidly. The states began to establish their own universities under public control and with public support. Six of the original states and 14 new states established state universities before the Civil War. In most cases religious interests sought to prevent the establishment of these universities (and were successful in doing so in seven other states) or tried to obtain public funds for their own private institutions. In 1862 the U.S. congress passed the Morrill act, which gave substantial land grants to the states for the establishment of agricultural and mechanical colleges. Many of the states used the funds from these grants for the strengthening of their state universities or for establishing separate state colleges of agriculture and engineering. With this stimulus the state university movement was accelerated in the latter part of the 19th century. (*See* also LAND-GRANT COLLEGES AND UNIVERSITIES.)

5. Modern U.S. Education.—In the century between the Civil War and the second half of the 20th century, U.S. education was extended, broadened and modified in several ways. Despite wide variety and differences among the several states the characteristics noted below were more or less national in scope.

Freedom of Public Education to All.—In the United States, in contrast with the historic dual systems of Europe where elementary education was designed for the lower classes and secondary education was reserved for the upper classes, the several states established their "ladder systems" beginning at the first year of schooling and extending through the graduate and professional schools of the university. Ideally every child was free to begin at the lowest level and progress as far as his abilities would take him. Indeed the welfare of society and the need for a common education in good citizenship led to compulsory attendance laws; beginning with Massachusetts in 1852, all states by 1918 had established some requirements for attendance at school. By 1960 five states required attendance to age 18 or high school graduation, another five to age 17 and forty to age 16.

The most obvious breakdowns in the ladder system have been the inequality among states in establishing good schools, the unequal ability of parents to afford higher education for their children and the establishment of segregated school systems for Negro and white children in 17 southern states and Washington, D.C., following the Civil War. Attacks upon the segregated school systems were intensified after World War II. Two supreme court decisions required southern universities to admit Negro students, and in the historic decision of May 17, 1954, the supreme court declared that segregation in schools was inherently a denial of equality of educational opportunity and thus prohibited by the 14th amendment to the U.S. constitution.

The "border" states moved more or less rapidly to comply. The

states of the "deep south," however, not only delayed action to desegregate their schools but even when required by federal court order to do so the state governors of Arkansas and Virginia closed some of the public schools in 1958 rather than permit them to become integrated.

Centralized Authority; Decentralized Administration.—Whereas there is relatively little centralized control of education by the federal government (except for court decisions), the authority for the sponsorship and control of public education is largely centralized in the hands of the several state governments as expressed in state constitutions, legislative enactments and court decisions. However, the day-to-day management and administration of schools has been largely delegated to local school districts operating within the authority of the state and the regulations of the state department of education. In general the people of the local school districts elect their own boards of education, which in turn levy school taxes and appoint local administrators and teachers for the schools. The intention is thus to establish a balance between the common values of general welfare to be achieved by centralized authority and the values of flexibility, originality and local initiative to be achieved by decentralized management.

Freedom for Private and Parochial Schools.—Despite the gradual growth of public education in the U.S. following the Civil War, private and religious groups continued freely to maintain, establish and support their own institutions. The U.S. supreme court decision in the Oregon case of 1925 reaffirmed this principle. In general the public policy was that no public funds should be used for the direct support or aid of religious institutions, in order to protect religious freedom and preserve the separation of church and state. Despite these restrictions the proportion of students enrolled in nonpublic schools increased from 9% of all school children in the 1930s to nearly 15% in the 1960s. Ninety per cent of these were in Roman Catholic schools. Controversies arose over the proposed use of public funds for the direct or indirect support of parochial schools. The U.S. supreme court decision in the Everson case in 1947 permitted public funds to be used for bus transportation of children to parochial schools as a public welfare benefit for the child. The court reaffirmed that no tax funds could be used to aid any or all churches to promote religious activities on the grounds that the first amendment to the constitution requires separation of church and state.

Financial Support From Larger Units.—After about 1850, the proportion of funds spent on all education came increasingly from public sources and taxation and decreasingly from private sources. Furthermore, an increasing proportion of public funds came from state and federal governments and less proportionately from local districts, cities, towns and counties. In 1930, 83% of all funds for public schools came from local units and only 17% from state sources; by 1960 about 40% was coming from the states. The basic trend was to achieve greater equality of educational facilities despite financial inequalities among local units. Correspondingly, local units tended to decrease in number and to grow larger in size as small districts were consolidated into larger districts (approximately 90,000 school districts in the U.S. in the second half of the 20th century). Nevertheless there remained great inequality of wealth among the states; some states spent four times more per pupil per year than did other states.

Federal Aid.—The question of federal aid for education was a recurring issue. In the 1870s and 1880s several attempts were made by Republicans to induce congress to pass the Hoar and Blair bills, which would have granted land or money to the states; but no bill was passed by both houses of congress at the same time. The issue was raised significantly again, this time with the Democratic party taking the lead, in the 1930s and especially in the years following World War II, becoming an issue in the 1960 presidential campaign. These attempts to provide federal funds for financial aid to the states for general support of education also were unsuccessful. Fear that federal support would mean federal control of education and that the central government would usurp the states' rights in education (especially in regard to implementing desegregation), and fear that public funds would be used to aid private and parochial schools as well as public schools were the rocks upon which the proposals for federal aid foundered.

Meanwhile, however, the federal government vastly increased its financial support for specialized types of education, notably for agricultural research (Hatch act of 1887), co-operative extension work in agriculture and home economics (Smith-Lever act in 1914), vocational education in secondary schools (Smith-Hughes act in 1917 and several others), federal relief programs in the depression years of the 1930s (National Youth administration and Civilian Conservation corps), war and defense training in World War II, educational benefits to veterans of World War II and grants for scientific research in colleges and universities. The federal school lunch program initiated in 1935 was continued under the National School Lunch act of 1946 and subsequent amendments. Legislation passed in 1950 authorized financial assistance for school construction and operation to local educational agencies in areas affected by federal defense or other activities.

The successful launching of the first artificial earth satellite, Sputnik I, by the U.S.S.R. in 1957 so alarmed congress about the state of U.S. education that it passed the National Defense Education act of 1958. This provided scholarships, loans and grants to improve teaching in science, mathematics and foreign languages, to develop television, radio, and audio-visual aids, and to promote guidance, counseling and testing services that would identify talented youth quickly and accurately.

Finally, in 1965, the congress passed a federal school aid bill providing for financial support for special programs designed to improve the educational opportunities of poor children in both public and private elementary and secondary schools and in preschool "headstart" programs; for the purchase of textbooks, library books and instructional equipment; and for supplemental education centres, educational research and state education agencies. The bill greatly enlarged the federal government's role in education and marked an important shift in the nation's policy on aid to parochial schools by providing that, while funds would be under the control of public-school agencies, their programs must provide for special services for nonpublic-school students.

Broader Tasks for Education.—In the light of the needs of a democratic, industrialized and complex society the educational needs of individuals broadened after the mid-19th century. The "three R's" (reading, writing, arithmetic) were considered to be as necessary as ever but no longer sufficient preparation for modern life. The educational program was gradually expanded to include studies appropriate to vocational and technical preparation, education for citizenship, personal adjustment and development and health and recreation as well as new studies in language, science, mathematics, social science and the arts. The sheer amount of information necessary to do advanced work in any field of knowledge required a longer period of study than ever before.

The most controversial curriculum question had to do with religious instruction in the public schools. Bible reading was permitted in many states but prohibited in a few. Released time for religious instruction within public school buildings was declared unconstitutional by the U.S. supreme court in the McCollum decision in 1948, but later conceded to be constitutional if conducted outside school buildings and with no coercion upon children to attend (Zorach decision of 1952). In June 1962, however, the supreme court ruled that the organized recitation in public school classrooms of a nondenominational prayer composed by the New York State Board of Regents was unconstitutional.

Increased Attention to Individual Development.—Outlooks toward the child and his development also underwent revision in accordance with developments in philosophy, psychology and religious beliefs. Earlier conceptions of the child as in need of strict discipline and even brutal punishment gave way to more sympathetic views of the child as an individual. Distinctive periods of child growth and development were recognized.

The modern outlook tried to take account of varying interests, capacities and needs of different children. Special attention was given to the physically and mentally handicapped child, the slow learner, the defective, the non-English-speaking, the diseased and the exceptional. Authoritarian discipline and corporal punishment

were softened, and greater attention was given to development of habits of self-discipline. Recurrent criticisms were made of "soft pedagogy," especially in the 20th century, but the new methods were defended in studies showing that children learned as much as, if not more than, under traditional methods.

Improvement of the Teaching Profession.—Merely "keeping school" was no longer sufficient. The period of preparation for teaching was extended to at least four years of education beyond high school—a training that would include the liberal arts as well as a professional body of knowledge for the teacher and administrator. University preparation was established for elementary as well as secondary school teachers. By the 1960s, 17 states required four years of college work for elementary school teachers and another 23 states required more than one year of college; 37 states required four years of college for secondary school teachers, 4 states required more than four years.

Widespread Availability of Education.—One result of the expansion of U.S. educational facilities was an enormous increase in attendance figures during the 100 years following the Civil War. While the total population was increasing from 31,000,000 in 1860 to 179,323,175 in 1960, the school and college enrollment increased much more rapidly. For example, at the end of World War I the total population was approximately 100,000,000 and attendance at all schools and colleges, public and nonpublic, was about 20,000,000. By 1960 the attendance had reached well over 45,000,000. While the total population was increasing by half in a period of 40 years, the school and college population was more than doubling. One American in four was attending an educational institution in the 1960s, not including adult and informal educational activities that touched perhaps 50,000,000 more. Tremendous shortages in school facilities and numbers of teachers marked the period following World War II.

Elementary school enrollment roughly paralleled population growth and decline, rising steadily from 16,000,000 in 1900 to 24,000,000 in 1930. Then it dropped to around 20,000,000 in the 1930s and early 1940s with the decline in birth rate during the depression years. But beginning in 1947–48 elementary school enrollment began to rise as a result of the increased birth rate following World War II until it reached more than 30,000,000 in 1960. Virtually 99% of children age 7 to 13 were in school.

During this period there was a more rapid rate of growth in secondary and higher education. Secondary school enrollment of 1,000,000 in 1910 had increased tenfold to more than 10,000,000 in 1960 (about 5% of the total school enrollment in 1910, and more than 32.6% in 1960). In 1900 only about 10% of high school-age youth were going to school; by 1930, 50% aged 14 to 17 were actually in school; and by the 1960s 90.3% of all children in this age group were actually in school. Universal secondary education was well on its way to being achieved. The wider range of abilities and the more heterogeneous character of the secondary school population were reflected in the fact that in 1900 about 75% of high school graduates went on to college, but in the early 1950s only about 25%. The proportion going on to college rapidly increased to 35% by the late 1950s.

An even greater rate of increase in enrollment characterized higher education. About 300,000 were enrolled in 1910, and nearly 4,000,000 in 1960. This represented a rise from about 2% of the total school and college enrollments to about 9% of the total number attending all educational institutions. Whereas about 5% of youth aged 18 to 21 were attending college in 1910, more than 35% of the age group were in higher institutions in the 1960s. Illiteracy among persons aged 14 or over had been reduced to about 2%, and the median number of years of schooling attained by all Americans was ten.

6. Changes in Organization and Program.—For most of the period from the Civil War to mid-20th century the typical pattern of educational organization was an eight-year elementary school, beginning at age six, followed by a four-year high school. Then came the four-year liberal arts college, followed by the graduate and professional schools. Significant rearrangements were made, especially after the turn of the 20th century, to give greater attention to children younger than six years of age in the kindergarten, to early adolescent youth in the junior high school and to older adolescents in the junior college.

Childhood Education.—The first supplement to the eight-year elementary school was the introduction from Germany of the kindergarten, which had been initiated by Friedrich Froebel to provide preschool education for children between four and six. The kindergarten made much of play activities, greater freedom and group methods and regard for the emotional and spiritual nature of the child. A private kindergarten was established in Wisconsin in 1855 and in Boston in the 1860s, and the St. Louis public school system added kindergartens under the direction of Susan Blow in 1873. By the early 1950s, 60% of all city school systems were operating kindergartens as part of the public school system, enrolling about 1,000,000 children; another 150,000 were in private kindergartens. Some systems included nursery schools, and preschool programs were expanded under the 1965 school aid bill.

In the elementary grades for children 6 to 12 or 14 the three R's remained staple, but the curriculum was gradually expanded to include such studies and activities as health, creative art, drawing and music, nature study, geography and history, manual training and domestic arts. Beginnings in this direction were made as early as the 1860s when the "object method" of teaching and methods of nature study were introduced according to the pattern of the Swiss educator Johann Heinrich Pestalozzi. Edward A. Sheldon and the normal school at Oswego, N.Y., were influential in spreading Pestalozzian ideas in America.

Another influential leader in making the child and his interests the centre of the educative process was Francis W. Parker in his schools at Quincy, Mass., and at the Cook County Normal school in Chicago in the 1880s and 1890s. Further stimulus to modern educational methods came from John Dewey through his experimental school at The University of Chicago in the late 19th and early 20th centuries and through his writings on educational theory and practice. The leading spokesman for the Dewey philosophy in education was William H. Kilpatrick of Teachers college, Columbia university.

Many plans were designed to individualize the curriculum and break the academic lock step; these included project methods, unit plans, homogeneous grouping, ability grouping and integrated programs. School systems expanded their services to include audio-visual aids, libraries, guidance departments, school lunches, health departments, recreation, transportation and work experience. The development of objective tests and measurements of scholastic achievement aided the process of diagnosing individual abilities and setting standards of school achievement for the various age and grade groups. Leaders in the psychological and scientific movement in education were Edward L. Thorndike of Teachers college, Columbia university, Charles H. Judd of The University of Chicago and Lewis M. Terman of Stanford university.

Youth Education.—One of the most distinctive and historically revolutionary characteristics of modern U.S. education was the attitude toward the education of children and youths aged 12 to 18. Universal secondary education was made possible legally by a number of court decisions in the 19th century, notably the Kalamazoo case in Michigan in 1874, which affirmed the right of local boards of education to establish and maintain free high schools as an integral part of the public school system and support them with general tax funds.

The basic pattern was a comprehensive coeducational high school offering a variety of courses, in contrast to the system in many countries where children are at age 12 sent to different kinds of schools—academic, technical, vocational, domestic science, etc. The U.S. comprehensive high school typically has not only several courses designed for nonacademic as well as academic pursuits but also the range of studies acceptable for college preparation.

This change in emphasis was signalized by several important statements by national bodies. The Committee of Ten on Secondary School Subjects in 1893 and the Committee on College Entrance Requirements in 1899 were especially concerned to standardize the secondary school curriculum with a view to college preparation. In contrast the *Seven Cardinal Principles of*

Secondary Education formulated in 1918 stressed health, command of the fundamental processes, worthy home membership, vocational preparation, civic education, leisure-time activities and ethical character as goals of secondary education. Similar objectives appeared in the statements of the Educational Policies commission from the 1930s onward, especially in *Education for All American Youth* in 1944.

Special provisions were made to adapt secondary education to the needs of adolescents. Organizationally this was done by the development of the junior high school, designed to provide an appropriate exploratory and general education for 13-, 14- and 15-year-olds in the seventh, eighth and ninth grades. Beginning in Ohio and California as early as 1909 and 1910, the junior high school was widely adopted until the six-year elementary school, the three-year junior high school and the three-year senior high school had become the commonest pattern of school organization by mid-20th century.

Similarly, at the top of the secondary system the junior college was established to provide continuing general education, vocational and semiprofessional preparation and opportunities for personal and social development for 18- to 20-year-olds. The junior college movement grew rapidly from about 2,300 students in 74 institutions in 1915 to more than 500 institutions enrolling more than 400,000 students in 1960. Whereas 75% of junior colleges were privately controlled in 1915, more than half were publicly controlled by 1960, and these enrolled more than 85% of all junior college students. In effect the public junior colleges were becoming the 13th and 14th grades of the public school system, providing an extended terminal education for many students and providing for others the first two years of undergraduate college work.

Higher Education.—By the early 1960s there were more than 1,300 degree-granting higher educational institutions in the United States, including (1) about 130 universities consisting normally of undergraduate colleges and professional and graduate schools; (2) nearly 700 four-year liberal arts colleges; (3) about 300 separate technical and professional schools; and (4) about 200 teachers' colleges. The universities enrolled approximately half of all students attending higher institutions. The liberal arts colleges were almost entirely under private or religious control, and about four-fifths of the teachers' colleges were public institutions. Of the total number of higher institutions of all kinds (including junior colleges), about two-thirds were under private control, but more than half of all students were in public institutions. Financial support for higher education was coming in increasing proportion from state and federal funds as compared with private sources of income and tuition.

The former curriculum embracing a few subjects with emphasis upon the classics, mathematics and philosophy had been expanded to include a large number of studies in modern languages and humanities, the sciences, the social sciences and the arts. The elective system whereby students had wide choice of studies outran the prescribed curriculum by the beginning of the 20th century, and then in turn the specialization permitted by the elective system was modified in the direction of requirements for a broad and general education. The ideal of a small liberal arts college persisted but was often overshadowed by the large university with its emphasis upon professional preparation and research. Many new scientific, technical and practical studies took their places alongside the traditional academic or cultural studies, adding to the tendency to specialize. The disciplinary and religious character of higher education had to compete with an emphasis upon greater freedom for students and greater concerns with social, civic and occupational goals.

See also sections on education in the state articles.

(R. F. Bs.)

B. Great Britain and the Commonwealth of Nations

1. Elementary Education in England to 1900.—The development of industry and the social unrest at the end of the 18th century, following on the French Revolution, combined to bring home to the public mind the need of a national system of day schools. Unfortunately, just at this moment the revival of Nonconformity as the result of the religious vitality of the Evangelical movement divided the nation once more into hostile camps, to which class distinctions lent additional bitterness. The controversy between Andrew Bell and Joseph Lancaster and their respective followers in the opening years of the 19th century served to define the religious difficulty substantially in the form in which it continued to exist for more than 100 years. Both these remarkable men conceived independently the idea of a national system of popular education upon a voluntary basis; both concurred in extolling the merits of the monitorial system, which each claimed to have originated. The controversy between them, begun upon personal grounds, resolved itself into a national contest of rival principles of religious teaching. Lancaster, as a young Quaker schoolmaster, confronted with pupils drawn from various religious bodies, planned his religious instruction upon the lines of doctrine common to all the orthodox Christian denominations. Thus he is the father of the undenominational religious teaching which later formed the basis of the Cowper-Temple compromise of the 1870 act (*see* below). But whereas the Cowper-Temple clause was purely negative in form and so seemed to point to an undogmatic religion, the Lancastrian teaching was essentially positive and dogmatic within its limits. The church as a whole refused to cooperate in religious teaching upon the basis of a common Christianity and joined issue with Lancaster and his Whig and Nonconformist following not merely upon the question of the exclusion of dogmatic formularies but also upon the question of the control of whatever religious teaching should be given. In fact, the vital question at this period was whether the clergy of the established church were to control national education. The religious issue was prominent in connection with the remarkable attempt at legislation made by the Whig statesman Samuel Whitbread in his Parochial Schools bill of 1807. It was rejected by the lords, mainly on the ground that it did not place education on a religious basis or sufficiently secure control to the minister of the parish.

Early Voluntary Schools.—The failure of the liberal proposals of Whitbread, and the strength of the opposition to any settlement on purely church lines (such as that advocated by Andrew Bell in 1808 for establishing schools under the control of the parochial clergy), rendered recourse to voluntary effort inevitable. In 1808 the Royal Lancasterian society was formed to carry on the work of Lancaster, the name being afterward changed to the British and Foreign School society. In 1811 the National Society for Promoting the Education of the Poor in the Principles of the Established Church throughout England and Wales was formed, with Bell as its superintendent. In voluntary effort on a grand scale the church easily outdistanced its opponents, and in 1831 the National society was able to show that there were more than 13,000 schools in connection with the church, of which about 6,500 were both day and Sunday schools, having a total attendance of 400,000.

The rapid development of the voluntary school system was no doubt greatly facilitated by the monitorial plan of teaching, upon which Bell and Lancaster equally relied. This plan never rested upon any educational theory; it was simply a rough-and-ready expedient for overcoming the practical difficulty caused by the dearth of competent teachers. Historically it is important as the precursor of the pupil-teacher system of apprentice teachers (*see* Teacher Training) which long formed the exclusive basis of the English elementary system.

Meantime, Lord Brougham in 1816 procured the appointment of a general commission of inquiry into endowed charities. The labours of this inquisition lasted for 20 years and led to the reformation of many cases of abuse or waste of wealthy endowments and eventually to the establishment of the Charity commission in 1853. In 1820 Brougham introduced a bill which proposed to require teachers to be members of the Church of England and to be appointed upon a certificate from the parochial clergyman and on the other hand to prohibit religious formularies and to confine religious instruction to Bible reading without comment. The bill naturally failed, through the opposition of the Nonconformists, and served only to accentuate the religious impasse.

Establishment of State Aid.—In 1832 the Whig government placed on the estimates a sum of £20,000 for public education, thus initiating the system of the annual grant voted by parliament. The funds thus granted were to be confined to the erection of school buildings, and to be administered only through the National and the British and Foreign School societies. In 1839 Lord Melbourne's government, by means of an order in council, established a Committee of Council on Education, and the sum voted by parliament was increased to £39,000. The original intention of the government was to establish a state normal school or teachers' training college as the foundation of a national system of education. Unfortunately this design had to be abandoned in view of the religious difficulty, with the result that the training of elementary teachers was left in private hands. In view of the limited resources placed at its disposal by parliament, the committee of council was at first compelled to confine its assistance to aid in the provision of school buildings, but in the distribution of the money three important conditions were at once imposed. In the first place, the continuing right of inspection was required in all cases; secondly, promoters were obliged to conform to a fixed standard of structural efficiency; thirdly, the building must be settled upon trusts permanently securing it to the education of poor children.

By the minute of Aug. 10, 1840, the committee of council concluded what came to be known as the concordat with the church. Under this minute no appointment was to be made of any persons to inspect schools in connection with the Church of England without the concurrence of the archbishop of the province, and what seems still more extraordinary to modern ideas, any such appointment could be revoked by the archbishop at any time. The altered financial relations, however, between the state and the voluntary managers brought about by the institution of maintenance grants soon rendered this concordat obsolete.

Among the first acts of the committee of council was the promulgation of a set of model trust deeds. The necessary conditions were the permanent appropriation of the site to purposes of education and the permanent right of government inspection; a conscience clause was not obligatory and indeed was only offered in the limited form of exemption from instruction in formularies and attendance at Sunday school or public worship. Special facilities for the conveyance of land for school purposes were afforded to limited owners by the School Sites acts of 1841 and subsequent years. The landed gentry responded with great public spirit to the call thus made upon their generosity by the state, with the result that the vast majority of rural, and many urban, parishes were freely endowed with sites for elementary schools.

The Grammar Schools act of 1840, which was passed to deal with the case of the decayed grammar (*i.e.*, classical) schools which abounded throughout the country, belongs to the history of elementary rather than secondary education. As a result of this act a considerable number of ancient endowments were reorganized so as to afford an improved elementary instead of an inefficient classical education, and the plans made under the act constituted an early, but not very successful, experiment in the direction of higher elementary schools.

In 1843 the committee of council decided to make grants-in-aid of the erection of normal schools or training colleges in connection with the National society and the British and Foreign School societies, thus marking the abandonment of the system of relying on voluntary effort for the provision of training colleges.

In 1846 an important step forward was taken in the foundation of the pupil-teacher system. The regulations of that year inaugurated annual maintenance grants in the form of stipends for apprenticed pupil-teachers receiving a prescribed course of instruction under the head teacher and a lower grade of stipendiary-monitors in schools where such instruction could not be provided. These regulations inaugurated the system of Queen's scholarships to assist pupil-teachers to proceed to a training college; they also established capitation grants for the support of such colleges and annual grants to elementary schools under government inspection of from £15 to £30 in aid of the salary of every trained teacher employed. At the same time provision was made for retirement pensions for elementary teachers.

To facilitate the recognition of denominational schools other than Church of England, the committee of council in 1847 issued a minute dispensing schools not connected with the established church from inquiries concerning their religious condition, and in the same year state aid was extended to Wesleyan and Roman Catholic schools. Jewish schools received recognition in 1851 upon condition that the Scriptures of the Old Testament should be daily read in them.

During the middle of the century various unsuccessful attempts were made to establish a national system of elementary schools upon the basis of rate aid. The only one that calls for notice is the bill introduced by Lord John Russell (called the Borough bill, because it was restricted to municipal boroughs) in 1853, which formed part of a comprehensive plan of legislative and administrative reform of which a portion was actually carried into effect. The bill as a measure for elementary education was supplemented by an administrative system of capitation grants for rural areas. The government plan also comprised a measure dealing with the administration of charitable trusts (which took shape as the Charitable Trusts act, 1853), the constitution of the department of science and art and university reform upon the lines recommended by the Oxford and Cambridge commissions.

The failure of the Borough bill did not affect the new system of capitation grants which was introduced by minute of the committee of council dated April 2, 1853. These grants were fixed at a scale varying from 3*s.* to 6*s.* per head, payable upon certain conditions, of which the most important were that the school must be under a certificated teacher and that three-quarters of the children must pass a prescribed examination. The capitation grant was, by minute of Jan. 26, 1856, extended to urban areas. As in the case of all the early grants, the regulations governing the distribution of the capitation grants were framed upon the principle that subventions of public money must be met by local funds derived from voluntary contributions, endowments and school fees; thus the basis of the denominational system as fostered by the state at this stage was one of financial partnership.

In 1856 a purely administrative bill was passed, establishing the office of vice-president of the Committee of Council on Education as a minister responsible to parliament. At the same time, the science and art department was transferred from the board of trade to the committee of council.

The Newcastle Commission.—The progress of state-aided education during this period may be measured by the increase of the annual parliamentary grant, which rose from £30,000 in 1839 to £663,400 in 1858. This expansion was viewed with misgiving by the friends of the denominational system and by the strong individualists of that day, who clung to the old ideal of voluntary initiative. These sections combined with the advocates of further state intervention to press for an inquiry, and a royal commission was appointed in 1858, under the chairmanship of the duke of Newcastle, to inquire into the state of popular education in England and to consider and report what measures, if any, were required for the extension of sound and cheap elementary instruction to all classes of the people. Their report, issued in 1861, contained an exhaustive account of the condition of elementary education and, with due allowance for the grave defects revealed, in particular the glaring inefficiency of the numerous little private-venture schools kept by "dames" and others, the graphic picture drawn by the commissioners constituted a striking tribute to the sterling qualities of self-help and religious earnestness which were characteristic of the time. It was found that in round numbers about 2,500,000 children were attending day schools, the proportion to population being one in seven, as compared with one in nine in France, one in eight in Holland and one in six in Prussia, where education was compulsory. On the other hand, of this number only 1,675.000 were in public schools of all kinds, only 1,100,000 in schools liable to inspection and 917,000 in schools receiving annual grants. Thus only one child in every 20 was attending a school whose efficiency could be in any way guaranteed by the state. The commissioners as a body rejected free and compulsory education in view of the religious difficulty and upon general

grounds of individualistic principle. In view of the solution adopted in 1902 it is of interest to note that the Newcastle commissioners deliberately rejected the parish as unfit to be taken as the unit of elementary education, upon the ground that management by parochial ratepayers must tend to be illiberal and niggardly, and recommended the constitution of county boards with power to levy a rate for the aid of existing voluntary schools.

The one definite achievement of the Newcastle commission was the system of payment by results. Impressed by the defects of the existing teaching, the commissioners reported that the only way of securing efficiency was to institute a searching examination by competent authority of every child in every school to which grants were to be paid, with the view of ascertaining whether the indispensable elements of knowledge were thoroughly acquired, and to make the prospects and position of the teacher dependent to a considerable extent upon the results of this examination. They recognized that to raise the character of the children, both morally and intellectually, was and must always be the highest aim of education; but they thought that the training in the rudiments of education had been lost sight of and that there was justice in the common complaint that while a quarter of the scholars were really taught, three-quarters after leaving school forgot almost everything they had learned there.

Robert Lowe (later Lord Sherbrooke), as vice-president of the committee of council (1859–64), adopted the system of payment by results in what became famous as the Revised code, issued in 1862. This provided for the payment of a grant of 4*s*. upon the old principle and a further grant of not more than 8*s*. upon the result of examination. Lowe declared of the system in the house of commons that "if it was costly it should at least be efficient; and if it was inefficient it should at least be cheap." In fact, it proved to be cheap; the grant fell from £813,400 in 1861 to £636,800 in 1865. Later, to meet objections, some modifications were introduced in the code under the Conservative government in 1867. The system of paying grants upon the result of individual examination of the scholars was not finally abolished till 1904.

The Act of 1870 and Its Effects.—In 1868 the Conservative government brought in, but did not proceed with, an education bill deliberately discarding the principle of rate aid on the ground that it would destroy voluntary contributions and gradually starve out the denominational schools. In 1867 and again in 1868, Liberals Henry Austin Bruce (afterward Lord Aberdare), W. E. Forster and Algernon Egerton introduced a bill which formed the basis of the measure of 1870. As redrafted in 1868 this bill proposed a universal system of municipal and parochial rating with liberty for voluntary schools to unite themselves to the rate-aided system under their existing management, subject to the acceptance of a conscience clause. The bill also proposed to empower town councils to co-opt outsiders upon their education committees. Both the principle of co-optation and the extension of rate aid to schools not under public control anticipated certain features of Balfour's Education act of 1902. In the meantime, in the country the Education league, originated at Birmingham, was carrying on propaganda in favour of free secular schools, while the opposing Education union urged a settlement upon the old lines. As a concession to the popular feeling against secularism, the league proposed to allow Bible reading without doctrinal exposition. Thus opinion was sufficiently focused to enable William Gladstone's administration in 1870 to undertake a comprehensive measure of educational reform.

The Elementary Education act of 1870 bore in every respect the marks of compromise. As Forster explained in introducing the bill, the object of the government was "to complete the voluntary system and to fill up gaps," not to supplant it. To this end the education department was charged with the duty of ascertaining whether or not there was in every parish a deficiency of school accommodation and of providing for the formation of school boards in every school district (*i.e.*, parish or municipal borough) requiring further school accommodations.

Three important changes were made in the measure during its passage through parliament: (1) In lieu of the rate aid as first suggested, the government proposed an increased grant from the treasury, that is to say, the voluntary schools were left as state-aided schools under private management, side by side with the new rate-supported schools. (2) The character of the religious instruction in the board schools was determined by a provision, which became known after the name of its author as the Cowper-Temple clause, directing that "no religious catechism or religious formulary which is distinctive of any particular denomination shall be taught in the school." This was not intended to exclude doctrinal exposition, and was in fact a compromise not merely between absolute secularism and denominationalism but between denominationalism and the view of those who would have the Bible read without note or comment. The Apostles' Creed as a symbol common to all denominations of Christians was held by Forster (at Gladstone's suggestion) not to be excluded under the Cowper-Temple clause. The result was the establishment in the schools, upon the lines laid down by Joseph Lancaster at the beginning of the century, of what may be termed the common Protestantism of the English nation. The Cowper-Temple compromise, notwithstanding its inherent want of logic, stood the test of experience for more than a generation against the consistent denominationalists on the one hand and the party of secular education on the other. (3) The third change in the bill was the substitution of the *ad hoc* school board for the municipally appointed board originally proposed. These boards were elected by the system of cumulative voting under which each elector had as many votes as there were candidates to be elected, with liberty to give all his votes to one candidate or to distribute them among the candidates as he thought fit. This system was much criticized as being unduly favourable to minorities, whose representation it was devised to secure; it continued, however, until the act of 1902.

School boards were empowered not only to acquire sites for schools under powers of compulsory purchase but also to take transfers of existing voluntary schools from their managers. The act of 1870 did not introduce either direct compulsory attendance or free education, but it took a distinct step forward in each direction by enabling school boards to frame bylaws, rendering attendance compulsory, and also to pay the school fees in cases of poverty. Building grants were continued temporarily for the benefit of those who applied (as voluntary managers alone could apply) before Dec. 31, 1870. On the other hand, the education department was authorized to refuse parliamentary grants to schools established in school-board districts after the passing of the act if the department thought such schools were unnecessary.

The following figures show the progress made under the act of 1870. In the year 1870 there was accommodation in inspected day schools for about 2,000,000 children; the average attendance was 1,168,000, and the number on the books about 1,500,000. It was computed, however, that there were, exclusive of the well-to-do classes, at least 1,500,000 children who attended no school at all or schools not under inspection. In 1876 accommodation had been provided for nearly 3,500,000, and of the 1,500,000 new places nearly two-thirds were provided by voluntary agencies. It was reported that these agencies had received grants-in-aid for about one-third of the schools they had built, the grants defraying about one-fifth of the cost of the aided schools. On the other hand, the growth of school boards was rapid and continuous, notwithstanding the permissive character of the act and the strenuous efforts of the voluntary agencies and their supporters to keep pace with the new demands. This development enabled Benjamin Disraeli's government to pass in 1876 a law, generally known as Lord Sandon's act, designed to improve school attendance and making it the duty of every parent to see that his child received efficient instruction in reading, writing and arithmetic.

This act had a marked effect on school attendance, which rose in four years by about 500,000. Parents were growing accustomed to sending their children to school and, with a substantial increase in school accommodation, a further advance was soon possible. This came in 1880 after the Liberals had returned to power. Gladstone's administration passed a short act—Mundella's act—which required school boards and attendance committees, required in all districts in which there were no school boards, to frame bylaws, if they had not already done so, governing the attendance

of children at school. There was now a complete system of universal compulsory education. Under the acts of 1876 and 1880 the average attendance increased from 2,000,000 in 1876 to 3,500,000 in 1878 and 4,000,000 in 1881; in terms of percentage to population, 8.06% in 1876, 9.60% in 1878 and 10.69% in 1881. In the last-mentioned year the annual grant rose to £2,200,000, having more than doubled in the decade.

In 1887 a royal commission under Viscount Cross was appointed to inquire into the working of the education acts. The labours of this commission produced a thorough discussion of the educational problem in all its aspects—political, administrative, scholastic and religious. For any clear recommendations with regard to the reorganization of education generally the moment was not opportune, inasmuch as the commission just preceded the establishment of the new county authorities, to which parliament was shortly to confide, under the Technical Instruction acts, powers with respect to instruction other than elementary. Nevertheless the report of the majority of the commissioners pointed unmistakably toward the solutions adopted in the act of 1902, and their definite recommendation that voluntary schools should be accorded rate aid without the imposition of the Cowper-Temple clause served as the basis of that legislation.

Of later developments, it is convenient to mention in the first place, out of chronological sequence, the practical establishment of free education by the act of 1891, not by the absolute prohibition of school fees but by the device of a special grant, payable by parliament in lieu of fees, called the fee grant. The result of this legislation and of subsequent administrative action was to place free education within the reach of every child, fees being retained (with few exceptions) only where some instruction of a higher elementary type was given.

2. Secondary and Technical Education to 1900.—The establishment of county councils by the Local Government act, 1888, introduced a new factor, destined to exert a determining influence upon subsequent developments of public education. In the first place, it at once rendered possible the partial and experimental provision for higher education attempted by the Technical Instruction acts, which affected secondary education as well as technical education in the proper sense of the term.

In order to understand the state of secondary education at this period it is necessary to refer to the first attempts made at state intervention. In 1861 the first step was taken by the appointment of a royal commission, presided over by Lord Clarendon, to inquire into the condition of nine of the chief endowed schools in the country, Eton, Winchester, Westminster, Charterhouse, St. Paul's, Merchant Taylors', Harrow, Rugby and Shrewsbury. The report of this commission led to a statute, the Public Schools act of 1864, which introduced certain reforms in the administration of seven of these schools, leaving the two great London day schools, St. Paul's and Merchant Taylors', outside its operation.

The Schools Enquiry Commission.—In 1864 the Schools Enquiry commission was appointed under the presidency of Lord Taunton to inquire into all the schools which had not been included either in the commission of 1861 or the Popular Education (Newcastle) commission of 1858. It thoroughly explored the field of secondary education and "its luminous and exhaustive report" (to quote the words of the Bryce commission of 1894) was an excellent introduction to the problem of public secondary education in England. The existence of numerous and frequently very wealthy endowments arising from private benefactions and bequests had at all times been a feature in education as in other departments of English social life. At the date of the Schools Enquiry commission the state of the ancient endowments was largely one of abuse. Many endowments intended for advanced education were applied for instruction of a purely elementary character, and that of an inferior kind; indeed the possession of an endowment in a rural locality not infrequently operated to prevent the establishment of an efficient state-aided school. The evidence showed that the proportion of scholars in the country grammar schools who were receiving some tincture of the classical education intended by the founders was steadily decreasing, and nothing had been done to bring the curriculum into harmony with the actual needs of the time. In addition to the general inelasticity of the curriculum, the special evils from which the grammar schools suffered were the want of effective governing bodies on the one hand and the freehold tenure of the headmasterships on the other.

The report of the commission was immediately followed in 1869 by the Endowed Schools act, which conferred upon a special commission (united in 1874 with the Charity commission) very wide and drastic powers of reorganizing ancient endowments. A direction for extending the benefits of endowments to girls did much to assist the movement for secondary education for girls. (*See* also CHARITY COMMISSIONERS FOR ENGLAND AND WALES.)

The Schools Enquiry commission also submitted proposals for the general organization of a system of secondary education. They recommended the establishment of three authorities: (1) a central authority; (2) a local or provincial authority, representing the county or a group of counties; and (3) a central council of education charged with examination duties. Further, it was proposed to raise the level of proprietary and private schools by offering them inspection and examination and by establishing a system of school registration. Lastly, it was proposed to confer upon towns and parishes powers of rating for the establishment of new schools. For these proposals as a whole the time was not ripe. The bill of 1869 attempted to give effect to the suggested creation of a central council, but exigencies of parliamentary time made it necessary to drop this part of the measure; the result was that the plan of the commissioners was only half carried out. Nevertheless the work accomplished under the Endowed Schools act and subsequent acts was sufficient to exert a considerable influence upon the secondary education of the country. Thus in 1895 the Bryce commission was able to report that plans under the acts had been made for 902 endowments in England, excluding Wales and Monmouth, leaving untouched only 546 out of the total of 1,448 endowments in England known to be subject to the acts. The gross income of the endowments known to be subject to the Endowed Schools acts, and therefore available for purposes of secondary education, was in 1895 about £735,000.

The creation by the Local Government act in 1888 of the representative and popular county authorities rendered the municipalization of secondary instruction at last possible. In 1889 the Technical Instruction act (extended by an act of 1891) empowered the councils of counties, boroughs and urban districts to levy a rate (not exceeding a penny on the pound) for the support of technical or manual instruction. Comparatively few councils were prepared to resort to their rating powers, but progress under these acts was greatly facilitated by the Local Taxation (Customs and Excise) act of 1890, which mentioned technical instruction as one of the purposes to which the imperial contribution paid to local authorities in respect of the beer and spirit duties might be applied. (*See* TECHNICAL EDUCATION.) By virtue of the liberal interpretation given to technical instruction by these acts the financial assistance afforded under them was extended to cover the whole field of mathematical and physical science, as well as modern languages.

At the same time the department of science and art gradually utilized its grants to encourage literary studies in secondary schools as well as the scientific and mathematical subjects to the promotion of which it was primarily directed. Thus the combined effect of the local resources available under the Technical Instruction act and the imperial grant administered by the department was gradually to develop a national system of secondary education with a marked bias toward physical science. But the schools giving higher education still practically consisted, apart from the big "public" (independent) schools, of endowed grammar schools or proprietary schools established by religious bodies or joint-stock companies. No public body had, as yet, the right to build a secondary school.

An undoubted stimulus was given to secondary education in the great centres of industry during the last quarter of the 19th century by the rise of the new university colleges (*q.v.*), among which must be reckoned those established expressly for women. At the same time (1889) a beginning was made of state aid to these colleges, through a committee appointed by the treasury in a min-

ute of July 1. Meanwhile, with the development of elementary education, the school boards found themselves obliged to provide for the further education of their best pupils in what were known as higher-grade elementary schools. These were really secondary schools of the third grade, and, as the Secondary Education commission observed, the school boards simply stepped in to fill the educational void which the Schools Enquiry commissioners had proposed to fill by schools of that name. Their creation was greatly fostered by the upper departments in such schools being recognized for grants by the science and art department. In fact they continued to multiply and prosper till 1901, when the famous judgment in the test case of *Rex* v. *Cockerton* pronounced them to be illegal. It was at once recognized that the legislature must, without delay, step in to secure the educational work which the undoubtedly correct principles of judicial interpretation had placed in jeopardy.

Secondary Education Commission.—Meanwhile, as far back as 1894, a royal commission had been appointed under James (later Lord) Bryce to inquire into secondary education. The principal recommendations of the commission were: (1) the unification of the existing central authorities, viz., the department of science and art, the Charity commission (so far as it dealt with educational endowments) and the education department, in one central office, and the establishment of an educational council to advise the minister of education in certain professional matters; (2) the establishment of local authorities; to consist of committees of the county councils with co-opted elements; (3) the formation of a register of teachers with a view to the encouragement of professional training, and a system of school registration upon the basis of inspection and examination. The first of these recommendations was carried out by the Board of Education act, 1899, and under the same act an attempt was made to give some effect to the third-named object, which unfortunately fell short of success. The realization of the second, and most important, of the recommendations was deferred till 1902, when it was brought about as part of a wider reorganization of the educational system.

In 1896 an endeavour was made to meet the demands of the voluntary managers of elementary schools by means of a bill introduced by Sir John Gorst. This bill with its provision for a special aid grant to be administered by county education authorities, which were to exist side by side with the school boards, represented a kind of compromise between the system of 1870 and what later developed in 1902. It encountered opposition in all quarters and was withdrawn. In 1897, however, the position of the denominational school was strengthened by the Voluntary Schools act, which provided for a special aid grant of 5*s*. per head of the scholars in average attendance in these schools.

Partial effect was given to the recommendations of the Secondary Education commission by the Board of Education act of 1899, which united the department of science and art with the education department in one central office under the title of the board of education, with a president and parliamentary secretary; provided for the transfer to this board of the powers of the Charity commissioners in relation to educational endowments; and provided also for a consultative committee, consisting, as to not less than two-thirds, of persons qualified to represent the views of university and other bodies interested in education, for the purpose of (1) framing a register of qualified teachers and (2) advising the board of education upon any matters referred to the committee by the board. In 1902 a tripartite division was adopted to correspond with the three branches of education with which the board of education was concerned, viz., elementary, secondary and technological. Mention may also be made here of another uncontroversial measure, the Elementary Education act of 1899, which dealt for the first time, from the point of view of the state, with mental deficiency.

3. Organization of a New Era.—Two statutes marked the beginning of a new era in the history of education in England and Wales. The Board of Education act, 1899 (*see* above), provided a unified central administration, while the Education act, 1902, established a comprehensive system of local government for both higher and elementary education. The latter was a bold, constructive measure sponsored by Arthur (later Lord) Balfour, who became prime minister during the act's long and stormy passage through parliament. In framing it he owed much to Sir Robert Morant, who, as the first permanent secretary of the board of education, was mainly responsible for bringing it into operation. It created new local education authorities, empowered them to provide secondary schools and develop technical education and made fundamental changes in the relations of the voluntary schools to the state.

Under the act the county and county borough councils became the local education authorities. The school boards were abolished; there were far too many of them (2,568) and they had never been a popular institution. But one concession was made to local pride: noncounty boroughs with a population of more than 10,000, and urban districts with a population of more than 20,000, were allowed under part iii of the act to exercise autonomous powers for elementary education. Except in these part iii areas, as they came to be called, the county councils were, like the county boroughs, responsible for both higher (*i.e.*, secondary and technical) and elementary education. All councils having powers under the act were required to appoint an education committee with a proportion of co-opted members with experience of education, of whom some were to be women. As the earlier reference to the case of *Rex* v. *Cockerton* indicated, there was urgent need of legislation to resolve the difficulties that had arisen over the provision of secondary education. The impasse that resulted from the Cockerton judgment was terminated by a provision in the act enabling local education authorities "to supply or aid the supply of education other than elementary." Taking advantage of this, local education authorities provided many new secondary schools which were mainly of one type. For in regulations issued in 1904 Morant, disregarding the opportunities offered by the wide terms of the act, set a pattern for their development based on the academic tradition of grammar and public schools.

It was the voluntary-school issue that made the act one of the most fiercely contested measures of the 20th century, especially the decision to give voluntary schools the benefits of rate aid. Voluntary schools as well as the council (former board) schools were brought under the general control of the new local education authorities, and the maintenance of the voluntary schools became as much a rate charge as that of the council schools. The managers of voluntary schools were, however, required to provide the school building, keep it in good repair and make such alterations as might reasonably be required. They retained the power of appointing teachers, subject to the consent of the local authority, which could not be withheld except on educational grounds. The managing body was to consist of four foundation managers and two local authority representatives, and the religious teaching was to be in accordance with the trust deed of the school. As a result, the dual system agreed upon in 1870 was not only confirmed but strengthened, while at the same time unified administration under the new local education authorities of all elementary schools opened the way to a general advance in this important branch of education.

By putting the voluntary schools "on the rates," Balfour aroused the bitter antagonism of Nonconformists, many of whom refused to pay the sum levied for education and under the leadership of John Clifford joined in a campaign known as passive resistance. In Wales some local authorities, responding to the eloquence of young Lloyd George, who denounced the act as "a fresh endowment of the church," refused to carry out their new statutory duties. The government countered their opposition by passing an act which empowered the board of education, in the case of default by a local authority, to make payments direct to the managers of schools. Happily the discord gradually died down and with its passing the board of education and local education authorities began to establish a good working relationship. At the same time, the teaching profession, through its national union and other associations, was slowly acquiring solidarity and becoming a third force in shaping educational policy. In a retrospective survey of the first half of the century the ministry of education described it as "the story of a progressive partnership between

the Central Department, the local education authorities and the teachers." Summarizing the aims pursued, the ministry claimed: "To build a single, but not uniform, system out of many diverse elements; to widen educational opportunity and at the same time to raise standards; to knit the educational system more closely into the life of an increasingly democratic and industrialized community; these are among the main ideas which, despite two major wars, have moved legislators and administrators alike" (*Education 1900–1950*, Report of the Ministry of Education for the year 1950, H.M.S.O., London, 1951).

The religious discord generated in 1902 gradually died down. With the advent of a Liberal government in 1906, bills were introduced by successive presidents of the board of education—Augustine Birrell, Reginald McKenna and Walter (later Lord) Runciman—to amend the provisions affecting religion in the 1902 act, but they all failed to reach the statute book. On the other hand, the Liberals, so active in promoting social legislation, passed measures which laid the foundation of two services which have achieved much for the well-being of children at school—school meals and medical inspection and treatment. A sense of partnership among all concerned in furthering education developed rapidly after David Lloyd George, when he became prime minister during World War I, invited H. A. L. Fisher, then vice-chancellor of Sheffield university, to become president of the board of education. The first occupant of the office to have a predominantly academic background, Fisher imparted a new spirit into administrative affairs with the assistance of Amherst Selby-Bigge, who had become permanent secretary.

Fisher's Education act of 1918, re-enacted with surviving earlier legislation in consolidated form in the Education act of 1921, aimed at the establishment of "a national system of public education available for all persons capable of profiting thereby." Local authorities were called upon to prepare plans for the orderly and progressive development of education. For the first time authorities were empowered to establish and assist nursery schools for children between two and five years of age. The school-leaving age was raised to 14, and power was given to local authorities to extend it to 15; the exemptions that made part-time attendance at school possible for older pupils—"half time" as it was called—were abolished. Provision was made for central schools and for classes for the older and more intelligent pupils in elementary schools. But perhaps the most notable clauses of this act were those designed to establish a system of compulsory continuation schools for young persons between 14 and 18 who were no longer in full-time attendance at school. The act also sought to give an added momentum to adult education. Unfortunately the financial restrictions imposed in the 1920s under the "Geddes axe" (*see* GEDDES, SIR ERIC CAMPBELL) played havoc with the Fisher act, and the principal gain derived from it was the raising of the leaving age and the abolition of half time. The project for compulsory continued education remained in abeyance until R. A. Butler revived it in the form of county colleges in the act of 1944, only to see it suffer a somewhat similar fate. The system of financing education, based on the Kempe report of 1914, which Fisher sponsored, survived the assault of the Geddes committee, which stigmatized it as a "money-spending device." Thereafter the main load of the education budget was shared between taxes and local rates, the contribution of the former consisting of block grants related to total expenditure and largely determined by an elaborate formula. Certain services were dealt with exceptionally; *e.g.*, school meals were paid for almost entirely by taxation and parental contributions; but generally speaking the grant was related to the number of children in the area and the capacity of the area to pay for their education. The incidence of the burden as between exchequer and locality varied, but the general effect of the formula in the 1950s was that the exchequer bore two-thirds of the expenditure and the local education authority one-third. This grant system did much to strengthen the conception of a constructive partnership between central and local authorities. The Local Government act of 1958, however, replaced the system by a general grant to local authorities.

Fisher's principal achievement was not his ill-starred act but certain administrative reforms that proved of enduring value. An outstanding one was the establishment of the Burnham committee—so-called because Lord Burnham was its first chairman. This led to the provision of national scales of salary for teachers, established the principle of collective bargaining on a national level and encouraged the practice of consultation between local authorities and teachers. It also drew public attention to the grossly inadequate salaries that many teachers were then receiving and provided permanent negotiating machinery for the revision of salary scales. Other important reforms were the establishment of state scholarships to enable talented pupils to proceed to the university, the institution of approved examining bodies for the award of school certificates and the formation of a Secondary Schools Examination council. Fisher also set up an Adult Education committee under the dynamic chairmanship of William Temple.

Although the 1920s were a bleak period, marked by financial stringency and problems created by juvenile unemployment, 1926 brought promise of better days with the publication of the report of the board of education's consultative committee on the *Education of the Adolescent*, generally known as the Hadow report. It concentrated public attention on the reorganization of education, urging the division of education into two stages, primary and post-primary, with 11 as the age of transfer. Thus it set the key to future policy and stimulated the provision of some good senior elementary schools, prototypes of the later secondary modern schools. The financial crisis of 1931 checked development, but one of the Hadow recommendations, advocating the raising of the leaving age to 15, found expression in the abortive Education act of 1936, which provided for this but with exemption at 14 for "beneficial employment." This act also enabled local authorities to make grants of 50%–75% to voluntary senior schools, thus encouraging the managers of voluntary schools to implement the recommendations of the Hadow report regarding reorganization. Other developments in this period were a Physical Training act and the planning of an extensive modernization of technical education. But early in 1939 the prospect of educational advance was overshadowed by the gathering threat of war. Toward the end of 1938 the consultative committee published another important report, *Secondary Education With Special Reference to Grammar Schools and Technical High Schools* (the Spens report). With the Hadow report it later formed the basis of the reconstruction embodied in the Education act of 1944.

4. Wartime Measures.—On Sept. 1, 1939, the day on which the leaving age was to have been raised to 15 under the act of 1936, the evacuation of children began from about 40 centres under a voluntary plan. Within 11 days 750,000 school children and many thousands below school age were transported to rural districts where arrangements had been made for their reception, billeting and schooling. No bombing then occurred, however, and by Christmas more than half the evacuees were back at home. During these first three months of war the public system of education was gravely disorganized in the populous areas to which so many evacuees had returned, for in these the schools could not be reopened until some kind of air-raid shelters had been provided. But gradually order was restored, schools were reopened and plans for further evacuation, if necessary, were completed. When heavy bombing began in Sept. 1940 the educational services were well prepared.

Largely as a consequence of the stress of wartime conditions, a number of educational services were developed. Previously the welfare of youth had been largely the responsibility of voluntary organizations, which covered only a limited field. At the outbreak of war these organizations were in danger, through loss of leaders and the onset of new demands, of being overwhelmed. The government, therefore, in Nov. 1939 launched a plan, "the service of youth," calling into partnership the local education authorities and the voluntary youth organizations and offering grants-in-aid of their joint efforts to provide educational and social facilities for young persons. The youth service has since become an integral part of the public system of education. War also gave a new significance to the provision of school meals. Under the Provision of Meals act, 1906, meals had been provided as a public

service mainly as a means of feeding needy children, the number fed daily averaging about 160,000 in 1939. Lord Woolton, as wartime minister of food, realized the value to national health of ensuring that children everywhere had their daily ration of milk and a nutritious midday meal; the board of education with the support of the ministry of food was soon engaged in promoting a school meals service on a nationwide scale. The service developed rapidly, parents contributing to the cost according to their means; by 1950 the number of children taking school dinners had reached 2,750,000, and about 5,000,000 children were having daily milk. Annual reports of the chief medical officer afford abundant evidence of the beneficial effects of this service upon the health and physique of school children. After the war there was an increasing concern for the education and welfare of handicapped and socially maladjusted children, and this was attributable to some extent to the experience gained with such children during evacuation. Many hostels, improvised for their occupation during the war, were taken over by local authorities, and there was a considerable increase in the number of residential and also day special schools. Camp schools, much used in wartime, stimulated an interest in such schools and in camping generally. Provision for boarding-school education was made in the Education act, 1944.

The most important consequence for education of the wartime upheaval was the demand it created for educational reform. The board of education was prompt in preparing for this and early in 1941 circulated to interested bodies a comprehensive document, seeking opinion on various fundamental issues. They received in reply more than 100 detailed memoranda, many of which were published by the bodies which had prepared them. Public interest in educational reform quickened, and in July 1941 R. A. Butler became president of the board of education. With J. Chuter Ede, the parliamentary secretary, and Sir Maurice Holmes, the permanent secretary, he entered into a long series of discussions with interested parties. Two years later, after protracted negotiations, he submitted to parliament a White Paper, *Educational Reconstruction*, in which he outlined the principles which the government proposed to follow in the education bill under preparation. In Dec. 1943 he introduced his bill, and, generally welcomed, it passed into law with certain additions and amendments as the Education act, 1944.

5. The 1944 Act.—So bold and comprehensive a measure would not have had so easy a passage if it had not been the product of a coalition government. While it respected tradition and retained some of the essential features of the acts of 1870 and 1902, it was also revolutionary, involving a thorough recasting of the educational system. The board of education with a president empowered only to superintend was replaced by a minister who was to direct and control the local education authorities. Subject to parliament, he was to have an almost absolute authority, and in support of his controlling function the act had 24 provisions enabling him to make regulations, 39 for directions by order and 38 for informal directions. He could also overrule local authorities, governors and managers if they appeared to him to be acting unreasonably. Vested with such authority a minister could do much to ensure a more even standard of educational opportunity throughout England and Wales, and he could determine priorities and take the lead in planning. The act provided two formidable planning devices; every local education authority was required to submit for the minister's approval a development plan for primary and secondary education and a plan for further education in its area. Two central advisory councils were constituted by the act, one for England and another for Wales. Unlike the former consultative committee, they had power, in addition to dealing with problems set by the minister, to tender advice on their own initiative.

The government decided to abolish those authorities, created by the act of 1902, which were responsible only for elementary education. The larger of these authorities, many of which had good records of administration, put up a strong case for survival; but their disappearance was essential to the government's policy of treating education as a continuous process and destroying the old division of education into higher and elementary. Some authorities were allowed to become excepted districts, holding special executive status within the system of county administration. As a result of the extinction of these authorities for elementary education only, the total number of education authorities in England and Wales was reduced from 315 to 146, namely the London County council, 83 county boroughs and 62 county councils. To enable the county education committees to keep in touch with local circumstances, provision was made for a considerable delegation to divisional executives, who with the various bodies of school governors and managers do much to ensure local interest and initiative.

The complexity of the educational system in England and Wales is partly because of the pioneer work done in the past by voluntary bodies and a desire to retain the voluntary element in the state system. The act of 1944 continued the religious compromise expressed in the acts of 1870 and 1902 but elaborated and modified it after much consultation with the parties concerned. The act required that in every state-aided primary and secondary school the day should "begin with collective worship on the part of all pupils" and that religious instruction should be given in every such school. As in the earlier legislation there was, however, a conscience clause and another to ensure that no teacher should suffer because of his religious convictions. The old timetable clause was repealed, with the result that religious teaching had no longer to be confined to the beginning and end of a session. Religious teaching was now to be open to inspection by H.M. inspectors.

The dual system was fully retained by the act of 1944, but some of the provisions were so elaborate as to make it difficult for anyone unfamiliar with their administration to understand them. One of the principal considerations was to ensure as far as possible that voluntary schools would be not less able than county schools (the new name for council schools) to comply with the building and other regulations prescribed by the minister. Voluntary managers were given the choice of two alternatives: their school could be either aided or controlled. An aided school is officially described as "a voluntary school in which the managers appoint the teachers, have responsibility for religious instruction, and meet half the cost of structural improvement and external repairs." A controlled school is "a voluntary school in which the local education authority is responsible wholly for the cost of structural improvements and maintenance, and, subject to the reservation of certain rights to the managers or governors, for the appointment of teachers and for religious instruction." In a controlled school the authority's representatives are in a majority on the governing body. There was yet another kind of voluntary school provided for in the act, namely a "special-agreement school"; this is a school "in receipt of financial assistance in respect of its construction, structural alterations or improvements from the local education authority under the Education act, 1936."

The essential difference between these kinds of voluntary schools is that in aided and special-agreement schools the religious teaching can be denominational every day, while in controlled schools denominational teaching can be given only twice a week, the syllabus otherwise conforming to that prescribed for county schools in the area. Such syllabuses are determined by a conference in each area of theologians, teachers and administrators. Although there is no specific reference to Christianity in the act, the general effect of the expanded compromise was to strengthen the Christian foundations of education in England and Wales.

Two fundamental reforms in the act were the abolition of the elementary school and the requirement of secondary education for all. The former distinction between elementary and higher education was replaced by a new classification of "three progressive stages to be known as primary education, secondary education, and further education." Thus the primary stage, compulsory from age 5, covers the period from 2 years old to 11–12; the secondary stage, compulsory to 15, covers the period from 11–12 to 18–19; while further education was officially described as "the post-secondary stage of education, comprising all vocational and non-vocational provision made for young people who have left

school, and for adults." Further education thus embraces not only the vast range of technical, commercial and art education and the wide field of adult education of a tutorial kind but also, in the words of the act, facilities for "leisure-time occupation, in such organized cultural and training activities as are suited to their requirements, for any persons over compulsory school age who are able and willing to profit by the facilities provided for that purpose."

6. Developments After World War II.—It was widely assumed in 1944 that it would take at least a generation to give full effect to the act, but progress was slower than then expected because of postwar economic conditions. It was soon demonstrated, however, that the act itself stood up well to the test of day-by-day administration, and later amending legislation was of a minor character involving no fundamental change. In spite of much frustration and delay, the postwar years were not unproductive; more new schools were erected than at any earlier period, and there was much development and thought in all the three stages of education. Little was done to associate the public schools with the general educational system, the problem on which the Fleming committee reported in 1944, while the part of the act affecting private schools was not brought into operation until 1957. On the other hand, and more important, the organization outlined in the report of the McNair committee (*Report on the Supply, Recruitment and Training of Teachers and Youth Leaders, 1944*) was set up, and although it was a period of full employment the supply of teachers was fairly well maintained although there were serious shortages in some areas and in certain subjects, notably science and mathematics. Universities and training colleges then became closely associated through the new institutes of education and the area training organizations, a national advisory council supervising training and supply. The abnormally high birth rate of the war and immediate postwar years created special difficulties of accommodation and staffing, and too often classes were large and classrooms overfull. The vast amount of rehousing and the considerable movements of population greatly intensified the demand for new schools, with the result that it was necessary to give priority in school building to centres of new population. In 1953 the select committee on estimates drew attention to the large amount of inadequate and unsuitable school accommodation still existing.

During postwar years much attention was given to educational principles and practice. At the primary stage this was focused upon method and, while belief in the value of activity, interest and play did not diminish, there was greater stress on self-discipline and on the importance of the "three R's," especially reading ability. At the secondary stage the question of how best to provide alternative types of education was a major issue not only in educational circles but also in party politics. The Norwood committee (1943) urged a tripartite system of grammar, modern and technical schools but some local authorities, including London, favoured comprehensive schools and, by 1958, 50 schools of this type had been established. Much thought was given to the curriculum and to methods of determining the ability and aptitude of entrants to the secondary stage, whereas in further education attention was directed to the best way of providing for advanced study and research in the technological field. In 1945 a committee under the chairmanship of Lord Percy reported on higher technological education, and subsequently there was prolonged debate as to whether to develop the higher studies in some of the existing technical colleges, to look to the universities to supply leading technologists or to create one or more new technical institutions of university rank. Early in 1953 the government announced its decision to promote the expansion of the Imperial College of Science and Technology within the University of London, and between 1957 and 1962 it was planned to about double the number of its students, bringing the total to approximately 3,000. The ministry of education also encouraged advanced study and research in some of the leading technical colleges and in 1956 issued a White Paper on *Technical Education*, which provided the basis for a policy of expansion. Another notable postwar development was the substantial increase in the number of young workers released by industrial and commercial firms for part-time continued education, and a welcome feature was the growing interest of industry in scientific and technological education.

7. Scotland.—For centuries the Scots have been zealous for education and are justly proud of their long tradition of free public schools. In the *First Book of Discipline* (1560), largely attributed to John Knox, emphasis is laid on the necessity of ensuring "the virtuous education and godly upbringing of the youth of this realm," an ideal still dominant in Scottish thought and practice. Several attempts were made in the 17th century to provide a system of schools, and ultimately in 1696 an act for "Settling of Schools" ordained that there should be a school and schoolmaster in every parish. Subsequently parish schools were generally provided, and, although elementary in character, many of them supplied a secondary education for the abler pupils, sending them directly to the university. There has never been in Scotland such a distinct separation of elementary and secondary education as in England. Nor has Scotland been seriously affected by religious differences about the provision of schools; kirk and state were able to work together for the advancement of education, much as did the theocracies of the New England states in America in the 17th century. But the parish school system had its shortcomings, the most serious being its failure to meet the needs of the larger towns. They relied chiefly on burgh schools and academies, both mainly secondary, and trusted largely to voluntary effort to provide elementary education. As in England this proved inadequate, and when population increased thousands of children were without schooling. It was also found that where parishes had a very large area or a scattered population, as in the Highlands and the islands, the parish school system could prove inadequate.

Although England and Scotland have shared one parliament since 1707, Scotland has fully retained its separate educational system and traditions, and the secretary of state for Scotland is responsible for the central administration of Scottish education. In the long series of separate enactments, one of the most important was the Education act of 1872, which set up elective school boards for the administration of parish and burgh schools and made education compulsory between ages 5 and 13. (The school-leaving age was raised to 14 in 1901 and to 15 in 1947.) The school boards had the task of filling the serious gaps in school provision in the large towns; when the act of 1872 was passed 30,000 additional school places were needed in Glasgow and more than 4,000 in Edinburgh. Religious instruction was given at the discretion of each school board subject to a conscience clause. With two or three exceptions the boards made the Bible and the Shorter Catechism the basis of instruction.

The Education (Scotland) act of 1918 was another important landmark. It provided that primary education should normally end at 12, made mandatory free intermediate and secondary schooling for all children able to profit by it and replaced the 947 school boards by 33 county *ad hoc* education authorities and 5 similar authorities for Edinburgh, Glasgow, Dundee, Aberdeen and Leith. It also provided for the transference to these authorities of Roman Catholic, Episcopalian and other voluntary schools but without diminishing their denominational character. Thus Scotland, unlike England, has no dual system. Other notable provisions in that act were the establishment of an advisory council and the institution of minimum scales of salary for teachers. In 1920 a national committee for the training of teachers was constituted, charged with the supervision of training centres at St. Andrews, Aberdeen, Edinburgh and Glasgow; it was also given responsibility for the former voluntary training colleges. In 1929 the *ad hoc* education authorities were abolished by the Local Government (Scotland) act, and the local government of education was entrusted to the county councils and the councils of Edinburgh, Glasgow, Dundee and Aberdeen. Since 1939 post-primary schools have been designated secondary and fall into two main categories: junior, for pupils intending to leave at 15, and senior for those staying to 17 or 18. The Education (Scotland) act of 1945 did not involve fundamental reconstruction like its English counterpart of 1944, for Scottish education was already organized in progressive stages, nor was it confronted with the problems of a

dual system. More important from the standpoint of reconstruction were three valuable reports of the Scottish Advisory Council on Education—*Primary Education* (1946), *Technical Education* (1946) and *Secondary Education* (1947). The last emphatically rejected "the tripartite organization" as "unsuitable for Scotland." (*See* also SCOTLAND.) (W. O. L. S.)

8. Commonwealth of Nations.—Religious schools were founded by missionaries soon after the first settlements had been established, but large-scale immigration caused a demand that soon exceeded the financial strength of the missions. This led to support from public funds, and interdenominational quarrels prepared the way for national systems which were to be free, compulsory and secular. Ambitious colonists everywhere desired for their children educational facilities at least as good as those available in the home countries and were eager to support colleges and universities, which thus began very early. Social equality facilitated the establishment of single-stream, nonselective secondary schools, and the demand for geographical equality of opportunity, especially between town and country, together with the financial weakness of rural local authorities, helped the growth of strong central authorities at the provincial level. Federation of separate colonies into dominions left control to the provinces or states, though there was little difference between the separate systems of each province. The models copied in each case were those of the home countries, and adaptation to local geographical and social conditions was slow. For an account of the development of education in the colonies *see* COMMONWEALTH OF NATIONS. In addition to the following descriptions of public education in Canada, Australia and New Zealand, *see* also separate articles on commonwealth members such as CEYLON; PAKISTAN.

Canada.—French Catholic education started with a Jesuit school in Quebec (1635) and by 1760 there were more than 30 elementary schools, 1 college and 2 seminaries, as well as more than 15 convent schools for girls, chiefly Ursuline. Probably about one-third of the French inhabitants were literate. In the English areas, inadequate facilities were provided by voluntary and missionary agencies. The Quebec act (1774) did not encourage French-speaking Catholic schools but allowed them to operate. From 1763 to about 1840 in eastern Canada and until 1800 in the west, schools for the people were run mainly by the church or the parish; they were supported by low fees and small grants from public sources. Secondary schools, either grammar schools or academies, depended upon fees. Later, strong central authorities promoted free schools largely dependent upon local taxation. Provincial control was enhanced in the interest of equalizing opportunity and from this system evolved the ten independent provincial systems of modern Canada. The British North America act of 1867 gave each province full authority over education, maintaining only the rights of denominational schools and leaving to the federal government the provision of education in extraprovincial territories. Universal free schooling was available in the east by 1870 and in the west by about 1910. In 1860 enrollment in day schools was 600,000; in 1960, 2,700,000. In 1860 an average of three years was spent in school; in 1960, 10 or 11 years.

Education for Indians was promoted by missionaries, but nomad life was a handicap although after 1830 the government gave a little financial help. The federal government accepted responsibility in 1868 and the code of 1894 made school attendance compulsory. For subsequent developments *see* CANADA: *Education* and *Education* sections of separate articles on the provinces.

Australia.—The chaplain of New South Wales started the first school in 1793 and by 1797 there were six Church of England schools. After 1816 Gov. Lachlan Macquarie tried to establish schools in all settlements, allocating part of the customs duties for their help, thereby accepting the principle of public support. The 1825 act gave full charge of education and £20,000 a year to the established church. In 1829 there were 36 schools and 1,265 pupils. Other denominations became active and religious rivalries hampered progress. Sir Richard Bourke (1833) called for a national secular system, similar to that proposed for Ireland. He was opposed by all religious groups and the resulting act of 1848 was a compromise, establishing a national and a denominational board of education. The great 1866 act, which served as a model to similar acts in the other colonies of Australia, anticipated the English act of 1870. It abolished the dual system and established free, secular and compulsory schools in all localities where a minimum of 25 pupils could attend. England was copied as regards curriculum, teaching methods, teacher training and inspection. From Scotland came the notion of education for all and free secondary education for the children of those who could not pay the fees of private schools. The developments in other colonies followed a very similar path. The nomadic habits of the aborigines made it difficult for missionaries to establish schools. The few which exist are aided by the commonwealth, which since 1945 has also provided special schools intended to adapt the aboriginals to settled civilization.

New Zealand.—The first Anglican mission school (for Maoris) was started in 1816. Wesleyans and Catholics soon followed, but the Church of England was never as strong as in Australia. The Grey ordinance (1847) instructed provincial authorities to pay grants to Anglicans, Catholics and Wesleyans, but some authorities refused to obey. The 1877 Education act established a secular, free, compulsory system of primary education organized under 12 (later 9) regional education boards. The secondary schools were left as independent institutions, each governed by a local board, with one-quarter of the education endowment allotted to their use. All but two were nationalized in 1920. In 1877 a central education department was set up, intended at first to distribute funds. It quickly grew in power so that it came to control education as completely as in any fully centralized system. At first, English (partly Scottish) models were copied in curriculums and methods. When George Hogben took control of the education department in 1899 he offered subsidies to secondary schools that taught science, agriculture and manual work. Partial failure led to the establishment of district high schools, intended to be agricultural, later (especially after 1920) of flourishing technical high schools.

Maori education was promoted by the missions, by 1847 receiving generous grants and after 1877 strongly supported by the department.

India.—An account of the evolution of education in India is presented under *Education in the Eastern World: India*, below. (J. A. La.)

C. France

In the middle ages in France, as elsewhere in Europe, the universities were the first educational institutions to become organized into faculties, teaching in Latin and subordinating all other disciplines to their final end, theology. Colleges were then founded to prepare young men for the university, and became the basis of secondary education. The Jesuit colleges which were created at the time of the Renaissance reconciled the teaching of the new humanism of the time with the established doctrines of the Roman Catholic Church, and flourished with special brilliance.

Despite the changes brought about by the Renaissance, the attention given to the sciences in the 17th and 18th centuries and the efforts of philanthropists such as St. Jean Baptiste de la Salle to develop a form of primary education, it was not until the advent of the French Revolution that the universal right to education was proclaimed.

The constitution of 1791 decreed "that public education shall be organized, common to every citizen and free in respect of those parts of education that are indispensable to all men." The Convention created the *écoles centrales* which brought the primacy of Latin to an abrupt end, introduced the sciences that had been looked at askance by the colleges before the Revolution, and based education on the French language.

Unfortunately the Revolution hardly had the opportunity to realize these principles, and Napoleon restored the old system, with his only concession a provision for the study of mathematics. He did, however, reorganize the structure of secondary and higher education in a unified state system, with secondary schools maintained by the *communes*, *lycées*, state establishments and universities. Within this structure the rector of a university headed a teaching body, recruited by the state and supervised by an in-

spectorate, ranging through various grades up to the university council. Grades of proficiency in studies from simple certificates, to the *baccalauréat, licence,* and doctorate were awarded on the result of examinations, and these tests were made a necessary condition of entry into such professions as medicine, law and teaching. This structure, despite many modifications, has survived until modern times.

1. Development of State Education.—French educational history in the 19th century is essentially the story of the struggle for the freedom of education, of the introduction at the secondary level of the scientific branches of learning, and, under the third republic, of the establishment of primary education, at once secular and compulsory, between the ages of 6 and 12. There was a sort of middle education between the ages of 13 and 16, and finally a professional and technical education.

Under the Restoration education fell inevitably under the control of the church, but under the Liberal monarchy François Guizot in 1833 passed a law which laid the foundations of modern primary instruction, obliging the *communes* to maintain schools and pay the teachers. The higher primary schools which he founded were unfortunately suppressed by the *loi Falloux;* their restoration constituted one of the great positive services rendered by the third republic to the cause of popular education. The *loi Falloux* of 1850, passed by the second republic under the influence of the prince president, restored the liberty of teaching, which meant in effect free scope for priestly schools (*see* FALLOUX, FRÉDÉRIC ALFRED PIERRE, COMTE DE). This law also made provision for separate communal schools for girls, for adult classes and for the technical instruction of apprentices. In 1854 France was divided for purposes of educational administration into 16 academies, each administered by a rector with an academy inspector under him for each department.

The ministry of Victor Duruy (1865–69), corresponding to the period of the Liberal empire, made primary schools for girls obligatory in *communes* of more than 500 inhabitants. Duruy also provided for the introduction of free instruction at the option of the *commune.*

The task of educational reform imposed itself upon the republic by a twofold necessity. The wars of 1866 and 1870 were victories for the Prussian schoolmaster, and aroused western Europe to the importance of popular education. For France the reform of popular education was an essential part of the work of national restoration. For the republic, too, menaced by older and hostile traditions, the creation of a national system of education inspired by its own spirit was an essential condition of the security of its government and the social ideals of which that government was the expression. Hence the energy with which the republican state addressed itself to the organization of primary instruction, "obligatory, gratuitous, secular."

By the law of June 1, 1878, there was imposed upon the *communes* the obligation of acquiring their school buildings; and as a grant in aid a sum of £2,400,000 was set aside for this purpose by the state. In 1879 a law was passed compelling every department to maintain training colleges for male and female teachers. The two higher normal schools of Fontenay and St. Cloud were founded to supply the training colleges with professors. During this period, among other certificates were established the *certificat d'aptitude pédagogique,* which qualified probationer-teachers (*stagiares*) for appointment as teachers in full standing (*titulaires*), and the *certificat d'aptitude* for primary inspectors and heads of normal schools. The law of June 16, 1881, rendered obligatory for all teachers, whether public or private, the *brevet de capacité.* It was found, however, impracticable to carry this law into immediate effect.

The laws making primary education free, compulsory and secular are indissolubly associated with the name of Jules Ferry. The law of June 16, 1881, abolished fees in all primary schools and training colleges, the law of 1882 established compulsory attendance, and finally the law of Oct. 30, 1886, enacted that none but lay persons should teach in the public schools and abolished in those schools all distinctively religious teaching. In the boys' schools, members of religious communities were to be displaced within five years, but in girls' schools the *religieuses* might remain till death or resignation. The law of Aug. 9, 1936, made education compulsory to the age of 14. The religious dissensions which broke out over the problem of the schools, and which were at one time keen, gradually died down. The government schools did, in fact, accept pupils and teachers of any philosophical or religious persuasion, and these worked together in a common humanism that respected every form of conviction.

2. Secondary Education.—In proceeding to sketch the French system of higher primary and secondary schools, it may be observed that European systems of higher education were generally framed upon the view that secondary education is a training distinct from the preparatory stage to the university, with aims and ideals of general culture which differentiate it radically and at the very outset from education of the elementary type. Down to the reform of 1902, explained below, the French system could be regarded both as a typical and extreme example of the European theory.

Higher Primary Schools.—The aim of the *écoles primaires supérieures* was to fill the void which must otherwise exist for those needing a higher education than the primary school could give. Throughout the organization of primary education the French kept steadily in view the danger of creating an intellectual proletariat. *"Nous poursuivons la culture générale du caractère et de l'esprit, mais nous cherchons en même temps à orienter l'enfant vers la vie pratique,"* says an official report. The aim of the higher primary school was to continue education in this spirit up to the age of 16 so as to prepare the scholar to take an honourable place in the higher ranks of skilled industry or in the middle ranks of the professions. In 1942 the *écoles primaires supérieures* were replaced by the *collèges modernes* ("modern schools").

Lycées, Classical Schools and Modern Schools.—French secondary education for boys is given in the *lycées,* which are secondary schools maintained and controlled by the state, in the so-called classical schools maintained by the municipalities and in the *collèges modernes* mentioned above.

Secondary Education for Girls.—The foundation of secondary schools for girls was in its way one of the most notable achievements of the third republic. It was inaugurated by the law of Dec. 22, 1890, called after its author the *loi Camille Sée.* At first the curriculums were different from those of the boys', and the course of study was only five years. There were no ancient languages, and mathematics was not carried to so high a level as in the boys' *lycées.* After 1942 there were three types of establishments, the same as for boys (*see* above).

Private Secondary Schools.—Secondary education in private schools, also shaken by the laws against religious orders, nevertheless continued to develop, and at one time the number of pupils in them was hardly smaller than the number of those in government secondary schools, although by the end of the 1950s the proportion of pupils in private schools was decreasing as the child population increased.

Secondary School Curriculum.—In 1902 reforms were made in the curriculum. The decree of May 31, 1902, provided for a full course of secondary studies of seven years' duration, divided into two cycles of four and three years. In the first cycle the scholar had two options. In section 1 Latin was obligatory and Greek optional from the beginning of the third year (*classe iv*). In section 2 there was no Latin. At the end of the first cycle the state granted a *certificat d'études secondaires du premier degré.* In the second cycle one of four courses might be taken: section 1 with Latin and Greek continued the old classical education; section 2 consisted of Latin and modern languages; section 3 of Latin and science; and section 4 of modern languages and science. The *baccalauréat,* or secondary school-leaving examination (*see* also EXAMINATIONS), conducted by the university, was adapted to all the courses.

Technical Schools.—A certain number of technical schools, formerly under the ministry of commerce, were brought under jurisdiction of the ministry of public instruction. They included six national professional schools, six *écoles nationales d'arts et métiers,* higher schools of commerce and *écoles pratiques de com-*

merce et d'industrie, as well as commercial and technical courses. There was also a network of institutions and schools run by the ministry of agriculture, from the national agricultural institute of Paris, and the national schools of agriculture at Montpellier and Rennes, down to the *fermes-écoles* and the *écoles pratiques d'agriculture*. In 1919 the *loi Astier* unified these diverse institutions and created a special tax, the *taxe d'apprentissage*, to provide for technical training. Since World War II, the *centres d'apprentissage* received pupils from the primary schools.

3. Reforms After World War II.—After World War II French educationists were much occupied in rebuilding schools that had been destroyed or damaged, and in providing additional accommodation for the extra numbers resulting from the wartime increase in the birth rate. At the same time there was a strong demand for educational reform, and this led the ministry of education to ask a commission, presided over first by P. Langevin and later by H. Wallon, to make a comprehensive survey of the educational system. The commission recommended a radical reconstruction of school organization and of university education, and advised a substantial reform of teaching methods. It was estimated that the proposals if fully implemented would increase the national education budget almost 50%. An important feature of the proposals was the stress laid on the differing needs of individual pupils and on the importance of having regard to aptitude and ability. There was a new emphasis on technical aspects of education. For the secondary stage two cycles were proposed. The first (ages 11–15) was designed to provide a course common to all pupils, with special subjects suited to individual needs; it was also recommended that this stage should be designed to disclose aptitudes and abilities. The second cycle (ages 15–18) was to be of a more specialized character with provision for part-time education. Experiments were carried out along these lines so as to facilitate the formulation of legislation. There also was a marked change in teaching method, with more emphasis on group and individual initiative. The proposals of the Langevin commission were not applied except in the case of the *classes nouvelles*, where they affected 200 *établissements du second degré* in the first four years. But these proposals were followed by other projects largely inspired by them.

On Jan. 6, 1959, the government under Charles de Gaulle passed a decree raising the school-leaving age from 14 to 16 and establishing for pupils entering an *établissement du second degré* a period of observation lasting two years (from 11 to 13), to make it easier to direct them to the branch of study for which they showed aptitude.

In addition measures were taken after 1950 obliging future teachers of the *second degré*, after passing the *licence*, to spend a year in professional training on the completion of which a *certificat d'aptitude à l'enseignement* was granted; *écoles normales d'apprentissage* were created to train teachers for the *centres d'apprentissage*, and the *école normale supérieur de l'enseignement technique* was developed for teachers in technical colleges. Two new *baccalauréats* covering technical and industrial subjects and the economic and humane sciences point to the value placed upon technical education. Teachers must pass the *baccalauréat* in an *école normale* and follow a course of professional training. At last, by the law of Dec. 31, 1959, it was made possible for private establishments to receive total or partial aid from the state in return for some degree of state control.

4. French Community.—The demand for education in French overseas territories had become no less keen than in the mother country in the second half of the 20th century. By the early 1960s, the general tendency was to develop in the territories of the French Community a type of education close to the French system, at the request of the inhabitants themselves seeking similar educational opportunities for their children. Great efforts were made to meet the costs of such a provision, to adapt education to local conditions, and to organize higher education.

See also FRANCE. (RO. G.)

D. GERMANY

1. Early Provision.—Martin Luther's famous letter to the German municipalities in 1524 urged upon them the duty of providing schools and upon parents the duty of sending their children to school. An attempt to carry this into effect was made by the electoral government of Saxony, which in 1528 issued an ordinance, drawn up by Philipp Melanchthon, providing for the establishment in every town and village of Latin schools, for the Protestant reformers were solidly in favour of classical education. The ordinance issued by the elector of Württemberg in 1559 represented the first systematic attempt to provide both elementary and higher education, directing the establishment of elementary schools throughout the country and of Latin schools (or *Particularschulen*) in every considerable centre of population. These promising beginnings were brought to nothing, however, in the troubled times of the Thirty Years' War, and by the desolation and national decadence that followed it. The permanent and positive value of Luther's pronouncement of 1524 lies not so much in its direct effects as in the associations which it established for Protestant Germany between the national religion and the educational duties of the individual and the state. This no doubt helped create that healthy public opinion which rendered the principle of compulsory school attendance acceptable in Prussia at a much earlier date than elsewhere, except in Scotland where a similar religious influence was supplied by John Knox. State intervention in education was almost coincident with the rise of the Prussian state. In 1717 Frederick William I ordered all children to attend school where schools existed. This was followed in 1736 by edicts for the establishment of schools in certain provinces and by a royal grant of 50,000 thalers for that purpose in the following year. In 1763 the *Landschulreglement* of Frederick the Great laid down the broad lines upon which the Prussian state thereafter proceeded, asserting the principle of compulsory school attendance.

2. Wilhelm von Humboldt.—However, the schools established a tradition of curriculum that ignored the changing needs of life and fields of knowledge and no effective reorganization of the educational system was carried out until after the disaster of Jena (1806), which brought about the virtual collapse of Prussia and at the same time introduced a period of reform in the government as a whole. One of the first acts of the minister Baron von Stein in 1807 was to abolish the semiecclesiastical *Oberschulkollegium* and to place education under the ministry of the interior, with Wilhelm von Humboldt (*q.v.*) at the head of a special section. Humboldt's policy in secondary education was a compromise between the narrow philological pedantry of the old Latin schools and the large demands of the new humanism of the period. The measure introduced by Humboldt in 1810 for the state examination and certification of teachers checked the then common practice of permitting unqualified theological students to teach in the schools, and at once raised the teaching profession to a high level of dignity and efficiency which of itself sufficed to place Prussia in the forefront of educational progress. It was due also to the initiative of Humboldt that the methods of J. H. Pestalozzi were introduced into the teachers' seminaries, through them to vitalize the elementary schools. To this period also belong the revival, in 1812, of the *Abiturientenexamen* ("the school-leaving examination"), which had fallen into abeyance, and the institution about the same time of the local authorities called *Schulvorstände* for the country and *Schuldeputationen* for the towns.

3. Developments After 1815.—Though the period that succeeded the peace of 1815 was one of political reaction, the work of administrative organization was carried on by defining the duties of the *Provinzial-Schulkollegium* and the *Regierung*. In 1834, an important step was taken in regard to secondary education by making it necessary for candidates for the learned professions, as well as for the civil service and for university studies, to pass the leaving examination of the *Gymnasiums*. Thus through the leaving examination the state held the key to the liberal careers and was thereby able to impose its own standards upon all secondary schools.

In connection with the *Kulturkampf*, or struggle between the state and the Roman Catholic Church, the *Schulaufsichtsgesetz* of 1872 reasserted the absolute right of the state alone to the supervision of the schools. Nevertheless the Prussian system remained

both for Catholics and Protestants essentially denominational. All schools, whether elementary or secondary, were Evangelical, Catholic, Jewish or mixed. In the elementary sphere, in particular, recourse was had to the mixed school only where the creeds were so intermingled that a confessional school was impracticable. In all cases the teachers were appointed with reference to religious faith; religious instruction was given in school hours and was inspected by the clergy.

The official classification or grading according to the type of curriculum of secondary schools in Prussia (and throughout Germany) was very precise. The following were the officially recognized types of the period: (A) Classical schools: (1) *Gymnasium,* with nine years' course; (2) *Progymnasium,* with six years' course. (B) Modern schools: (1) with Latin (semiclassical)—(a) *Realgymnasium* (nine years' course), (b) *Realprogymnasium* (six years' course); (2) without Latin (nonclassical)—(a) *Oberrealschule* (nine years' course), (b) *Realschule* (six years' course).

The differentiation between the types was the result of a natural educational development corresponding with the economic changes which transformed Prussia from an agricultural to an industrial state. The classical schools long retained their social prestige and a definite educational advantage in that their pupils only were admissible to the universities. From the foundation of the empire (1871) the history of secondary education was largely concerned with a struggle for a wider recognition of the work of the newer schools. The movement received a considerable impetus by the action of the emperor, who summoned a school conference in 1890 at which he set the keynote with the statement, "It is our duty to educate young men to become young Germans and not young Greeks or Romans." New schedules were framed in which the hours devoted to Latin were considerably reduced, and no pupil could obtain a leaving certificate without a satisfactory mark in the mother tongue. The results satisfied neither party, and the reform lasted only a single school generation. In 1900, after a second conference, equality of privileges was granted to three types of schools, subject to certain reservations—the theological faculties continued to admit only students from classical schools and the pupils of the *Oberrealschule* were excluded by their lack of Latin from the medical faculties, but insofar as Latin was required for other studies, such as law or history, it could be acquired at the university itself.

Although the official curriculums were binding on the schools, their rigidity was not absolute; experiments were possible, but they were carefully supervised. It was thus that the modifications of the classical school curriculum known as the Frankfurter system came into being, after a similar experiment had been tried at Altona. The chief innovation—and there the two schemes agreed —was the postponement of the beginning of Latin to *Untertertia* (lower fourth form) and the introduction of French as the first foreign language. This enabled parents to defer their decision as to the form of their son's education until he was about 12 years of age.

A further instance of the willingness of the authorities to sanction reasonable changes was seen in the permission accorded to certain schools to vary the course of study in the top classes, as a preparation for the freedom of choice of the university.

4. Girls' Schools.—In Prussia, as elsewhere, the higher education of girls lagged far behind that of boys and received little attention from the state or municipality, except insofar as the services of women teachers were needed in the elementary schools. Thus it came about that in Prussia secondary schools for girls were dealt with administratively as part of the elementary school system. After the establishment of the empire a conference of directors and teachers of these schools was held at Weimar and put forth a reasoned plea for better organization and improved status. The advocates of reform, however, were not at unity in their aims; some wished to lay stress on ethical, literary and aesthetic training, others stressed intellectual development and claimed an equal share in all the culture of the age. But even in the schools the women fought an unequal battle, for all the heads and a large part of the staff were men, usually academically trained. The women continually demanded a larger share of the work, and this was secured by the establishment of a new higher examination for women teachers. University study though not prescribed was in fact essential, and yet women had not the right of access to the university in Germany. They were allowed to take the *Abiturientenexamen,* for which private institutions prepared them, but their admission to the university rested with the professor.

Economic necessity and the growing strength of the women's movement at last brought the desired change. New schemes were issued in 1908, organizing the girls' schools in two degrees: the *Lyceum,* a ten-class institution for girls from 6 to 16; and an *Oberlyceum* of three classes of varying types, one of which might be a training department for teachers, another for home life. But apart from these normal courses, opportunity was given to girls to follow from their 12th or 13th year courses similar to those of the higher schools for boys. The form generally preferred was that of the *Realgymnasium.* At the same time a ministerial decree opened the German universities to women on the same terms as men.

5. The Weimar Republic.—In no sphere of public activity did the establishment of the German republic after World War I cause more far-reaching changes than in that of education. The ultimate aims which these innovations envisaged were clearly stated in the Weimar constitution, and led to a single system of national education. It was recognized that this goal could be reached only by gradual steps, and the responsibility for educational administration was left with the federated states. The state ministries, however, had to observe the principles enunciated in the constitution and had to conform to the federal laws.

The elementary school, which under the old regime was a class school, became a national institution, serving all and used by all. It had no rivals, and private elementary schools were forbidden. The *Einheitsschule* ("common school"), which the popular parties had demanded before World War I, became an accomplished fact as far as the first four years of the course were concerned. As a concession, reluctantly granted, specially gifted children were allowed to complete the course in three years.

When the *Grundschule* ("basic school") had been passed the child might be transferred to a secondary school, organized to lead on to the university, or he might go to the *Mittelschule,* if he wished to enter commerce or industry about the age of 16, or he might remain at the elementary school, if he had to enter on employment at the earliest possible age.

After 1918 the interests of poor but gifted boys were well served. Two new types of schools catered to their particular needs. There was first the *deutsche Oberschule,* in which, in harmony with the sentiment of the Weimar constitution, the emphasis was laid on the training of a national spirit, and German history, literature and art were all studied from this national standpoint, though foreign languages were not excluded. These schools replaced, to a large extent, the old institutions which prepared former elementary school pupils for admission to the training colleges for teachers of primary schools.

The other new type was the *Aufbauschule* ("built-on" or supplementary school). Its place in the educational scheme resembled the high school of the United States in that it received only pupils who had completed the elementary school course.

6. The Third *Reich.*—Under Adolf Hitler the formal organization of the elementary and secondary systems was not changed radically, but the content of education underwent a vast transformation to make it conform with National Socialist ideology. Youth labour camps were established in which the educational keynote was nationalistic and utilitarian. The personnel of the schools was transformed, studies were wrested from their proper position and twisted to fit fascist theories and principles, and indoctrination permeated the whole educational system; wherever German influence extended before and during World War II, anti-Semitism followed, resulting in the expulsion of Jewish teachers. (*See* also NATIONAL SOCIALISM; FASCISM; ANTI-SEMITISM.) The traditional nine-year course was reduced to eight, and potential Nazi leaders were sent to *Adolf-Hitlerschulen,* administered by the party. During this period the number of *Gymnasiums* was

reduced, the Nazis favouring the *deutsche Oberschule*, with its emphasis on German tradition. The system introduced during the Weimar republic which placed teacher preparation on a university basis was discarded and replaced by one which was to recruit candidates at the age of 14 from a new type of higher primary school (*Hauptschule*) and train them in small institutions for five years. This represented a return to a system against which German teachers had been protesting for a century.

(A. E. Tw.; Jr. E. W.)

7. Changes After World War II.—For several years after World War II education was conducted in each zone under the supervision of the British, Americans, French and Soviets, respectively, and under the Allied control council. In 1948 the council suggested the general principles for the reorganization of the educational systems. In May 1949 the Federal Republic of Germany (West Germany), consisting of seven *Länder* and three city-states, was established, and in Oct. 1949, the German Democratic Republic (East Germany) was created. The basic law of the Federal Republic (May 23, 1949) granted autonomy in educational matters, and the *Länder* and city-states passed their own laws. In 1949 a standing conference of ministers of education was established to discuss problems common to all; it is advised by a federal educational council, created in 1953.

Since each member of the Federal Republic administers its own system, education in Germany is marked by uniformity and diversity. The uniformity is due to provisions in the basic law regarding the status of private schools and making religious instruction a part of the regular curriculum but not compulsory. Compulsory attendance is required full-time from age 6 to 14 or 15 and part-time to 18. Tuition fees and supplies are free in all the systems except that of Württemberg-Baden. Full-time attendance to 15 is compulsory in Bremen, Hamburg, west Berlin and Schleswig-Holstein. Pre-schools and kindergartens are private. The length of the basic school (*Grundschule*) is four years in the *Länder* and six years in the city-states, and is followed by four years in the upper division of the elementary school, or by three, four, or five years in an intermediate form of secondary education, or by six, eight, or nine years in an academic, technical, or general secondary school leading to the university. Generally the system in the city-states approximates the *Einheitsschule* idea, although the traditional forms of secondary education are still selective. As elsewhere there are considerable criticisms of the overemphasis on the intellectual and too little attention to other educative factors.

(I. L. K.)

E. The U.S.S.R.

1. The Tsarist Period.—Except in the western Ukraine and Belorussia, the system of education in Russia at the beginning of the 18th century was directed from St. Petersburg by the tsarist government and was imparted in Russian. Whereas in western Europe education was initiated by the church and was subordinated to church ideals and purposes, the Russian school system was started by Peter the Great (1672–1725) as a state organization for purposes of administration in peace and war and for the development of mining and industry. Peter the Great did not intend to promote the Orthodox faith or formal classical learning, whether Greek, Latin or Slavonic. He created mathematical, navigation, artillery and engineering schools for utilitarian purposes. Thus the schools were secular and scientific and were controlled and maintained by the state. The Moscow School of Navigation and Mathematics was founded in 1701 on the model of the Royal Mathematical school at Christ's hospital in London. The Moscow school served as a centre for a whole system of lower-vocational schools and trained sailors, teachers, engineers and craftsmen. These utilitarian, secular and scientific characteristics of Peter's schools became the dominant features of the Russian system, but, as a result of the many changes of policy of his successors, they did not develop into a national system of education. Only the Naval academy (developed from the Moscow School of Navigation) and the Academy of Sciences survived all the vicissitudes of Russian history and were, in the 1960s, among the leading institutions of the U.S.S.R. The Academic University of St. Petersburg was soon closed and gave way to the University of Moscow, founded in 1755.

A second attempt at building up a national system of schools was made by Catherine II. After many abortive schemes Catherine issued in 1786 a statute for schools, which can be considered the first Russian education act for the whole country. According to this act a two-year course in minor schools was to be started in every district town and a five-year course in major schools in every provincial town. Religion was taught only in the three lower classes and Latin only for those pupils who intended to enter *gimnazii* ("secondary school") and Moscow university. Other subjects included Russian (26 hours a week per school), arithmetic (18), foreign languages (21), morals (5), geography (11), history (16), sciences (10), mathematics and physics (14), and drawing (30). As this curriculum shows, Catherinian schools were also utilitarian, scientific and secular. At the end of the 18th century 254 towns had the new schools, but 250 smaller towns and rural districts had no schools whatever. The Catherinian system was state-controlled, coeducational and free to all subjects of the empress, including serfs.

The third attempt was made by Alexander I, and was influenced by the French Revolutionary leaders, the marquis de Condorcet, Gilbert Romme and Pierre Daunou and the English utilitarians, J. Bentham and J. Lancaster. The new statutes (Vilna, 1803 and Russian provinces, 1804) maintained the principles of utility and secular scientific instruction. The parochial schools in the rural areas were to instruct the peasantry in reading, writing and arithmetic and elements of agriculture, the district schools of urban areas and the provincial schools (*gimnazii*) were to give instruction in subjects necessary for civil servants (law, political economy, technology and commerce). The whole system was state-controlled, free for all subjects of the tsar and formed a continuous ladder leading to the universities. During Alexander's reign the old Catherinian schools were remodeled and many new schools founded. In 1825 there were six universities (Moscow, St. Petersburg, Dorpat, Vilna [Vilnius], Kharkov and Kazan), four lyceums (Odessa, Kremenets, Nezhin and Yaroslavl), three veterinary institutes, two forestry institutes, 60 *gimnazii*, 370 district schools and 600 parochial schools. In addition there were 18 girls' secondary schools and about 360 private schools for privileged classes. The students of higher institutions received maintenance grants so that out of a total of 3,000 students 1,300 were state scholars.

The successor of Alexander I, Nicholas I, considered this democratic trend harmful and decreed that "It is necessary that in every school the subjects of instruction and the very methods of teaching should be in accordance with the future destination of pupils, that nobody should aim to rise above that position in which it is his lot to remain." In consequence in 1827 serfs were forbidden to enter *gimnazii* and universities. The new statute decreed that parochial schools were intended for the peasants, the district schools for merchants and other townspeople, and *gimnazii* for children of the gentry and civil servants. Instruction in the *gimnazii* in Latin and Greek was increased (69 hours out of 270). Although the legislation of Nicholas I established a class system, one way for the gentry and another for the rest, the utilitarian character of the whole system remained. In 1849 even the *gimnazii* were divided into two departments, one with Latin (only 20 hours) and another without Latin, which accepted all subjects, except serfs.

The Russian radical intelligentsia was fiercely opposed to the privileged schools for the gentry and demanded the re-establishment of a democratic system with a more modern curriculum in secondary schools. This was coupled with the demand for the emancipation of the serfs and the equality of women in education. The new tsar, Alexander II, inaugurated a period of liberal reforms. The serfs were emancipated in 1861 and thus all social restrictions were removed. A new system of local government in rural areas (*zemstvo*) was enacted with a right to found schools for the peasantry, now free. Although the reign of Alexander II was marred by some reactionary measures the net result was an unprecedented growth of schools in the rural areas, which the com-

bined efforts of the government, *zemstvos* and peasant communities produced. The utilitarian trend was evident in the establishment of technical schools with vocational differentiation. The education of women was promoted and the first higher courses for women were founded in main cities.

The assassination of Alexander II by revolutionaries led to a second period of reaction under Alexander III. All reforms were suspended and the growth of educational institutions interrupted. The chief procurator of the Holy Synod, K. P. Pobêdonostsev, attempted to build up a rival system of parochial schools under the control of the orthodox clergy and the minister of public instruction, T. D. Delyanov, tried to return to the class system of Nicholas I. These reactionary measures only temporarily set back the growth of education.

The reign of the last tsar saw a constant hesitation between concessions to liberal demands of the intelligentsia and attempts to stop the growing revolutionary movement. The establishment of the state *duma* (*q.v.*), the first Russian house of representatives, resulted in a rapid growth of industry and education. However, all the comprehensive schemes of the state *duma* for a radical reform of education were obstructed by the tsarist government. The deepening gulf between the tsar and the people resulted in the Revolution of 1917 and the abdication of Nicholas II.

2. The Soviet Period.—The history of education during Soviet rule may be divided into four periods: 1917–22; 1923–33; 1934–41; and the period since World War II.

The period of 1917–1922 was the time of civil war, and of general disorganization of social and economic life. The Soviet authorities had not yet elaborated a Marxist theory of education and relied on the radical tradition of the Russian intelligentsia and a few remarks of Marx on polytechnical education. The anarchist-communist ideas were reflected in the Education act of 1918. The demand for social equality resulted in the transformation of the old class system into a comprehensive school consisting of primary school of four grades (8–12) and secondary school of five grades (12–17). Pupils' self-government and control by Communist youth organizations supplanted the old discipline and teacher's authority. All private schools were nationalized and religious instruction was eliminated from the curriculum. All examinations were abolished and the entrance to higher institutions was open to all citizens of more than 16 years of age.

During the second period the Communist party developed a Marxist policy in education that was more realistic and more utilitarian. The Education act, 1923, reflected these views. As the government had to train new cadres of the Communist party and new technicians, school discipline was tightened and the authority of teachers restored. Subject instruction was reintroduced to fit the rapid industrialization of the country. In 1928 technical education was given priority over general culture and the two upper grades of secondary schools were transformed into technical schools. The universities were dissolved into special institutes and faculties of philosophy and history were closed. The number of higher institutions increased to 900 and the number of students to 400,000.

The quantitative success of the new policy unavoidably lowered the standard of general education. The third period, 1933–41, therefore was devoted to the reintroduction of general culture as the basis of technical education. The subjects of history and geography were separated from the general "complex" of social studies and the time devoted to political indoctrination was considerably cut. General secondary schools and the old universities were restored with old faculties. Examinations and old academic degrees were reintroduced and the number of technical institutes reduced to 345. To raise the general culture of technical students all technical institutes introduced in 1934 the so-called "universities of cultures" which were made compulsory. The administration was made more centralized by creating in 1933 a federal (union) organ for higher education. In 1940 a federal ministry of labour reserves was founded to administer all vocational education throughout the U.S.S.R. School reform was started during World War II. In 1943 special military schools (Suvorov schools for the army and Nakhimov schools for the navy) were founded as boarding institutions. In the same year the Academy of Pedagogical Sciences was established in Moscow. In July 1943 a decree was issued introducing separate schools for boys and girls in larger towns. Compulsory coeducation was reintroduced in 1954 (*see* COEDUCATION).

3. Developments After World War II.—After the war and reconstruction period the growth of schools of every level was very rapid. The fees in the upper grades of secondary schools were abolished in 1956 and the number of pupils in the three upper grades (8, 9 and 10) rose to 5,200,000. It was evident that the majority of graduates of secondary schools could not continue their education in higher institutions and had to enter directly into industrial and agricultural manual occupations. This led to a most important reform, enacted in 1958. In November of that year N. S. Khrushchev presented his memorandum on the connection of school and life to the central committee of the Communist party. In December the U.S.S.R. government enacted Khrushchev's theses as law and in April 1959 the Russian Soviet Federated Socialist Republic, or Russia proper government followed suit. Both laws dealt with "the strengthening of connection between school and life." The whole system of education was reorganized in accordance with these laws. The main features of the new organization were as follows:

1. Compulsory school attendance was extended to eight years (7 to 15) and the seven-year school transformed into an eight-year school.

2. Secondary education was extended by a year (9, 10 and 11 grades) to run from 15 to 18 years of age. This period could be spent in three different ways: (*a*) at the evening (part-time) secondary school for young peasants and workers who were employed in industry and agriculture; (*b*) at a full-time secondary school combining general education with practical production, based on the ideas of polytechnical education; and (*c*) at technical and special secondary schools that combined general and technical (or artistic) education.

3. The boarding-school system was extended to an eleven-year course, combining the eight-year school with three years of polytechnical secondary school.

4. Higher institutions were opened to graduates of secondary schools who qualified after a severe competitive examination, preference heing given to candidates with practical experience in factories, state farms and collective farms.

The reorganization was started in 1959. *See* also UNION OF SOVIET SOCIALIST REPUBLICS: *Education.* (N. H.)

III. THE EASTERN WORLD

Writers on oriental education have usually chosen either India or China as a type. These represent the two great civilizations of the orient and both have exerted great influence on neighbouring countries. In this article, Indian education and Chinese education will be discussed as the two major types, with Japanese education as a variant. (*See* also CLASSICAL EDUCATION: *In the Orient.*) Indian civilization was metaphysical, religious and otherworldly, while Chinese civilization was humanistic and more concerned with worldly interests such as the problems of human relations and the organization of society and the state. Japan, on the other hand, was distinguished by its nationalism and military tradition; though it borrowed much from China in culture and education, subsequent development made it quite different from China or India. Since India was for more than a century a British colony, Indian education in that period is examined as an example of colonial education in the orient.

The most important difference between eastern and western culture lies in the fact that at the time the west was emerging from the conservatism and stagnation of medievalism, India and China were both under foreign rule. In one case, colonial education prevented a recapture of ancient creative spirit; in the other, an insecure alien dynasty adopting Chinese culture as superior to its own was so anxious to preserve the traditional forms and institutions and so afraid of innovations and new ideas that a once thriving civilization was left behind while the rest of the world moved on. In Japan, however, social and political conditions were

more favourable for a quick transition from medievalism to modernism, and Japanese education reflected the new spirit of national resurgence. In most countries in the eastern world, a new and vibrant national life is in the making, and education has become an important instrument of change and progress.

A. India

The formative period of Indian literature, culture and education extended over a number of centuries prior to the Christian era. Vedic literature, consisting of sacred hymns and historical poems and ballads, was composed before 1000 B.C. From 1000 to 200 B.C. was a most creative period and metaphysics as well as mathematics and early science made noteworthy progress. It was the age of the Upanishads and the Sutras, when new branches of learning enriched the content of education.

By about 500 A.D., a decline in creativity was observable. The caste system was becoming more and more rigid; education became more narrow in content and restricted to certain classes of the population; child marriages struck a blow to feminine education; intellectual creativity had vanished. The deterioration of Indian culture and education coincided with a series of foreign invasions after the 4th century which culminated in the establishment of Muslim rule. Buddhism died out and Buddhist art and education were given a severe blow. Only Hinduism survived as the religion of the majority of people in India. After the Muslims came the Portuguese traders, the first Europeans in India, followed by the Dutch and the French. In time Great Britain became the leading power there.

1. Vedic Education.—The literature of ancient India was religious in nature. The Vedas, collections of sacred hymns, constituted the basic books; to them were later added the Upanishads (philosophical treatises), the Sutras (instructions in the form of aphorisms), and the Brahmanas (theological and ritual treatises) (*see* Sanskrit Literature). Since they did not appear in writing till about 300 B.C., oral instruction was the only means of transmitting the cultural heritage.

In early times the warriors and commoners shared the opportunity of teaching and learning, but, later on, education became a monopoly of the priestly class, the Brahmans. It was maintained that the sacred literature was the spoken word of God, and, in the absence of written books, only the select few were competent to pass it on without distortion. As the caste system became more rigid, the Brahmans became the only teachers not only of Vedic literature but also of non-Vedic subjects preparing for military and commercial careers. In time the Shudras (non-Aryan stock) and the outcastes were completely debarred from education, and in medieval India education became an exclusive privilege of the Brahmans.

Priestly domination of education enhanced its religious character and rituals were prescribed for various stages of a student's life. Before taking up the Vedic studies, he went through the elaborate Upanayana ritual, which included a shave, a bath, the offering of a sacrifice to the sacred fire and other symbolic acts. He also promised to submit to a strict discipline, to observe decorum of behaviour, and to practice abstinence and celibacy until the completion of his course of study.

Another religious duty of the student was to beg for his food, and it was a practice for families to offer food to him. Even rich students well able to take care of their own needs had to do some begging. This was believed to be of value in teaching students to be humble and in encouraging society to support young persons struggling for an education.

Excepting vocational training in the form of an apprenticeship system, the chief aims of education were to develop piety and religious discipline and to transmit the heritage of the past. The caste system called for differentiated programs for different classes. Such programs were narrow and specific and did not require the mastery of a broad range of subjects.

Study was conceived of as discipleship, and the student owed the utmost reverence and obedience to his mentor (guru) who, in the ideal case, instructed him without fee in the Vedas and certain ancillary subjects, such as phonetics, etymology and grammar. Memorization was a major aim, with an emphasis upon the recall of unquestioned knowledge which has continued to mark the Indian student.

Elementary schools were commonly held in a temple or a private home. Some Gurukulas, or schools of Vedic studies, developed into centres of learning, in large towns or in forests near them, to which outstanding teachers and pupils were drawn. The earliest of these "ancient universities" now known is Taksashila, in the far northwestern part of India, which existed from the 7th to the 3rd century B.C. More than 60 distinct arts and sciences were taught there by master teachers, assisted by their abler pupils. Other leading "ancient universities" were Benares (Varanasi), which came into prominence as a centre of Brahmanical and Sanskritic learning after Taksashila disappeared, and the greatest of all, Nalanda, in Bihar. Founded in the 6th century A.D. as a Buddhist monastery, Nalanda grew in the course of 800 years into a great complex of libraries, hostels and lecture halls, to which students flocked from all parts of Asia.

2. Decline of Creative Spirit.—Originally Indian education was progressive and liberal. Secular studies such as mathematics, astronomy, history, economics and chemistry received as much attention as theology and ritualism. The caste system had not become so rigid, and all members of the early Aryan community (not merely the Brahmans) were given the right of education, women as well as men. (Later child marriages came into vogue and Vedic education was prohibited to women.) Before deterioration set in, literacy in the population was as high as 60%. How far Indian education degenerated may be seen from the fact that on the eve of World War II less than 10% of the population was literate.

Buddhist education was a reaction against caste education and the monopoly of the Brahmans. Its content was Buddhist, not Vedic, literature, and it was available to all people regardless of caste. The Buddhist school was the monastery, and the boy of exceptional ability but of humble origin could be taught there, although religious and humanistic learning was not available to the majority of Indian youth. An elaborate system of apprenticeship, under the control of highly organized guilds, provided vocational training to the sons of artisans and maintained a high order of technical skill. The nunneries provided a stimulus to women's education. During the period when Buddhism was active and growing, Buddhist universities, such as Nalanda, were among the most celebrated centres of learning in India.

During the period of Muslim rule, Koranic schools and centres of higher learning (Madrasahs) were established in such places as Agra, Lahore and Delhi. Although some Hindu and Buddhist universities were destroyed, private patronage maintained the Hindu system of education to the end of the Mogul period, and the first Europeans found a large complex of Hindu and Muslim educational institutions throughout the country.

Unfortunately, foreign conquests and the entrenchment of an inflexible caste system gradually put an end to the progressive and creative trends. Perhaps even the earlier period, with the reliance on oral instruction, recapitulation, and memory work, was already producing adverse effects on the creative spirit. At any rate, medieval India was engrossed in narrow otherwordly interests to the neglect of secular studies. Even in religious studies, conformity to the sacred books discouraged critical thinking or any deviation from orthodoxy. Concentration on Sanskrit and the neglect of the vernacular tongue further restricted education to the limited few.

3. British Education in India.—In the beginning the British in India had little interest in education. Some feared that education would merely work to the disadvantage of the conquerors. Others felt that education was the concern of religious groups and therefore the government should stay out of it in order to maintain its policy of religious neutrality. Moreover, England itself had traditionally adopted a laissez-faire policy in education, and the British were used to considering education as a luxury to be enjoyed by the privileged class.

The British East India company did nothing about education until it was directed by the British parliament in 1813 to set

aside a sum each year for the education of the natives. This provision was not immediately implemented. It took 10 years to organize a Committee of Public Instruction for Bengal and one for Madras. Then a controversy arose as to whether the money should be used to promote oriental learning or western learning. The debate between the Orientalists and the Anglicists was settled in favour of the latter when Thomas Babington Macaulay's "Minute on Indian Education" of 1835 recommended that higher education in India should be devoted to western learning, and that English should be the medium of instruction. This ruling determined the character of Indian education for the ensuing century. Primary education did not enter the discussion; Orientalists and Anglicists alike were concerned only with using funds for higher education.

In 1859 the administration of India passed into the hands of the British crown and the control of education was subsequently transferred to the provincial governments. Private schools multiplied but government responsibility for education was neglected. Without government initiative and support, a comprehensive plan of national education was impossible.

The characteristics of British education in India may be briefly summarized as follows: The central purpose was to impart western learning. English was the sole medium of instruction. The educational program was top-heavy; the education of a few in the universities was considered more important than the education of the masses. Through the decades a number of commissions and reports criticized this preoccupation with higher education and urged more attention to Indian languages and Indian culture, but inertia as well as the lack of funds prevented any fundamental change in the pattern of colonial education. Universities were organized according to the English model. They were concerned with culture as the English understood it; their main task was to produce the kind of Indians who could serve in various capacities in the British colonial administration in India. Since the narrow literary curriculum did not fit the students for anything other than government service, there grew up in time an oversupply of university graduates who could not find employment and who constituted a discontented group feeling ill at home in Indian society. Their education had neglected India's own heritage and kept them removed from the masses. Secondary education was geared to higher education, its purpose being to prepare students for the university. There was consequently the same exclusive concern with western knowledge and the neglect of Indian languages and Indian culture. Primary education received scant attention. There were missionary schools and private schools established by Indians, but the government did little to promote the education of the masses.

4. Critique of British Education.—Rising Indian nationalism in the latter part of the 19th century became more and more critical of the domination of western learning. It demanded more attention to Indian languages and Indian culture and a state system of education with provisions for compulsory universal education for the masses. The Indian National congress, the All-India Muslim league and other groups raised their voices against the British system of education. Nor were British authorities altogether blind to the needs of the country. An official survey in 1904 reported that four out of five villages were without a school and recommended that the state should accept greater responsibility for primary education. The promise, however, remained unfulfilled.

Nevertheless, British education made important contributions to Indian life. It opened the doors to modern western learning and broke down the provincialism of medieval India. Western learning also gave birth to liberal ideas and stimulated the very movement of nationalism that opposed British colonialism. Moreover, the British stressed secular education as contrasted with India's traditional religious education, and they also introduced an educational program ignoring caste distinctions.

If an effort had been made to integrate the new western learning with India's own heritage, the introduction of it would have been a great blessing. Unfortunately, British education in India did not escape the evils of colonial education. Its main concern was to produce candidates of the bureaucracy and public servants reared in the English tradition. It saw no value in India's cultural heritage and native languages. It rejected indigenous education and imposed on a conquered people what was essentially a foreign product. As Macaulay said in his "Minute on Indian Education," the aim of British education in India was to produce "a class of persons, Indian in blood and colour, but English in taste, opinions, in morals, and intellect."

Too much of the student's time and energy was absorbed in the effort to master a foreign language; *i.e.,* English. Most reprehensible was the neglect of primary education. Only lip service was paid to popular education, and after a century of British rule India remained a predominantly illiterate country.

5. Independent India.—Under Mohandas Gandhi's leadership, an All-India National Educational conference was convened at Wardha in Oct. 1937. The conference proposed what became known as the Wardha Scheme, providing for free compulsory education in the mother tongue, with the curriculum organized around manual and productive work in the form of a basic craft. The period of universal compulsory education was to be divided into a junior level (age 6–11) and a senior level (age 11–14). Those desiring secondary education would, at the age of 11, enter the secondary schools for a six-year course. Two types of secondary schools were to be provided: the academic high school, preparing for the university, and the technical or vocational school complete in itself.

After India became independent, its leaders saw clearly the need of a comprehensive plan for a national system of education. Two proposals have guided the thinking of Indian planners: the Wardha Scheme and the Sargent report. The latter, entitled *Post-War Educational Development in India,* was prepared by Sir John Sargent, educational adviser to the government of India, in 1944. It recommended free compulsory education of eight years, subdivided into the junior basic (age 6–11) and the senior basic (11–14). About 20% of selected pupils from the junior basic schools were to be admitted for secondary education, which was bifurcated into the academic high school and the technical high school. The university would take 10% or less of the gifted pupils completing the high school.

The influence of the Wardha Scheme on the Sargent report is obvious. Needless to say, such a plan could not be carried out in a short time, and in the early 1960s compulsory universal education in India remained a hope to be realized in the future. There were not enough schools and not enough teachers for a nationwide program of universal popular education, and financial limitations prescribed slow progress toward the goals.

The British practice of leaving education to the provinces still prevailed, and there was no direct control or supervision of education by the government of India. The local schools were ill-equipped, the teachers inadequately trained. Many pupils who started primary education dropped out prematurely; only a third reached the fourth class.

Theoretically, the academic high school and the technical high school were two alternatives of equal importance, but the academic high school still enjoyed a much higher prestige and most young people chose it in preference to the vernacular vocational school. A rigid curriculum in the English language still characterized the academic high school; it was the gateway to the university and government service and was dominated by the matriculation examination.

Nevertheless, noteworthy progress was made. The constitution of the Indian republic laid down the principle of compulsory education till the age of 14, and it stipulated equality of status and opportunity for all citizens. Scholarships, though limited in number, were provided for needy students. Teachers' salaries were raised and the number of trained teachers increased. Attention was given to adult education and to the gradual elimination of illiteracy. Hindi was declared the state language of independent India, and Indian thought and culture became appropriate subjects for study and research. As the tempo of economic development is stepped up in India, educational progress will doubtless also be accelerated there. *See* also INDIA: *Education.*

B. China

In its long history China has been invaded and conquered many times. Its territories have expanded and shrunk, and more than once China was divided, with different rulers controlling independent areas. Yet China has a continuous history of several thousand years. This continuity is in essence a cultural continuity, made possible by a well-organized system of education which produced a cultural unity transcending local differences and separatist tendencies.

It has been said that China often absorbed and conquered her conquerors. This was true when conquerors of inferior culture but greater military might adopted Chinese culture and perpetuated Chinese ideas and Chinese institutions. The influence of Chinese culture of neighbouring countries has been extensive and lasting. Chinese thought, Chinese religions, Chinese art, and the Chinese language were imported into Korea and Japan. In both these countries the study of classics was in large part the study of Chinese classics, and the Chinese written language remains as the basis of advanced Korean and Japanese writing. There are also clear indications of Chinese influence on the language and culture of countries in southeast Asia, such as Vietnam and Burma.

Written literature and educational institutions appeared in China more than 2,000 years before Christ. Even in those early times, records were kept of the names of rulers and major events in government and social life. A great increase in the volume of literature and interest in education took place in the Chou dynasty (*c.* 1122–256 B.C.), which saw the rise of the classical schools of philosophy later identified as Confucianism, Taoism, Moism, Legalism and their subsidiary offshoots (*see* Chinese Philosophy).

These schools of thought are so well known that some people consider the Chou dynasty as the only creative period of Chinese civilization. Actually, Chinese culture flourished in different ways in different periods. The Han dynasty (202 B.C.–A.D. 221) was known for its military prowess as well as scholarly historical works, the T'ang dynasty (A.D. 618–906) for its matchless poetry, its artistic achievements and its contributions to Buddhist thought, while in the Sung dynasty (A.D. 960–1279) Chinese creativity found expression in exquisite paintings and in a new school of thought known as neo-Confucianism. Instead of one creative period followed by steady decline and stagnation, China's civilization grew slowly and gradually. Now and then development was interrupted by periods of relative sterility and stagnation. The 19th century was such a period; unfortunately it was at this time the west first came to know China.

Even in the realm of philosophy, the dominance of Confucianism came about gradually and its content was subject to change and reinterpretation through the centuries. Historians speak of the age of classical schools of philosophy in China as the period of the "hundred schools." There were diverse schools competing for ascendancy, each offering solutions to the problems of the day. Unlike Indian philosophy, these schools were less concerned with metaphysical and strictly religious questions than with practical social, economic and political problems. The presence of diverse schools indicated not only a wide range of intellectual activity but also the freedom to differ and to propose vastly different ways of solving the problems of life. Confucianism was only one of the rival schools; Confucius actually retired in frustration because his principles were not generally accepted, and his illustrious disciple Mencius complained that too many people were flocking to rival schools.

At the close of the Chou dynasty Confucianism was no more influential than the other schools. Moreover, it was the first school of thought to meet official ban and persecution, when the emperor of Ch'in ordered Confucian books to be burned (213 B.C.). In reaction to this persecution the ensuing dynasty of Han made an earnest effort to revive Confucian learning and thus took the first steps toward making Confucianism a state cult (136 B.C.).

There was another reason why Confucianism became the dominant school of thought in China. Its ideas were more directly applicable to government and more in line with the traditional social order. Confucius frankly stated that his teachings were essentially conservative. He did not challenge the feudal society of his day; he merely wished to stabilize it. His teachings supported and strengthened the old family system. Besides, Confucianism had a larger body of literature which could be made the basis of education.

1. Ancient Education.—A unique characteristic of ancient Chinese education was the identification of education with government service. A major aim of education was to prepare for positions in the civil bureaucracy, which dominated Chinese government much more than the military chieftains. For this reason, the provision of education was early recognized as a function of the government. Its concern, however, was not to extend elementary education to the many, but to enable the few to prove themselves worthy of public office.

A national university was established in 125 B.C.; in the 2nd century A.D. some 30,000 students were enrolled. In subsequent periods, Chinese universities attracted students from Korea and Japan, who took Chinese ideas and Chinese institutions back to their homeland. Much attention was given to libraries. When the capital was moved from one city to another, one of the important tasks was to make sure that the new capital would have a good imperial library. The invention of papermaking in the 1st century A.D. and of printing in the 9th century were important milestones in the production of books in large quantities and in making learning available to more people.

In time, the state became more interested in the selection of scholars than in the making of scholars, more concerned with the conducting of examinations than in the establishment of schools. The civil examination system itself was also the result of centuries of evolution. The practice of selecting government personnel by examinations began in the 2nd century B.C., but even then the content of the examinations was subject to change.

The resulting system became a most useful instrument for establishing an "aristocracy of scholars" whereby China could be sure of a cultural unity by entrusting the government to scholars reared in a common tradition, nurtured in a common intellectual heritage and dedicated to common principles of political and social life. Selection was rigorous. After preliminary examinations, the first stage of screening, there were three ascending levels of examinations; successful candidates were awarded academic degrees corresponding, interestingly enough, to the modern bachelor's, master's, and doctor's degrees. The three degrees were known as *hsiu-ts'ai* ("flowering talent"), *chü-jen* ("promoted man"), and *chin-shih* ("advanced scholar"). The examination for the first degree was given in the county seat, that for the second in the provincial capital; the highest examination was given once in three years in the national capital only. The most distinguished of those who passed the "advanced scholar" examination were granted membership in the Hanlin academy, the highest honour a scholar could attain.

The examinations were strict and, on the whole, administered with fairness. The names of the candidates did not appear on the examination papers, to avoid favouritism on the part of examiners. The examinations lasted for several days and the candidate was closeted in his cubicle and shut off from all contacts. In general, only 1% of those sitting for an examination could expect to pass. Success, however, meant not only a gateway to high position but immense glory and pride to the family and even to the home community. One who attained the highest degree achieved national fame and his home became a shrine to which his neighbours looked with pride; long after his day it remained a point of interest in his city or village, a centre of attraction to travelers and tourists.

Much could be said for the Chinese examination system at its best. It was the root of the Chinese tradition of government by civilians. It made the scholars the most highly esteemed people of the land. It offered an open and equal opportunity to all men of ability. Ability, not birth, determined one's position in the social hierarchy. Chinese society was not without classes but there was a high degree of mobility, and education was the chief channel by which one could raise his own position and that of his family.

The examinations were open to all. There was no age limit, and

failure in an examination did not prevent further attempts in the future. Cases were known of father and son, even grandfather and grandson, sitting in the same examination.

Equal opportunity, of course, was limited by the many years needed for study before the examinations. No doubt many an able youth never had the opportunity of advancement because his family could not afford to support him in a prolonged period of study. On the other hand, it was not uncommon for a family, a clan or even a whole village to contribute to the support of a promising lad to enable him to study for the examinations, and the absence of rigid classes is evidenced by the fact that parents of even the poorest families could always cherish the hope that one of their sons might some day become a scholar and thus rise to the top of the social and economic scale.

At the same time, the system had serious drawbacks. The evils arising from the domination of education by examinations were as damaging in China as in British education in India. The sole aim of the student was to pass the examinations. The nature of the examinations determined the content of education; nothing not covered by the examinations was of importance to scholars.

The evils were accentuated as the content of the examinations became more and more limited in scope. Chinese education in early times was broad and liberal. The educated person was expected to possess virtuous character and to have acquired harmony and equilibrium in thought and action. He was supposed to be versed in the "six arts," namely rituals, music, archery, charioteering, writing and mathematics. In time, however, this broad concept of education was forgotten and the examinations concentrated on the testing of literary ability and knowledge of the classics. Art, music and science were left out; even arithmetic was not given a place alongside reading and writing.

The classics formerly encompassed more than the Confucian books. In the T'ang dynasty, scholars studied Taoism and Buddhism as well as Confucian classics. In later periods, however, the examinations were concerned exclusively with Confucian learning (*see* CHINESE LITERATURE).

Higher criticism was once an important phase of scholarship. As early as the Han dynasty, scholars critically examined the classical texts to determine their authenticity. Other scholars in later dynasties concerned themselves with critical interpretation of the classics. After the Mongol conquest, however, the Ming rulers were so concerned with the restoration of Chinese institutions that they bent backwards to be conservative; under Manchu rule this conservatism was enhanced and led to sterility and stagnation.

Chinese education went through a process of degeneration somewhat like the loss of creativity in India and not unlike the formalization of classical learning in the west. Education devolved into the uncritical and verbatim reproduction of the ideas and writings of past scholars. Essay writing, which constituted the major part of the examinations, became the mechanical imitation of a style of writing; form was more important than content. With its narrow content and formalistic methods of learning, the educational program was quite out of tune with the traditional spirit of Chinese education, to say nothing of its utter inadequacy to meet the new needs of the modern age.

2. The Chinese Renaissance.—The impact of the west and the spectacular rise of Japan caused a great shock to the Chinese nation and created a demand for a radical change in education. A modern school system was adopted in 1903 and the old examination system was abolished in 1905. Christian missionary schools played an important role; they ranked among the outstanding pioneering schools of modern China. With the founding of the republic in 1912, modernization and westernization gained momentum, and a system of schools comparable in external features to the American system was evolved.

Elementary education consisted of six years. There were two stages of secondary education: the three-year junior middle school or junior vocational school, followed by the three-year senior middle school or senior vocational school or normal school. The senior middle school led to the four-year college or university or to technical or professional schools. This system, with minor variations introduced from time to time, remained until the Communist conquest of the Chinese mainland.

With the new schools came a flood of new ideas. The years during and after World War I were such a period of intellectual ferment that they have been called the Chinese Renaissance. Wilsonian democracy, Marxism, John Dewey's educational ideas, the philosophies of Bertrand Russell and his contemporaries all had their eager disciples and exponents in China. New books and new periodicals sprang up like mushrooms.

One of the most important phases of the Renaissance was the literary revolution which aimed to revitalize the Chinese language and make it more accessible to the common people. There was such a vast difference between the written language (classical Chinese) and the spoken tongue that a learner could recognize every word of a book without comprehending any of the subject matter. It was the common practice for beginning readers to learn the words by rote memory and then to learn the meanings later by translating the written words into everyday speech. All books were written in the classical style. The leaders of the literary revolution boldly attacked this problem and proposed to change the written language from the classical to the vernacular style, called pai-hua (plain talk). Books and periodicals began to appear in pai-hua, and textbooks were rewritten so that the learner could comprehend the meaning as soon as he learned the words.

The literary revolution gave an impetus to extending educational opportunity to the many, and compulsory universal education and the gradual elimination of illiteracy became matters of urgent concern.

Two names deserve mention in connection with these movements. One leader was Hu Shih (*q.v.*), a philosopher and historian educated in U.S. universities. He was not only in favour of writing letters and elementary textbooks in the pai-hua, but he boldly asserted that even China's great classics could be rewritten in the vernacular style so that they could be understood and appreciated by the common man. His volume *History of Chinese Philosophy*, written in the style of everyday speech, opened up new possibilities of applying modern methods of research and critical thinking to the study of China's heritage.

Another pioneer was James Yang-ch'u Yen, whose interest in mass education began when he was a Y.M.C.A. worker with the Chinese Labour corps in France during World War I. Finding that one of the great desires of the illiterate labourers was to communicate with their families at home, he organized classes to teach them to write simple letters. Soon the workers, thrilled by their ability to read and write, wanted to be informed of current events and war developments. Simple news sheets were prepared to satisfy this urge and the labourers read them with absorbing interest. After the war, Yen and his associates brought the idea to China and started other experiments in mass education. In time, a nationwide movement was launched with the support of the government as well as public-spirited citizens.

Despite the new interest in education, progress was slow and irregular in the early years of the republic on account of political instability. When the country was embroiled in civil strife, no government was in power long enough to make constructive long-range plans. In view of inadequate government support, private effort in education became especially important. Outstanding among the private schools were the Christian missionary schools. Christian education offered a complete range of schools from the kindergarten and the primary school through the university. These institutions were pioneers in women's education, in coeducation, in music education and in physical education. They were distinguished for their stability, their freedom from shifting politics and their good instruction in English and in western learning. Despite subsequent criticisms of their "denationalization" their contributions to modern Chinese education were of inestimable value.

3. Education Under the Nationalist Government.—After 1930, the Nationalist government gained in prestige and stability. For the first time in the modern period, China had a government able to make long-range plans for national reconstruction, and a well-organized national system of education came into being. The

government demanded centralized control of all phases of national life, and private education was put under strict government control, to the extent that little variation from the public-supported schools was permitted. The public schools, however, were for the first time assured of financial support. National universities won recognition at home and abroad as outstanding centres of learning and research.

Further progress was made in mass education. Adult education programs showed more imagination and creative ideas than the rigidly controlled program of the schools. Promising beginnings were made in social education, which encompassed a wide range of activities including public libraries, museums, recreation centres, and the use of the radio and of films for educational purposes.

Schools and school enrollment increased steadily from 1930 to 1937, when progress was interrupted by war. A realistic plan was formulated to achieve universal compulsory education by stages. By 1937, 43% of school age children were enrolled in some form of primary school. Though many of the schools were incomplete primary schools or part-time schools, there is no doubt that great strides were being made toward the goal of universal education.

The same trend was continued on the island of Formosa (Taiwan). The Nationalists built on the foundation laid by the Japanese and maintained a steady increase in school enrollment. More than 90% of school age children attended elementary schools and more than 2,500,000 persons out of a total population of about 10,000,000 were enrolled in schools and colleges of the island.

4. Communist Education.—Education was a very important phase of the Communist program of total revolution. Its task was to change the thinking, attitudes, habits, and behaviour patterns of the people to conform with the ideology and policies of the regime. It was indistinguishable from indoctrination and propaganda. Formal and informal education were merged into one integrated process, governed by the same objectives. Students and teachers were expected to be active in politics, not only to learn the ideology but to take part in political tasks and propaganda activities (*see* also SCHOOL ADMINISTRATION: *Political Party Control*).

The curriculum was purged of "feudal and bourgeois ideology." The study of Marxism-Leninism and "thought reform" by means of inquisitional sessions of "criticism and self-criticism" in small, closely supervised groups was accorded first importance. The study of the Russian language was energetically promoted. Soviet textbooks, Soviet theories, and Soviet methods were considered the last word in education.

The Communists were not bound by tradition and they boldly adopted new forms and new methods to achieve their objectives. There were "universities" with courses to be completed within a few months and "colleges" which were actually part-time adult education agencies. There were "spare-time schools" and "spare-time universities" which peasants and workers attended when they were not working.

Illiteracy was being eliminated rapidly. Official statistics claim that in the early 1960s, 94% of school age children were enrolled in schools. When the Communists came to power in 1949 there were 350,000 schools with 25,000,000 pupils; by 1960 there were nearly 1,000,000 schools with more than 100,000,000 pupils. The percentage of "worker-peasant youth" in the school population increased year by year. Language reform was pushed ahead by the use of a simplified form of writing and by the experimental use of an alphabet.

See also CHINA: *Education*. (T. H. C.)

C. JAPAN

1. Chinese Influence and Tokugawa Rule.—Japan's earliest educational system followed the adoption of Chinese political institutions in the 7th century A.D. and was designed to educate the aristocracy in Chinese learning as a prerequisite to social standing and political eminence. The 8th century code of *Yōrō* provided for a national university, whose students came to number about 400, and a supporting network of provincial schools. The principal emphasis in these schools was on Confucian learning, and high officials were for a time expected to qualify for office by passing examinations. From the year 704 to 937 only 65 students qualified for the highest degree of "exceptional talent," however, and since selection of students was restricted to sons of families of high court rank the education and examination system never operated to favour social mobility as in China. Private and family schools supplemented the official colleges while continuing the same emphasis, and Buddhist schools trained young men in the sacred law. Literary training was highly developed at the Heian court and its courtiers and ladies produced a great literature, but learning did not penetrate beyond the aristocracy.

As the Chinese governmental models became inadequate to deal with the growing provincial interests and opportunities for official positions at court became fewer, the system of official education declined. The court aristocracy became less prosperous and the feudal warrior groups did not immediately gain the opportunity to acquire learning. As a result the Buddhist clergy were for several centuries the chief bearers of the scholarly tradition. During the 15th and 16th centuries new literary and philosophical developments benefited from the patronage of feudal lords and with the years of peace that followed the establishment of Tokugawa rule in 1600 education and learning flourished.

The Tokugawa shoguns encouraged their retainers to take up Confucian learning and their vassals followed the example of the shogun in this as in other things. Shogunal and fief schools for ranking samurai emphasized a curriculum of Chinese Confucian learning as well as military arts. Private schools and academies transmitted much of the same teaching to groups of commoners able to afford prolonged study, with the result that prominent rural leaders and urban merchants were frequently well-educated. Everywhere *terakoya* ("temple schools") were established to train commoners in the rudiments of literacy. Outstanding teachers and scholars trained disciples of varied social origins from many areas, and a number of theorists wrote widely on educational philosophy; one of the most notable of the theorists was Kaibara Ekken (1630–1714). Thus the Tokugawa years of peace equipped Japan for the 19th century process of nation building.

2. Western Influence and Compulsory Education.—In late Tokugawa days schools of western learning multiplied and produced many leading educators of modern times, among them Fukuzawa Yukichi (1834–1901), founder of Keiō university in 1868. Out of the shogunate's school for western learning came Tokyo Imperial university, formed in 1877 as the pinnacle of the modern educational system and designed to train government servants. In 1872 an educational law decreed that all people, regardless of class or sex, should receive education. The country was initially divided into eight university districts which were further subdivided into middle, secondary and elementary school districts. In the years that followed the government pursued its educational goals vigorously, experimenting with a number of foreign institutional models. Private institutions grew in number, and Waseda university, founded in 1882 by Ōkuma Shigenobu, ranked with Keiō as a leading university.

Progress in public education in 19th-century Japan profited from the alacrity with which most groups seized upon the new learning as providing the means for personal and national advancement. In an age in which Samuel Smiles' *Self Help* was a best seller, education in the practical learning seemed to offer the key to modernization. Gradually, however, government leaders came to fear that in the rush for progress much of the stability provided by old values might be lost. As a result they strengthened central controls, reintroduced Confucian and Shintō values, and oriented the system that resulted toward service for a family-state and divine father-emperor. Japan enforced universal compulsory education with the same efficiency exhibited in building industries and modernizing the military forces. Just as Prussia set the pace for universal education in the West, so Japan became the most literate nation in the orient. Indeed, its record in the first half of the 20th century of enrolling 99.5% of school age children in primary schools excelled that of most western nations.

After 1885 the system of public education received its definitive form. Minister of Education Mori Arinori incorporated German

organizational and pedagogical patterns to ensure a strongly nationalist emphasis. Even these measures drew resistance from nationalists who deprecated German influence. In 1890 an imperial rescript on education provided the ideological basis for the system, making it clear that traditional Confucian and Shintō values were to serve as the basis of moral education. This emphasis was implemented by courses on "ethics" (*shūshin*) which served as the core of the curriculum. In 1903 a system of national textbooks was added, giving the educational ministry the capacity to alter, add or delete indoctrination in accordance with political currents.

3. Changes After World War II.—After Japan's surrender in 1945 the educational system came in for sweeping revision in line with the suggestions of U.S. observers and Japanese educators. Compulsory education was increased from six to nine years. The imperial rescript of 1890 was rescinded by diet action and the Fundamental Law of Education of March 1947 set the tone for an education dedicated to the goals of democracy, peace and individual dignity. "Ethics" disappeared from the curriculum, and traditional units of study were replaced by social studies designed to prepare children for life in a democratic society. Administratively the powers of the educational ministry were curbed; textbooks were privately produced and schools were controlled locally by elective boards of education. The complex prewar system of specialty schools for boys and girls gave way to the U.S. sequence of grammar, junior high and senior high schools, while prefectural universities broadened educational opportunities.

After the recovery of Japanese independence in 1952, modifications were made in the postwar pattern to increase central direction and hinder political indoctrination by the radical and powerful Teachers' union. Controls on textbook certification were strengthened, boards of education were made appointive, plans for a "morals" (*dōtoku*) course were announced and efficiency ratings for teachers were instituted. The principal postwar changes of general education and broader opportunity, however, enjoyed widespread support and seemed well adapted to postwar Japanese society. By 1960 Japan had over 21,000,000 pupils in lower schools, nearly 80,000 students in about 250 junior colleges, and over 500,000 students in more than 200 universities.

(M. B. J.)

IV. NEWLY EMERGING NATIONS

A. Tradition, Change and Curriculum

Consideration of education in newly emerging nations should take at least four factors into account:

1. Nationalism may be the dominant international force of the 20th century. Within a few years after the end of World War II, more than 40 new nations, containing over one-quarter of the world's population, came into existence.

2. Of the estimated 3,250,000,000 people in the world, only about one in three have enough to eat and a reasonable opportunity for education. Surveys among African school children indicate that 60 to 70% are malnourished, and 50% need nursing care, medical attention or hospitalization for diseases attributable to malnutrition. Over 50% of the world's children do not have consistent schooling of any sort.

3. For the first time in human history, the underprivileged two-thirds of mankind are aware that they have the right to, and the possibility of, a better life.

4. Education is considered the pathway to personal and national improvement, but the educational problems that must be surmounted include illiteracy, disease, poor land and material resources, shortages of teachers and classrooms, elementary industrial development—and little experience with solving any of them.

The interplay of these factors is complicated by the perennial conflict between tradition and change. Tradition can be a source of unity and continuity, providing a sense of historical identity and individuality, and preserving established social structures and customs. Tradition, on the other hand, impedes progress when it clearly contradicts what is needed. For example, most newly emerging countries have a shortage of working capital, yet an estimated 10–15% of the wealth in many countries is buried in the ground or worn as rings and bracelets. The development of stable banks and co-operatives in most countries has eliminated the need for this practice, but it is continued while the buried wealth is urgently needed for other purposes, including education.

But change, too, can be a mixed blessing in emerging countries. The young Togolese, for example, live in two worlds and belong completely to neither. Sophisticated French education has alienated him from native traditions and imbued him with values and expectations of European culture, but at the same time he is excluded from that culture and denied the material basis for the style of life he has been taught to want.

Six themes represent a composite picture of the types of curricular development that seem best suited to the needs of newly emerging nations: education for good citizenship, education for health improvement, education for vocational competence, education for professional and managerial competence, education for industrial and commercial development, and education for adults.

1. Education for Citizenship.—This theme helps individuals to come to terms with their environment and with other people, and it also helps them to gain an appreciation and an understanding of their own environment. It deals with the organization and processes of government and the rights and responsibilities of citizens. It helps people gain an appreciation and an understanding of their own culture and its history, legends, art, music and dances, and social structure. Such education does not need to be narrow and negative or excessively nationalistic; it can be positive and broad. Bolivian children first learn Bolivian songs and dances, and Indian children first learn Indian songs and dances. Citizenship education moves from the family to the neighbourhood, to the school, to the community, to the nation and to the world. But the roots remain deeply planted in one's own culture.

2. Health Education.—This important theme is being stressed in many newly emerging nations. Preventive health measures are included in the curriculum in many ways. For example, in some countries home economics and homemaking courses for girls include detailed lessons on nutrition, food preservation, disposal of wastes and disease prevention and cure; and social studies classes include lessons on the social aspects of disease, as well as community action programs for public health. Priority upon health education may be necessary only for a short time in some emerging countries; others may require it for several generations.

3. Vocational Education.—This is concerned primarily with the vocation of agriculture, since over two-thirds of mankind is directly involved in it, but education for vocational competence includes many other occupations also. In the region of Lake Patzcuaro in Mexico, some villages exist largely from the catch of the lake; one village specializes in making sombreros; another makes a particular type of blouse; and another is noted for its mat weavers. Education, by introducing new trades, is helping these and other villages to diversify their types of occupation to achieve more rewarding and more reliable patterns of livelihood.

In the early post-World War II years, leaders in some new countries sought to raise quickly their economic standards through rapid industrialization, but they generally came to realize the fallacy of that priority. They found that more could be accomplished by increasing the productivity of agriculture than by increasing the productivity of industry, because a relatively low capital output for agriculture yields a fairly high increase in crops. This improvement can be achieved through land and credit reforms, co-operatives, improved seeds, improved techniques and methods such as better breeding of livestock, and adapted fertilizers, while industrial development requires skilled workers and trained management and large expenditures for construction, equipment and machinery.

The transition from agriculture for subsistence to agriculture for exchange, and the further evolution toward an industrial society, may be accomplished in a few generations in some countries; other countries will be in transition for many generations. It is likely that programs of education for emerging countries, in general, will need a "rural-bias" for some time to come (see *Rural and Fundamental Education*, below).

4. Professional and Managerial Education.—In some new

nations the curricula for training students for the civil service and for professional and managerial competence are developed along with curricula that emphasize health education and rural education—in the same school building. In other countries such education is developed in a separate school. Comprehensive high schools are a vital part of the U.S. system of education, but they may not serve the needs and circumstances found in many countries. The comprehensive, or common, school evolved in a country with one language, with good communications and transportation, with a relatively long history of independence, and with industrial development well under way when the common school evolved. Some modification of the comprehensive high school may be useful in emerging countries that have high concentrations of populations, but most new nations have found it advisable to set up special schools for occupations that require specialized training.

Some educators have criticized the small numbers of African students who are admitted to secondary education, which is a prerequisite for higher civil service and professional and managerial occupations. This question is largely a matter of economics. A nation cannot afford to train large numbers of skilled people unless the economy can provide jobs for them. In addition to the wastage of money and manpower, a political factor enters into consideration—the problem of the "educated unemployed."

5. Industrial and Commercial Education.—Every society undergoing development must have highly skilled people, but it also must have laboratory technicians and hospital assistants, carpenters and brick layers, accountants and clerks, and welders and machine operators, foremen, inspectors, production supervisors, draftsmen, electricians, mechanics and so forth.

Education for industrial, technical, and commercial competence usually takes place in special programs. For example, students at the Ifunda Trade School in Tanganyika study for three years such courses as building, carpentry, joinery, metalwork and mechanics. The students then are placed as apprentices in industry for two years of on-the-job training. The program accepts students who have completed the first eight grades of school and passed the standard examinations. In some other countries students can go directly from primary schools to trade schools and then enter technical schools. In nearly all countries the trend has been toward emphasis on industrial, technical and commercial training.

6. Adult Education.—This is a concomitant theme in the sense that it usually is developed with the other themes but generally in a separate stream. It is apart, yet it is inextricably related to the effectiveness of the school program. Since parents exercise strong control over their children in most emerging countries, some advantages of school will be lost unless parents are enlightened along with the children. Experience has indicated that a well planned, integrated program of adult education is necessary for progress in over-all development, especially in relation to rural and fundamental education (*see* below). *See* also ADULT EDUCATION. (R. I. M.)

B. Rural and Fundamental Education

Rural education is concerned with all educational programs, including adult education, agricultural education and community improvement projects as well as the local schools, for people living or working on farms or in villages and hamlets. Even in highly industrialized countries rural education is oriented toward agricultural pursuits and domestic arts, emphasizing fundamental education with instruction in basic facts and skills needed in the students' daily lives; the curriculum may be characterized as functional in that it is based on the concrete and practical as compared with the formal, abstract and theoretical.

There is a growing emphasis on functional education in most of the newly developing countries. Educational opportunities are provided through a variety of types of school organization: for example, the *núcleos* in Bolivia, the community schools in the Philippine *barrios,* the tribal schools in Iran, the tent schools of nomadic tribes in Ethiopia and the Second Unit Rural schools of Puerto Rico. All of these programs have been concerned with developing basic skills and knowledge in a manner which respects the particular culture, initiating community improvement at a pace acceptable in the community.

Where educational institutions in rural situations have emphasized the school as a place for formal classes in academic subjects, other agencies have supplemented the work of the school through adult education and community improvement. An increasing number of schools, however, have accepted the responsibility for directing the curriculum toward the needs of all citizens. Education becomes a constant interaction between school and community, a co-operative program that utilizes the skills, the abilities and the efforts of the entire citizenry toward the improvement of community living. The traditional school program does not in itself equip the graduate to participate or take leadership in the community. Participation in community development requires not only the possession of basic skills and knowledge but also the acceptance of personal responsibility toward the community, skill in human relations and the ability to work co-operatively with other persons.

In much of Asia, as in parts of Africa, the generally accepted concept of education as being only for the elite, has led to the educated person's developing a distaste for manual labour. Economic development has been hindered. Even where schools were modern, farmers continued to employ primitive methods of agriculture. In the Philippines the newer concept of the teacher's role includes both teaching children and leading adults. At every level newer methods of teaching seek to develop skills, impart useful information, inculcate positive attitudes and provide a maximum of carry-over to life situations. Building sanitary latrines, keeping animals corraled, obtaining a pure water supply, growing fruits and vegetables—these represent opportunities to put education to work on people's fundamental problems.

Many agencies other than schools have worked at the task of rural education. A few examples are: the Community Welfare centre in Ncora, Africa; the Himayatsagar Extension centre in Hyderabad, India; government workers sponsoring Fundamental Education projects in Ceylon; the Near East foundation; regional fundamental education centres of the United Nations Educational, Scientific and Cultural organization (UNESCO) in Mexico and the United Arab Republic; the Peace Corps (*q.v.*); and many others. Christian missions from Europe and North America, Buddhists in Asia and Muslims from the U.A.R. have influenced rural education in many sectors of the world.

One of the most significant signs of educational progress throughout the world has been the development of rural-school community centres. In these the school leaders assist in teaching both adults and children. The emphasis is on the solution of economic and social problems to bring about improved agricultural practices, sanitation, health, literacy, homes and communities. Among the countries where such developments have made substantial gains are Puerto Rico, the U.A.R., Korea and the Philippines.

If the gap between where many nations find themselves and their concept of their rightful role is to be bridged in a comparatively short time, the education of adults must proceed apace with that of children. In rural cultures life has not become compartmentalized; therefore, the task of rural education becomes a total community concern. Experience of community educators in the tropics suggests certain guidelines. The most important and lasting results have been achieved by recognizing cultural factors, involving people in learning to help themselves, respecting the opinions of those affected and gaining community acceptance of educational purposes.

The culture of the nations of South America, the West Indies and Central America is derived from the American Indian, Spain, Portugal and France. In general, the educational system has provided two branches—one for the elite and the other for those of lesser station. In Mexico, Uruguay and Brazil there has been considerable progress toward a single plan for all. The church has been the principal avenue through which the state expressed its interest in education, and church missions have been ardently active in rural regions, church education being public education. The modern period in education has been characterized as one of ferment and one which is creating new educational forms. Mexico,

Venezuela and Argentina are seeking the incorporation of the masses in the educational process, creating an educational profession to do this gigantic task.

The degree of centralization varies widely from country to country (*see* SCHOOL ADMINISTRATION). In Haiti, as in many other nations, the school system is centralized under the ministry of national education. The rural primary system covers a six-year period divided into three two-year courses. As in Europe the student enters the secondary school by passing a state administered written examination. The five major types of rural elementary schools are farm, rural, village, communal and presbyterial. Schools are often not accessible. Rural secondary schools are few indeed.

In Mexico, there were practically no rural schools before 1920. Within 30 years 80% of the public elementary schools were rural. Of these 70% were supported by the federal government, 24% by state and municipal governments and 8% were private or mixed private and government. All schools are required to adopt a common curriculum related to their particular needs so there is a great variety of programs designed to improve community life. There are still rural regions without elementary schools and many existing schools provide instruction only for two or three grades. The rural normal schools are federally supported. The *misión cultural* is a distinctively Mexican educational invention to promote community education in the fields of public health, agriculture, construction, trades and industry, music, recreation and rural mechanics.

Nations with advanced educational programs are taking increasing responsibility for providing technical aid and services to the newly developing nations, in order that the gulf between them may be reduced rather than widened. From the world view education is still primarily a rural problem.

See also ADULT EDUCATION; AGRICULTURAL EDUCATION AND RESEARCH; AUDIO-VISUAL EDUCATION, and references under "Education, History of" in the Index. (J. E. BR.)

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EDUCATION, INTERNATIONAL. International education may mean education on international relations, education for internationalism or education for foreign or international service, but it usually refers to the exchange of persons for educational purposes between nations, and in this sense is as old as the academic community. From the wandering scholar who journeyed from Rome to Athens to the 20th-century Fulbright fellow in Delhi or Paris, men have traveled abroad in search of knowledge and training. The earliest formal universities in France and Italy attracted students from all Europe. And the 19th-century gentleman was not considered truly cultured until he had made the "grand tour" of the continental schools.

What had been a leisurely, informal movement became a big business in the 20th century, and the Mecca of the exchangee shifted from Europe to the United States. The largest number of foreign students in the U.S. in the late 1950s came from the far east, Latin America sending the next largest number and Europe the third largest. Engineering, the humanities and the social sciences were the most popular fields of study. On the other hand, almost two-thirds of U.S. students studying abroad were in Europe. The fields of study attracting the most U.S. students abroad were medicine, the humanities, theology and the natural and physical sciences.

Students, however, were not the only members of the exchange population. Foreign physicians training in U.S. hospitals and foreign faculty members teaching and doing research in U.S. colleges and universities swelled the numbers. At the same time, a number of U.S. faculty members were overseas on teaching or research assignments.

Governments, colleges and universities, foundations, corporations, organizations and individuals, all became sponsors of exchangees, providing the necessary funds for international study. However, a number of exchange scholars were self-supporting financially.

The basic purpose of educational exchange is, of course, to educate. In the 20th century, however, other new and important considerations motivated the sponsors and practitioners of international education. Among the most important were the attainment of world peace through international understanding and the sharing of technical knowledge with underdeveloped countries. These new goals brought many changes to the exchange of persons. Governments which tended to view exchange of persons as an arm of foreign policy naturally emphasized exchanges with those countries or areas considered politically critical. Programs with underdeveloped countries stressed opportunities in the practical application of science and technology.

See Institute of International Education, *Open Doors 1959: a Report on International Exchange;* Quincy Wright, *The Study of International Relations,* with extensive bibliography (1955). (G. K. H.)

EDUCATION, PHILOSOPHY OF, is the attempt to formulate the over-all objectives, content and strategy of education in terms of a consistent, integrated organization. The literature of nearly every age is laden with advice on rearing the younger generation. The abundance of this advice would indicate that perplexities in child training are perennial. For their solution there have been various resources on which to draw. To seek help from the direction of educational philosophy, however, may strike the average layman as rather formidable. As a matter of fact, however, educational philosophy is nothing more than an extension and refinement of common sense.

Scope and Function.—When confronted with the complexities of child rearing, the usual tendency is to approach them in common-sense fashion. This common sense is drawn from a long accumulation of firsthand experiences with children which is handed down from generation to generation. Yet, sound as common sense may be when winnowed by succeeding generations, it suffers from a kind of shortsightedness born of its closeness to firsthand experience. This shortsightedness immediately becomes evident when one extends the range of common sense to other times and places. The writer of Ecclesiasticus in the Old Testament, for example, warned parents not to play or laugh with their children if they wished to save themselves from later grief and sorrow. While this may have seemed sound common sense in the Holy Land of biblical times, it would generally make nonsense in 20th-century Europe or America.

In other words, common sense cannot stand by itself; it needs correction and refinement. It needs a wider or longer view of its object. This is provided by "theory" which, etymologically, has the same Greek root as "theatre" and emphasizes the idea of getting a panoramic view or understanding of the whole area of concern. Common sense can be refined and made more dependable theoretically in two directions. In one direction the educator tries to become more exact. He breaks an educational problem down into its component parts. Then he studies only as many parts, or variables, as he can control experimentally. By allowing one of these to vary while he holds the rest constant, he notes the consequences. Thus he is able to achieve a high degree of reliability and objectivity about the precise role of this particular variable. To refine common sense in this manner is to refine it scientifically.

A second direction the educator might take to improve on common sense would again start with an awareness of the variables involved. But this time, instead of working with only a limited number of them, he would insist on taking as many as possible into account, whether or not he can control them. In doing so he excludes any hope of gaining reliability or objectivity in his thinking. But he gains a certain wholeness of viewpoint. To seek, to think and to act in the light of all the relevant factors is to take a philosophical point of view of the situation.

Although science and philosophy seem to refine common sense by proceeding in opposite directions, it would be a mistake to consider them incompatible with each other. On the contrary, they really complement each other. The parent or teacher will want to refine his common-sense reaction to educational perplexities not just in one or the other direction but rather in both. Impressive as is the usual consensus on scientific results, this consensus is purchased at the price of limited results. On the other hand, disturbing as may be the perennial disagreement among educational philosophers, this is the price of attempting to train a child in the light of all the diverse circumstances bearing on him.

To illustrate, take the case of a child not doing well in school. Time was when common sense might have crowned him with a dunce's cap. Mistrusting so simple a solution, the modern teacher would undoubtedly try to extend the range of his understanding of this case by calling to his aid a variety of experts with scientific training. He might first consult the school psychologist regarding the child's I.Q. and his results on standardized achievement tests. High in the former, the pupil might be low in the latter. In accounting for this discrepancy the help of a psychiatrist might be needed. The family doctor might find the child to be the victim of some debilitating disease, or a visiting teacher might find the child's home to be in a poor environment or to suffer from unemployment of the father or to be rent by religious differences between the parents. Each diagnosis would have its own limited therapy. But what to do in the light of all the circumstances, how to balance all the relevant values: this is much more than a simple task for common sense.

On the way to striking a balance it may be necessary to inquire just how to conceive the nature of the child, how to state the proper ends of education—and of life itself, for that matter—how to decide the proper roles of church and state in promoting the child's welfare, how to be assured of the logic by which this analysis has proceeded and how to deal with a number of other equally weighty questions.

As the questions just raised suggest, philosophy is not a simple discipline. To answer the kind of educational problems posed it is necessary to recognize three main subdivisions of philosophical effort. One has to do with values or ethics. It examines the nature of the good. Without a criterion of value the parent or teacher will be on uncertain ground in determining the aims of education or which parts of the social heritage should be included in the curriculum. A second major subdivision concerns itself with knowledge, or technically, epistemology. It inquires how the learner comes to know and whether what he knows is true. Keeping an eye on the canons of knowledge provides a yardstick by which both teacher and learner can constantly measure the curriculum and methods of instruction employed. A third and final category of philosophy considers the nature of reality or, again more technically, metaphysics. There will be continual differences of opinion about the good and the true in education, which can only be adjudicated by appeal to what is the real nature of man and the world he inhabits. To determine the generic traits of reality may seem to be just a matter of common sense, but it is far from being so easy a matter.

If the educator must appeal controversial questions about the good and the true to the generic traits of reality, it would appear that a sound philosophy of education rests ultimately on a metaphysical base. As a matter of fact, this is what a number of notable educational philosophers have held. But just what is reality? For instance, are its dimensions—and consequently those of education as well—measured by the here and now or do they include the hereafter as well? If they include the latter too, how can the parent or teacher know with certainty what these dimensions require as to the ends, content and method of instruction? The answer is highly speculative at best. One can argue logically enough to a number of different conclusions but which conclusion, which set of premises from which these conclusions take their origin, is the *true* one? This analysis would make it appear that questions of epistemology take precedence over questions of metaphysics. But a moment ago it seemed that what was true depended on what was real. Now it appears that what is real depends on what can be taken to be true.

This impasse directs attention to the fact that the truth about reality perhaps can never be completely known. On the one hand, this may be due to human limitations in the capacity to know anything. On the other, it may point to the need for redefining the role of philosophy. Some think philosophy should help educators by clarifying the statements in which they clothe their educational theories, policies and practices. Men use language in three different ways, they point out. One is cognitive; it represents or describes what is the fact. Another is emotive; it expresses feeling. And a third is persuasive or imperative; it seeks to influence the conduct of others. When educators misuse or confuse these uses they will need philosophy, in the sense of linguistic analysis, to untangle themselves.

Take Horace Mann's statement that everyone born into this world has a natural right to an education. Supposedly Mann was using language in the first sense as he seems to be making a descriptive statement of fact. On closer analysis, however, he may well have been trying to convince others of this principle, the third

sense. Indeed, not only may he have been trying to convince others but to sweep them into his camp by the implied justification that the principle was anchored in fact. But is it a fact? Or just an expression of Mann's own feelings, the second category? And, if he was speaking descriptively, what does he mean by "natural?" Is there any factual—observational, empirical—evidence that would lay this query to rest? And if not, is the statement as a fact meaningless? However Mann's statement is taken, philosophy should help the educator to be aware of the possible different meanings.

History.—Whatever the scope and function of educational philosophy, it has been important only intermittently throughout the long span of educational history. Prior to the 20th century, teachers and writers on education for the most part have been content to follow the lead of common sense. This was the case with the great Roman educator, Quintilian (*c.* A.D. 35–*c.* 95), when he wrote his *Institutio oratoria.* The later *Ratio studiorum* of the Jesuits (1599) was also largely a distillate of the firsthand experience of the members of that great teaching order. John Locke (1632–1704), when he wrote *Some Thoughts Concerning Education,* confined himself to his earlier experiences as a tutor instead of giving his "thoughts" the larger theoretical setting of his *An Essay Concerning Humane Understanding.* And even Jean Jacques Rousseau (1712–1778) included many purely empirical exhortations in his *Émile,* which must be considered a leading work in educational philosophy.

A few great philosophers like Aristotle and Aquinas gave theoretical attention to education, but only in a limited rather than a systematic way. Thus Aristotle (384–322 B.C.) treated education as an aspect of his *Politics,* holding that the theory of education should conform to the pattern of the state. Hence, since the Greek state admitted of freemen and slaves, he conceived and handed down to posterity the division between liberal and vocational education. But the clue to his larger political setting of education lay in the idea of happiness, the clue to which, in turn, lay in the practice of virtue. Aquinas (1225–1274) turned his attention briefly to education in his *De magistro* where he described the function of the teacher as analogous to that of the physician. Since the physician cannot heal his patient but can only assist the processes of nature to heal itself, so it is not only bad grammar but bad theory to expect the teacher to "learn" his pupil. The pupil must be self-active in learning. Teaching can only assist this process; it cannot be a substitute for it.

Among the few who have given major attention to refining common-sense educational notions by philosophical theory the first, and perhaps the greatest was Plato (427–347 B.C.). His famous work, the *Republic,* written as a dialogue between Socrates and various others, still stands as one of the greatest educational essays of all time. Going far beyond specific rule-of-thumb directives for the immediate teaching of the young, Plato placed education in the larger setting of social improvement. Imperfections in the existing state of affairs impressed him as all too evident. But these imperfections were only apparent. Behind the world of appearances lay the true world of perfect reality. The main business of education was to aid the human intellect by a dialectical or logical process to pierce through the shifting shadows of the immediate world to the ideal world of reality beyond. After acquiring a firm grasp on ultimate truth through the dialectic process it would be possible to rule the state justly.

But precisely what is the dialectic of learning ultimate truth? Plato early concluded that there was no hope of the mind acquiring this kind of knowledge from outside itself. Knowledge must, therefore, emanate from ideas which were innate at birth. This natal knowledge was so latent, however, that the individual seemed to have forgotten it. The educative process, consequently, became one of reminiscence. Using the Socratic method of asking questions, the teacher literally tried to draw the truth out of his pupils. (It is no accident that the English word education stems from the Latin *educere,* meaning "to lead forth.")

Plato was well aware of the fact that not everyone responded with equal competence to the dialectical process of drawing forth ideal forms of knowledge. As a matter of fact, he recognized three levels of ability. To the topmost level he entrusted the government. The best-educated men, those most able to lay hold the ideal form of truth, were to rule. Indeed justice required it for, Plato said, a just education obtains where each one is educated according to his ability, but in such a way as to benefit the whole social group.

After Plato there was a long pause in systematic theoretical thinking about education. Only one attempt, a failure, was made to implement his own theory in practice. No doubt the *Republic* was too utopian even for the advanced times in which Plato lived. In spite of such intervening educational classics as those already mentioned, the next educational work of philosophical stature was Rousseau's *Émile.* Envisaging many specific directives for rearing Émile, Rousseau, like Plato, conceived the larger task of education to be one of social regeneration. Rousseau saw 18th-century society as honeycombed with injustices and iniquities. Consequently a conventional education in the customs of the day would be similarly corrupted. From what source, then, was education to draw its purifying influence? From nature, said Rousseau. As he put it in the opening sentences of *Émile,* everything is good as it comes from the hands of the Creator; it is only in the hands of man that it degenerates.

A principal implication of this statement was that child nature is fundamentally good. This ran counter to the widely held Christian conviction that original nature is tainted with sin. Nevertheless, if Rousseau was right, the hope for social regeneration was to be realized by an education patterned closely after nature rather than social custom. The educational directive to parents and teachers, therefore, was to give the child freedom to express his native goodness. If free rein for his native tendencies produced untoward results, then let the child learn from the consequences of his acts. Rural rather than urban life seemed to Rousseau the better place in which his educational philosophy could work itself out. But to claim that this point of view was antisocial on this account or on account of his emphasis on freedom is overstating the case.

In the century following Rousseau, Johann Friedrich Herbart (1776–1841) was undoubtedly the leading philosopher to give systematic attention to educational problems. The main bearing of his thinking on the problems of parents and teachers was moral and psychological (psychology at the time being still a philosophical rather than a scientific discipline). Herbart took the concept of association of ideas, a notion at least as old as Aristotle, and developed it into the educational theory of apperception. According to this theory the pupil does not just perceive the new thing to be learned but he *apper*ceives it or, in more familiar language, he learns the new in terms of the old. To take better advantage of this principle Herbart arranged the curriculum according to his "culture epoch" theory. This theory, also of long standing before Herbart adapted it to his own ends, called for the child to repeat in the course of his education the various epochs—savagery, nomadism, agrarianism, etc.—through which the race had passed in its long history.

Next in line of great educational philosophers was John Dewey (1859–1952). Like Rousseau and Plato before him, he too conceived of education as an instrument of social reform. Unlike Rousseau, however, he did not accept nature uncritically as his standard; nor did he, like Plato, seek his standard in some ideal realm behind and beyond nature. Following the lead of modern science, Dewey saw reform as basically experimental. Consequently problem solving, first expounded in his *How We Think,* became the basic method in the classroom. This method started with some problem, preferably the child's own, drawn from the community in which he lived. After clearly defining the difficulty, the child was taught to gather data for its solution. With these resources and the guidance of the teacher, he learned to formulate a hypothesis for overcoming the obstacles standing in his way. The final step was to test the hypothesis by acting on it to see whether the consequences of action bore out the anticipations of the hypothesis. Thus learning necessarily involved student activity for Dewey as it did for Aquinas. But to St. Thomas' psychological justification for activity Dewey added an epistemological

one as well. In other words, it not only is a fact that learning is self-active, but one must also be active to learn what is true.

The social corollary of Dewey's method naturally called for the fullest possible sharing of ideas and resources for the solving of problems. Only in this way could there be continual and effective reconstruction of individual and social experience. Indeed, maximizing communication (increasing the sharing of ideas) within any social group on the one hand and between social groups on the other is the measure of the good or democratic society which Dewey laid down in the most famous of all his educational works, *Democracy and Education*. There can be little doubt that Dewey subscribed to the necessary compatibility of the scheme of education with the social frame demanded by Aristotle. Yet, while in Aristotle's time the separation of liberal and vocational education was compatible with a social frame admitting of freemen and slaves, Dewey insisted on the interpenetration of liberal and vocational education in a social frame where everyone was free and everyone worked.

20th-Century Philosophies.—While systematic writers on philosophy of education were rare before the 20th century, there was a veritable flood of them after 1900. In fact, it is probably not overstating the case to say that more books appeared in this field in the first half of the 20th century than in all the preceding centuries put together. It would appear that the tremendous advances of science and the enormous growth in complexity of political and economic organization created a situation in which the common-sense approach to education became progressively less and less adequate. The variable forces which drive education this way and that were so numerous and diverse that parents and teachers would have been overwhelmed without the advantage of a comprehensive theory or philosophy of education.

Progressive Education.—First to sense the need for bringing educational philosophy abreast of the times was a group who gathered under the banner and title of "progressive education" or, as it was called in Europe, "the new education." At first they were loud in protest against the rigidity and aridity of the traditional education inherited from preceding centuries. To point education in a new direction they founded numerous experimental schools. It soon became clear, however, that the founders of these schools were by no means of one mind in their educational theory. Roughly two theories were evident.

One wing of the progressive movement seemed to take its inspiration from Rousseau. It made a fetish of freedom for the child. It was as anxious to get away from the conventional molds of the 19th and 20th centuries as Rousseau had been to break those of the 18th. Along the way it received encouragement from some of the kindergartners who followed Friedrich Wilhelm Froebel (1782–1852) too closely, from G. Stanley Hall (1844–1924) whose theory of catharsis took Herbart's culture epochs too literally, and from some followers of Sigmund Freud (1856–1939) who sought freer self-expression as a way of avoiding neuroses caused by social repression.

Another wing of the progressive movement took Dewey for its leader. Less romantic than the former group, it was sobered by the hard facts met in the experimental method. Nevertheless it was definitely liberal in outlook. Its theory of progress was Darwinian and therefore "open-ended" in character, as William James would have said. Consequently neither the values embodied in the aims of education nor the truths included in the curriculum could take any final or fixed form. Leaning heavily on Dewey's essay, *The Influence of Darwin on Philosophy*, the progressives held to the theory that the end of education was growth and the only end of growth, more growth. (*See* also PROGRESSIVE EDUCATION.)

Traditionalism.—The progressive philosophy of education, starting at the end of the 19th century, had some difficulty gaining momentum. At first the sheer inertia of tradition impeded its pace. After World War I, however, it commenced to make such headway that alarmed traditionalists began to oppose it actively. Yet it was a decade or so before the philosophy underlying traditional education was made explicit. That one had long been implicit no one seemed to doubt. The surprising fact was that no one in recent centuries had taken occasion to state it systematically. Perhaps there was such general agreement on it that there was no occasion to define or explain it until its dominance was challenged.

On the whole, this unstated philosophy of education was conservatively religious in character. Consequently, as already hinted, it not only took a dim view of the romantic wing of progressive education but tended to be very skeptical of the Darwinian implications of the second or pragmatic wing as well. Fearful of the flux and relativity implied in the latter position, it bore down heavily on enduring values and the unchanging nature of truth undergirding education. To assure themselves of such stability, some traditionalists based their educational theories on Plato, and particularly on his notion that the real world was not this temporal one of change but an unchanging ideal one supporting it.

Others pieced together various elements of Aristotle's general philosophy to produce much the same educational result. Unlike Plato, Aristotle did not relegate change to a realm of unreality. On the contrary, he saw change as the process by which an organism is able to realize its potentialities. In fact, every species has a cycle of development from birth to maturity through which it fulfills itself. While change, growth and development unmistakably occur within this cycle, the cycle itself does not change. In this way Aristotle managed to strike a brilliant synthesis of the static and dynamic which has appealed to his followers right down to the 20th century. But to claim that the cycle does not change is to claim that species do not change, and to claim this is to fly in the face of Darwin's *On the Origin of Species*. The neo-Aristotelian educators were too shrewd to do exactly that. Rather they met the issue obliquely. It will be time enough, they asserted, to turn progressive when a new species of man actually emerges. In the meantime, lacking evidence that the nature of man had changed within the period of recorded history, they found a stable base for their educational theories in the apparently unchanging nature of man. Therefore they held that the aim of education, instead of varying with time and place, ought to be the same for everyone everywhere and always. The most notable advocates of this philosophy of education have been Robert M. Hutchins (1899–) and Mortimer J. Adler (1902–).

Religious Absolutes.—Still others have grounded the aims of education and the truths of the curriculum in religious absolutes. They have, consequently, a theology as well as a philosophy of education. In addition to scientific and metaphysical truth, they depend on supernaturally revealed truth as well. This last, which in no sense contradicts the other two, makes them absolutely sure of the rightness of their philosophy of education. As a consequence they feel they can teach with greater authority than can the adherents of other philosophies. This supreme confidence poses a problem for the public schools patronized by parents and staffed by teachers of contrary viewpoints. The private or parochial school has been a necessary corollary of theological philosophies of education. This position is particularly characteristic of Roman Catholic writers as witness J. D. Redden and F. A. Ryan's *A Catholic Philosophy of Education* (1956).

Democratic and Non-Democratic Philosophies.—All the foregoing philosophies of education claim to be democratic. All therefore are libertarian and equalitarian in the best tradition of the French and American revolutions. Loyalty to the tradition of freedom would cause them to lay considerable store by the worth of the individual as a rational being capable of making decisions and would therefore educate him for moral and political autonomy. Their belief in individuality, reinforced by psychology's scientific study of individual differences in the 20th century, would cause them to insist on a large measure of freedom to express this individuality. This would extend all the way from a flexible curriculum to an assurance of academic freedom in the discussion of controversial issues. The connection of freedom with individual differences has necessitated some reconstruction of the time-honoured conception of equalitarianism. Instead of meaning identical education for each child, equalitarianism has come to refer to an equality of educational opportunity. But even this has not seemed altogether just. Some have held, with Platonic justice in mind, that those with superior abilities should have superior educational opportunities. Thus freedom and equality have been

seen to be incompatible dimensions of democratic education.

Not all 20th-century philosophies of education, it needs mention, have been set in a democratic frame of reference. The Fascists, for example, took exception to the individualism of democratic education. Because of an individualistic education, democracies were subject to the whims of changing majorities, Fascists thought, and therefore lacking in stable ideals. Against this ideology fascism posed the view of a state as organically something more than the sum of the individuals who compose it, as an entity that has ends of its own which, if in conflict with the individual's, are nonetheless quite superior to his personal educational hopes and ambitions. Though the individual was subordinated to the state, fascists hoped that he would actually achieve a greater fulfillment of his personality by being taught to identify it with the longer-range and less selfish interests of the body politic.

The Communists, too, took exception to the individualism of democratic education, especially in its western or capitalistic form. The motivation of individual success in the latter's schools they found quite bourgeois and inferior to social service in a proletarian society. In the U.S.S.R. talented individuals were advanced in school, not for their own interest, but because of the use their talents would be to the state as a whole. The best interests of the state were determined by the Communist party line. In this line all students were indoctrinated throughout their educational careers. Students together with their parents and teachers could have an abiding confidence in their indoctrination because it was rooted in Marxist philosophy. Drawing on a theory of culture epochs not unlike those of Herbart, Marx was convinced of the scientific inevitability of communism as the final historical epoch. With anxiety over ultimate ends dispelled, there should be no surprise in the Communist confidence that the Communist student was freer than the democratic one. Whether this contention was right or wrong, it led to some confusion when Communists described their educational philosophy in the same terms of democracy and freedom that western nations did.

The "cold war" of the mid-20th century tended to make the differences between various educational philosophies sharper and more rigid rather than more flexible and therefore more negotiable. While this outcome was unfortunate, the resounding clash of opinion focused attention on the importance of educational philosophy as never before.

For further discussion of philosophical concepts referred to in this article *see* separate articles on EPISTEMOLOGY; METAPHYSICS; KNOWLEDGE, THEORY OF; VALUE, THEORY OF, etc. *See* also PHILOSOPHY, HISTORY OF and articles on various philosophers and educators.

See also EDUCATION, HISTORY OF.

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EDUCATION, SOCIETIES OF. Voluntary associations concerned with various aspects of education have become numerous since the early 19th century. The first were philanthropic and charitable associations to provide schools for children of the working class, such as the National Society for Promoting the Education of the Poor in the Principles of the Established Church (1811) and the undenominational British and Foreign School society (1808), in England; and such organizations as the Free School Society of New York (1805), in the United States. Subsequently, associations were formed to advocate the establishment of free tax-supported schools (*e.g.,* National Public Schools Association in England, and the Pennsylvania Society for the Promotion of Public Schools).

The following discussion is concerned principally with professional societies of teachers, school administrators and other educators.

For nonprofessional organizations *see* ADULT EDUCATION; PARENTS AND TEACHERS, NATIONAL CONGRESS OF.

PROFESSIONAL ASSOCIATIONS

With the spread of education and the establishment of statewide or national educational systems, teaching became recognized as a profession. Professional associations of educators, formed at first on a local basis, had been founded in 23 of the 31 states then comprising the United States, when in 1857 the National Teachers association (later, National Education association) was founded. Similarly, in England, delegates from 26 local teachers' associations established the National Union of Teachers (1870).

In many countries the objectives of defending teachers' interests has led to the formation of separate organizations for teachers at different school levels. In some cases, the organizations have formed close ties with labour unions or with political parties, while in other cases such ties have been carefully avoided.

National or regional associations exist in such fields as administration, audio-visual education, business and commercial education, counseling and guidance, higher education, home economics and other areas of special interest.

The efforts of independent and professional educational associations to raise the economic and social status of the teaching profession are paralleled by their contribution toward raising the quality of teaching. They promote educational research and the application of research findings; help to establish standards for the certification of teachers; promote continued in-service training and exchange of professional knowledge through publications and conferences; establish codes of ethics for the teaching profession; inform the public on educational issues; advocate educational reform; and defend impartial and objective teaching against political and other pressures.

UNITED STATES

More than 7,500 professional associations of educators are listed in official directories. The range of their activities is very wide. They hold periodic meetings, issue publications, maintain committees and study-groups, and carry on research. The organizations are local, state and national in scope. There is scarcely a county that does not have an organization, and every city has one or more. State-wide organizations are particularly important for the defense of teachers' interests, because educational authority is vested in the several states.

The most influential educational organization in the United States, the National Education Association (N.E.A.), was organized at Philadelphia, Pa., in 1857, under the name of the National Teachers' association. Its general purposes may be considered the objectives of many educational associations in the U.S.: "The purpose and object of the incorporation shall be to elevate the character, to advance the interests of the profession of teaching, and to promote the cause of education in the United States." Departments of the N.E.A. include, for example, those on adult education, art education, audio-visual instruction, business education, classroom teachers, deans of women, educational research, educational secretaries, elementary school principals, exceptional children, health, physical education and recreation, higher education, home economics, industrial arts, journalism directors, kindergarten-primary education, mathematics teachers, music educators, retired teachers, rural education, school administrators, school public relations, science teachers, secondary school principals, social studies, speech teachers, supervision and curriculum development, teachers' colleges and vocational education. New departments may be created and old ones discontinued or reorganized.

The N.E.A. representative assembly was created in 1921. In it state and local educational associations may be represented according to the number of their members who belong to the national body. The representatives take part in business sessions and in establishing the general policy. Under this reorganization, the association undertook to carry its influence and support to every teacher in the United States. The membership was extended from 8,557 in 1918 to more than 642,000 by the second half of the 20th century.

The N.E.A. is concerned with promoting teacher welfare through the establishment of retirement systems and the assurance of tenure of position, increasing the numbers of teachers and ob-

taining reasonable teacher loads, and the defense of teachers and schools.

Many national organizations represent special interests. The American Council on Education is a federation of associations, schools and universities with special committees on education of women, education in international affairs, co-operation in teacher education and other phases of educational interest.

The American Federation of Teachers, an affiliate of the American Federation of Labor-Congress of Industrial Organizations, seeks to promote the economic welfare of teachers and to protect academic freedom. The National Council of Teachers of English is one of the largest of the many groups concerned with specific subjects and which conduct studies, hold conventions and publish influential periodicals. The National Catholic Educational association, made up of educators in Catholic institutions, serves as a clearinghouse for the exchange of ideas and as a means of promoting co-operation among the members. It seeks to safeguard and promote Roman Catholic educational interests. The American Association of University Professors is concerned with the problems of professors, particularly tenure and academic freedom.

GREAT BRITAIN

The largest educational association in England is the National Union of Teachers. From an organization of some 400 elementary teachers in 1870, it has become in the second half of the 20th century a comprehensive professional organization with more than 220,000 members, serving in all types of schools and establishments for further education. The union retains its original character as a union of local associations. The controlling body is an annual conference of about 2,000 delegates, held at Easter, representing the local associations which, for the most part, are grouped together in 60 county associations. The executive board consists of 40 members, directing a large professional and clerical staff. The union's principal objects are to associate and unite the teachers of England and Wales; to provide means for co-operation and expression of collective opinion upon matters affecting education and the teaching profession; and to secure the establishment of an efficient national system of education. It is concerned to promote an integrated system of education and a unified profession of teachers. It seeks to raise the general level of salaries through negotiations, and has the majority representation on the Teachers Panel of the Burnham (Main) committee which deals with the salaries of teachers in primary and secondary schools. The union provides legal assistance to its members and works for better conditions of tenure and service, adequate pensions, safeguards against unjust dismissal and greater freedom for the teacher. It works for educational development through membership in ministry committees and national educational bodies such as the National Committee for Visual Aids in Education and the National Foundation for Educational Research, by maintaining an information service and by organizing refresher courses for teachers.

There are four major associations of teachers in secondary schools: the Association of Head Mistresses incorporated (founded 1874), the Incorporated Association of Head Masters (founded 1890), the Association of Assistant Mistresses in Secondary Schools incorporated (founded 1884) and the Association of Assistant Masters in Secondary Schools incorporated (founded 1891). They have branches or divisions throughout England, Wales and Northern Ireland. The majority of their 35,000 members are in the schools which were termed secondary before the 1944 Education act, after which they became known as the secondary grammar schools; but teachers in secondary modern and secondary technical schools are also included in their membership. The aims of the four associations are to promote the cause of education generally, and of secondary education in particular, and to protect the interests and improve the professional status of their members. The Headmasters' conference (1896) is limited to 200 members and is confined to the headmasters of independent and direct grant schools and such other headmasters as may be invited to apply for election.

Teachers in Scotland are associated in the Educational Institute of Scotland.

Other associations serve a wide variety of interests: university teachers of Great Britain are represented by the Association of University Teachers (founded 1919). In technical education, there are three main associations. The Association of Teachers in Technical Institutions was founded in 1904 for the advancement of technical education and the safeguarding of professional interests. It issues the *Technical Journal* monthly. The Association of Technical Institutions includes representatives from technical institutions in Great Britain. There is also an Association of Principals of Technical Institutions. On the administrative side, there are the Association of Education Committees, representative of the education committees of local education authorities, and the Association of Education Officers. There are numerous subject associations. The New Education fellowship, founded to promote progressive educational practice, became an internal association.

INTERNATIONAL ASPECTS

Education associations have developed considerably in the Commonwealth of Nations and in western European countries, and they are emerging also in other parts of the world. The Canadian Education association, originally the Dominion Education association, held its first annual meeting in 1892 and the Canadian Teachers federation was organized in 1920, the Canadian School Trustees association in 1923 and the Canadian Federation of Home and School in 1928. In European countries, the structure and goals of the education associations tend to reflect prevailing policies in education and the way in which the school system is organized; thus the important Ligue française de l'enseignement with 2,000,000 members (founded 1866), aims to protect secular public education in France. Distinctions occur between primary, secondary, technical and higher education groups in France, Germany, the Netherlands and most other European states. Divisions along confessional and political lines are also common. In Asia there has been a remarkable growth of education associations in Japan, where almost all aspects of professional, political and trade union interests are reflected in the groups.

Many efforts have been made during the 20th century to create international federations of education associations. The movement has become accentuated since World War II; in most cases these federations are concerned with some single specializations. Attention should be drawn, however, to the more broadly based federations of recent origin, *e.g.*, the World Confederation of Organizations of the Teaching Profession. This was established in 1951 with strong backing from British and American teachers' associations, following negotiations between three organizations: International Federation of Teachers' associations, International Federation of Secondary Teachers, and World Organization of the Teaching Profession. By 1957, its membership included national associations in 52 countries. The confederation excludes from its debates all questions involving political, political party or religious controversy and makes no racial discrimination. Its purposes are to foster a conception of education directed toward the promotion of international understanding and good will; to improve teaching methods, educational organization, and the academic and professional training of teachers; to defend the rights and interests of the teaching profession; and to promote closer relationships between teachers. The confederation holds regional and world conferences, advises national groups on techniques of building professional organizations, studies particular problems, and maintains a research and information centre at its headquarters in Washington, D.C.

Among other international organizations of teachers may be mentioned the World Federation of Teachers' Unions (founded 1945), which is the Teachers Trade department of the Communist World Federation of Trade Unions, and the World Union of Catholic Teachers (founded 1910), of which the headquarters is in Rome. (H. J. Ab.)

EDUCATIONAL ARCHITECTURE includes a wide range of buildings in type, size and standard of accommodation. They vary from a one-room rural school to a university campus; from the simplest of structures to significant examples of modern architecture.

ELEMENTARY (PRIMARY) AND SECONDARY SCHOOL ARCHITECTURE

The characteristics of educational architecture depend on the characteristics of the education for which it is designed. A rigid, unimaginative system of education will be reflected in rigid, institutional buildings; an educational system that is free to grow and experiment will require freedom in its buildings.

In the past school buildings were generally recognizable by a particular character, an identifiable architecture with a sombre dignity, real or assumed. In the 1930s, however, a change began to take place, arising in part from changes in educational theory, in part from a new attitude of architects, in which there was a growing awareness that the character of a school environment must be determined by the activities and life within the school.

The environment needed for school children in the second half of the 20th century is radically different from that at the beginning of the century. Learning has come to be concerned not only with the static processes of the mind but also with the activities of the whole body, for which are necessary not only more space and equipment but also more imaginative arrangements and treatments of space, based on a more scientific, less formalistic approach. All countries are striving to provide more educational opportunities for greater numbers of children, and large educational building programs are widespread, demanding co-operative effort of teachers, architects and administrators. (M. Cr.)

United States

Historic Development.—Since the success of representative government depends upon an enlightened citizenry, education has long been mandatory in the United States (*see* Education, History of: *United States*). Puritan emphasis on Bible reading and individual salvation led to the erection of schoolhouses for all classes. The middle states adopted a parochial school system supported by churches that were often able to build large schools, richer architecturally than those of New England, with separate rooms for each grade. Wealthy planters in the south generally relied upon apprenticeship and private tutoring until after the Revolution.

As neighbourhoods grew, and more pupils had to be housed than could be handled by one teacher, larger square or rectangular buildings were erected with two to four rooms off a central hallway, sometimes on each of two or three stories. The most advanced buildings had internal plumbing and tall windows; heat was provided by stoves in classrooms, later from a furnace in the cellar; most buildings were of wood, and fire was a common hazard. Some 18th-century buildings were noteworthy for architectural reasons; for example, the Academy at Schenectady, N.Y., designed by Philip Hooker. Most, however, were utilitarian, and improvised rooms were used throughout the 19th century. Henry Barnard's *School Architecture*, published in 1849, set a high standard, virtually unrealized by contemporary school buildings, and he enlisted the aid of the architect James Renwick, who incorporated Barnard's suggestions in such buildings as the Tryon Park school in New York city, which provided good light, ventilation, sanitation and safety within commodious spaces, treated in Gothic Revival style.

Such buildings, however, were not common. In 1901 E. M. Wheelwright, school architect in Boston, deplored the sad condition of school buildings. Wheelwright wanted to reduce classrooms to accommodate no more than 40 to 48 pupils and to lessen the standard room width of 28 ft., and he insisted upon better sites with play areas. The architect-engineer William Atkinson attempted to incorporate educational ideas in his design for a low building in which large window areas filled one classroom wall while the remaining walls were solid, but his farsighted scheme was shunted aside in deference to standard, multiple-story-plan types, either closed (in the form of a solid rectangle, a hollow rectangle with interior courts or a rectangle with interior auditorium and courts) or open (in the form of the letters I, T, U, E or H).

In 1925 the National Education association issued a report, *Schoolhouse Planning*, which reinforced state and local codes to establish concise standards for school buildings. Classrooms generally became 12 ft. high, 22 to 24 ft. deep and long enough to accommodate 30 to 40 pupils at fixed seat and desk units. Daylight came from windows in one wall with a surface equal to 20% of the floor area, and artificial illumination from pendant incandescent fixtures supplemented natural light. These standards perpetuated themselves past all justification, and they distracted attention from imaginative attacks upon spaces for instruction.

Role of the School in the 20th Century.—The earliest architectural recognition of progressive education did not appear till 1908. John Dewey and his sister had incorporated into their thinking the Froebelian and Pestalozzian methods of object-centred instruction. They thought that the theatre, art and music were important instruments of education and that school architecture should reflect domestic architecture. The suburban Chicago school built by Frank Lloyd Wright for Mrs. Avery Coonley, to whom the Deweys were educational advisors, was child-scaled and set among gardens and a pool, the classroom wing containing activity spaces and specially designed furniture: teacher-student relations were informal and close. Published in the Deweys' *Schools of To-morrow*, it heralded the advent of modern schools in the middle west, among them D. H. Perkins' Carl Schurz high school in Chicago, built in 1910.

As schools came to include more students seeking training in science and technology rather than the classics, new kinds of classrooms, museums and laboratories for scientific instruction became necessary. Athletics and physical health, requiring gymnasiums and clinics for dental care, eye and ear testing and general examination, became the responsibility of the schools. The space needed by expanding curriculums was most easily provided on rural sites where buildings could be spread out. About 1915 California offered some noteworthy examples of well-planned educational facilities, such as Elmer Grey's one-story open-air school at Pasadena and Myron Hunt's patio schools with one-story shops and classrooms surrounding a cloistral walk.

The belief that the school should be the cultural centre for the community led often to the planning of schools on a community and regional basis. Motor transport made it possible to plan large consolidated schools on undeveloped land where buildings could be disposed with a low density and large playgrounds, athletic fields, parking areas and landscaping. Kindergartens became accepted portions of elementary schools, and classrooms in elementary schools generally contained movable furniture, sinks, work counters and abundant storage space. A floor area of 30 to 35 sq.ft. per child was common, and the resulting deep rooms required multiple sources of daylight. Hence, single-story structures prevailed. Often there were playrooms, auditoriums and gymnasiums, though in small schools a multi-purpose room served several functions, including that of a place for public gatherings. Probably the most significant building was the Hempstead high school on Long Island, N.Y., built in 1920 by Ernest Sibley. After a careful environmental study, which showed the need for an adult centre, the school was designed in two sections, with a classroom wing and a community block containing the auditorium, gymnasium, shops and administrative offices.

Led chiefly by European *émigré* architects, U.S. school designers after about 1935 experimented with the distinctive forms of modern architecture; particularly notable were those designed by R. Neutra, Eliel Saarinen and W. Lecaze. Their work culminated in one remarkable classic of modern design, the Acalanes high school at Lafayette, Calif. (Franklin and Kump's design, 1941). Built on a finger plan, the school had pavilion-type classrooms spread outward from a core containing the administrative offices, space for athletics, an auditorium, cafeteria and shops. Growth of new communities during World War II offered architects opportunities to design modern schools like Saarinen's at Center Line, Mich., and Franklin and Kump's at Ducor, Calif. Intensive investigation of school needs by architects and educators around mid-century, such as that conducted by the Texas Agricultural and Mechanical college, led to results like William Caudill's core scheme for classrooms, where one compact unit contained all mechanical equipment.

Types of Plan.—Seven basic school plan types may be dis-

cerned: (1) the wing plan, with classrooms on one or both sides of central corridors; (2) the finger plan, with several pavilions of classrooms projecting from a central core; (3) the cluster-type plan, with two or four classrooms grouped about a play space; (4) the loft plan, with large building blocks divided into classrooms and corridors; (5) the multi-use-corridor plan, in which the circulation space serves also as activity space for classrooms; (6) the core-type plan, which eliminates corridors and places the classrooms back to back against a utility core; (7) a campus plan, used for a few large high schools, in which separate buildings are erected for classrooms, shops, gymnasiums and auditoriums. Each of these has advantages and inherent disadvantages.

Particular study should be made of several schools. The Blythe Park school at Riverside, Ill., by Perkins & Will, and numerous other schools by these architects, showed a human quality in design that had wide appeal. The climatic conditions of the south presented special problems which were met, for example, in the shaded courtyards of the elementary school at West Columbia, Tex. (1952; Donald Barthelme & Associates), and in the umbrella-type roof protecting clusters of classrooms in the elementary school at Port Arthur, Tex. (1952; Caudill, Rowlett, Scott, Neff & Associates). Cluster-type plans for more temperate climates were developed for the Heathcote elementary school at Scarsdale, N.Y. (1953; Perkins & Will), and the elementary school at Darien, Conn. (1953; Ketchum, Giná & Sharp). An example of the loft plan appeared in the high school at Killsdale, Calif. (1953; John Lyon Reid). The Sunset Community centre, San Francisco, Calif. (1952; Wurster, Bernardi & Emmons, co-ordinating architects), was but one of many examples in which large school complexes were used as centres for community educational, recreational and social life. Although these and other schools were outstanding, they did not pass uncriticized, particularly by those who questioned the expense or luxury of schools like the Heathcote at Scarsdale. (*See* also CITY PLANNING.)

Private Schools.—Private-school architecture contains a few unique problems, notably those of providing residence and dining facilities for the school community. In general, private schools utilize the campus type of planning. Except for a few notable schools like Cranbrook, at Bloomfield Hills, Mich. (Eliel Saarinen), their architecture has been conservative. Lawrenceville school (Lawrenceville, N.J.), Phillips Exeter academy (Exeter, N.H.) and St. Paul's school (Concord, N.H.), for example, followed the fashions prevailing at Ivy league colleges, and not until after mid-century did a few schools like Phillips academy (Andover, Mass.) begin to exemplify modern design. (A. B.-B.)

GREAT BRITAIN

Historical Background.—From their medieval beginnings as part of monastic establishments, schools in Britain have been closely associated with the church, and the buildings, often situated in the shadow of the churches, were markedly ecclesiastical in character. It was not until nearly the end of the 19th century, with the advent of school boards empowered to provide and maintain school accommodation for all children from 5 to 13 years of age, that the beginning of an organized system of education, and consequently of school building, began to emerge. The board schools, many of them still to be seen, reflected in their planning and character the type of education for which they were built. Their design was dominated by the requirements of supervision and control, and the materials of which they were constructed were characterized by strength and endurance. Such schools were—and still are—almost indestructible. Classrooms were tightly planned around a central hall or marching corridor, with consequent problems of noise, poor ventilation and inadequate lighting.

With the establishment of the board of education at the turn of the century, and the beginning of local education authority administration, new standards began to influence school design. The Schools medical service, for example, drew attention to the health of children, and the first building regulations appeared in 1905, laying down requirements for such things as lighting, ventilation and hygiene. Classrooms became standardized in area and height, and more open planning with cross ventilation was introduced. Accommodation was increased to include such spaces as practical rooms, gymnasiums and assembly halls. A pattern of school layout became established: on restricted urban sites, a symmetrical quadrangular plan arrangement; in areas where space was less restricted, long wings of classrooms strung along single loaded corridors. Few schools were more than two stories in height; many were on one floor. Roofs were pitched, and up to the 1930s elevations were broadly neo-Georgian in style. During that decade the modern architectural movement began to influence school design, and a new style based on a more imaginative approach was beginning to emerge when World War II put a stop to school building.

After 1945.—The schools of the public educational system in England and Wales were designed and built by the local education authorities and by the churches, and in Scotland entirely by the local authorities. These largely autonomous bodies were free to adopt whatever kind of school architecture they wished, provided their buildings neither exceeded the maximum cost nor fell below the minimum standards laid down by the central government. Most schools were designed in the architects' departments of local authorities, the remainder by architects in private practice.

It was necessary to build large numbers of schools after 1945, partly because of bomb damage, movement of population and the raising of the school-leaving age, but mainly because of the rise in the birth rate. Between 1945 and 1960 the school population in England and Wales increased by 40%. By Dec. 1960, accommodation for 2,800,000 new places had been provided, and many improvements carried out to existing accommodation, at a total cost of £620,000,000, excluding architects' fees and furniture and equipment. Although building costs doubled during this period, the cost of new schools was actually reduced without educational loss. In 1960 the average area of the new schools was approximately 42 sq.ft. per pupil under 11 years of age and approximately 72 sq.ft. per pupil over 11 years. Of this area, roughly 60% was teaching space, the proportion of nonteaching space having been considerably reduced. An even larger school building program was planned for the 1970s, in order to raise the standards of old schools, to relieve overcrowding and to implement the policy of expanding secondary education envisaged in the Education act, 1944.

In 1945 each authority set out to survey its long-term educational and building requirements, and subsequently worked to an agreed annual building program in order to ensure the best distribution of available resources. In 1949 the ministry of education set up a development group within its architects and building branch, in which educators, administrators and architects together undertook investigation and actual school design and building, in collaboration with individual local authorities. In this way solutions to selected educational and technical problems were put forward, and the experience thus gained was shared; there was a working relationship between local and central authorities, between educators, administrators and technicians. After the war, developments in school architecture were in part encouraged by the stringent conditions under which schools had to be designed and built; large numbers were needed at a time of limited financial resources, competing programs of national reconstruction, rising costs and shortages of materials and of manpower.

Prefabricated systems of construction were widely associated with Britain's new schools, though many schools were of course built by traditional methods. Prefabrication did not develop from architectural dogma, nor as a temporary expedient in an emergency. Although it was indeed an answer to acute shortages of building materials and of site labour, it was vested with permanent architectural and educational qualities. Prefabricated schools proved not only to be sufficiently competitive in terms of cost but also to result in higher productivity on the building site. They combined standardization, for large-scale economical production, with flexibility in plan and section; the method, not the result, was standardized. Such schools brought with them an informality which was in sympathy with modern trends in education. Prefabricating methods were applied to steel, concrete, timber and aluminum, and as a result an important section of the building

industry grew to serve the school building program.

Experience has shown, however, that the success of such architecture depends on the close and continuous association of architect, educator and administrator. Its development has been made possible because the majority of schools were the responsibility of local authorities who employed both educators and architects, and because of the stimulus the ministry's development group was able to give. The collaboration of several local authorities, in order to increase the benefits of the prefabricated systems, was a logical outcome, and proved that further advances in terms of costs and quality could be achieved, provided that higher educational and architectural quality was the motive rather than mass production for its own sake.

School architecture is not only a question of building techniques; at the beginning of the 1960s the best schools were the result of continuous and joint development of both architecture and education, and their designers were sensitive to changing needs of education. These schools had not only formal architectural significance but also a quality of environment which was dependent on the sensitive and imaginative treatment of such things as acoustics, heating, lighting, colour and furniture. In all these aspects the school building programs promoted research and development, to the advantage of the building industry as a whole, and of school architecture in particular. School architecture in Britain does not have the stamp of personality because it has not been influenced by dominant individuals; it has been a concerted and largely anonymous effort of many specialists. (M. Cr.)

Public Schools.—The architecture of English public schools was created piecemeal, according to the date and type of the educational foundation concerned, and in this its history follows that of the Oxford and Cambridge colleges. Isolated examples of late medieval or early Tudor buildings, such as Eton and Winchester, were followed by sporadic development culminating in a spate of Victorian building in the second half of the 19th century. The superficial styles of these buildings varied, but in general some form of Gothic revival was most popular, and the collaboration of public school governors with their architects has resulted in very little work of outstanding architectural merit. A considerable degree of austerity is common to many of the interiors, although this does not apply in cases such as Stowe where a fine 18th-century mansion was converted to school use. (E. C. D.)

Europe

Continental European schools in the 20th century, like those of Great Britain and the United States, were in need of rebuilding, though little was done before the middle of the century when Britain began to play a leading part. New schools clearly reflected the educational ideas of such 19th-century reformers as Froebel and Pestalozzi. Glass-walled pavilions were set in gardens in close touch with nature and in imitation of the ideal domestic architecture. Classrooms were often set at an angle to each other to avoid the massed effect of a block and to provide a feeling of intimacy. Health facilities, such as showers and rest rooms, were provided increasingly, and classrooms and corridors were used as recreational spaces and for handicrafts and practical activities. The emphasis was on artistic design and colour that was likely to appeal to children.

Advanced building before World War II was mainly in response to the needs of handicapped and backward children. In Holland J. Duiker built an open-air school at Amsterdam, remarkable for its tower of glass-sided balconies. Near Paris E. E. Beaudouin and M. Lods designed the Suresnes school (1935–36) set in gardens and provided with extensive medical services and collapsible canvas beds for afternoon resting. Hermann Baur's primary school in Basle, with copper roofing and glass walls, was built on a child scale.

After 1945, occupied or devastated countries faced the need for reconstruction at a time when their national economics were too strained to admit much school building. The most notable schools were constructed, therefore, in countries which escaped the worst effects of the war. P. Hedqvist followed up his prewar Bromma high school with a communal school at Stockholm (1944) and the brick Abrahamsberg school (1946). Nils Ahrbom and H. Zimdahl built the Eriksdal school, with its tunnel-like sports hall, and Åke Lindqvist Björkhagen elementary school. In Switzerland the Bachtobelstrasse school at Zürich (A. H. Steiner, city architect; 1946) continued the theme of building for the particular needs of children by constructing timber pavilions surrounded by trees, while the Lucerne school of Felsberg (E. Jauch and E. Bürgi; 1948) followed a similar idea with two-storied buildings stepped up a slope. The Parc Geisendorf at Geneva (G. Brera and P. Waltenspuhl) with its mosaic floor was similarly adapted to child living. In Finland the Tapiola kindergarten (Viljo Rewell; 1956) and the Kulosaari school (J. Järvi; 1954–55) were both built near Helsinki; the latter is remarkable for the contrasting diagonal lines of its brick hall.

In the Netherlands W. M. Dudok's school at Hilversum was a superb example of modern planning; the Spinoza school at Utrecht (D. J. Schenk) used exterior colour and emphatic vertical lines to counter the length of its pavilions. Brederode school, Bergen (J. C. de Vries and T. Wijnalda) provided yet another original ground plan.

After the Suresnes school and that which André Lurçat erected at Villejuif in 1932, French architecture developed little that was new, though provincial construction—for example, the Poitiers scheme of 19 projects for village schools—continued. In such schools as the Paris Lycées at Boulevard Bassières (1953) attempts were made to vary the classroom blocks.

In Italy, Mussolini's building enthusiasm unfortunately did not extend to the schools, and though in other fields Italian architecture after World War II was both interesting and enterprising, provision for schools was inadequate.

Recovery from war devastation in Germany was slow but by the 1950s, and often with financial assistance from the United States, schools like the Gänsberg school (G. Wilhelm) and the Gymnasium (H. Brüllmann) at Stuttgart, the Mainz-Gustavsburg school (F. Novotny) with pavilions and covered ways, and the Hanover Gymnasium (city architects department with W. Dierschke and A. Bätjer-Kiene) were built. The ability to plan from the beginning (a result of war devastation) rather than to carry out extensions of old schools favoured the architect, and though the new schools were not often outstanding for their architectural originality, they were built in large numbers.

Later interesting new buildings were Danish: the Sond school at Copenhagen (K. Gottlob; 1947) is notable for its dramatic hall with oval galleries and its glass-sided ramp; Arne Jacobsen introduced a variant on the garden theme with the Søborg school, Copenhagen (1952), and the Munkegaard school at Gentofte (1952–56), designed as a series of one-storied classrooms regularly checkered with courtyards.

See also Lighting: *Specific Lighting Applications: School Lighting;* Heating and Ventilation.

UNIVERSITY AND COLLEGE ARCHITECTURE

Historical Developments

From the 12th to the 19th centuries university functional requirements remained simple—instruction was mainly oral and required little equipment—and until the end of the period architectural changes were due either to changed building technique or to the upheaval of taste marked by the Renaissance. Most universities other than Oxford and Cambridge from the 16th century onward followed the general type of Renaissance palace, a large square block in an urban street, with a courtyard surrounded by one or two galleried floors containing classrooms and, in some cases, rudimentary living accommodation. Examples are Cracow (1494), Padua (1542) and Bologna (1562–67).

The popular conception of university architecture, however, owes nothing to any of these centralized continental institutions. It is based on the Oxford and Cambridge colleges, which from the 13th century to the present have been societies of teachers and students living as self-contained and sovereign communities which in loose federal association form the two universities, select their entrants and regulate their academic affairs. Nearly all the colleges consist of one or more quadrangles approached by a tower

gated against riots of townsfolk or unruly students. Within this arrangement the outstanding elements are a chapel, dining hall and kitchens, a library and living quarters. The latter consist of separate sets of rooms, each with a living room, bedroom and pantry, built in pairs up staircases. The domestic scale of the colleges is due to this arrangement: the quadrangles are seldom more than 100 ft. square, their sides punctuated every 30 ft. by the small staircase entrances, and, apart from towers and spires, none of their buildings higher than 40 ft. or so to the ridge. The college buildings, apart from exceptional chapels like King's, Cambridge, and Christchurch, Oxford (which also doubles as a cathedral), were and are severely simple and unpretentious, typical of the humbler domestic architecture of their periods. By mid-20th century standards they are mostly cold and damp, with few bathrooms and uncertain hot water. But the calm isolation of their quadrangles is still valued in a noisy age, their cool lawns, generous gardens, mellow brick and crumbling stone, and above all their intimate scale, have endeared them to generations of undergraduates and made them imitated, often inappropriately, throughout the world.

Such noncollegiate buildings as Oxford and Cambridge possess remain relatively few, but they include some of the outstanding masterpieces of the English Renaissance style: Sir Christopher Wren's Sheldonian theatre (1664–69) used for ceremonial conclaves, the Clarendon building (1711–24) and James Gibbs' Radcliffe Camera (1739–47) at Oxford; and the Senate house at Cambridge (James Gibbs, 1722–30).

A new phase of development began in mid-18th-century France with the establishment of the technical colleges of the Écoles des Mines, des Ponts et Chaussées, et du Génie. Growing industrialization demanded institutions for training scientists and technologists instead of the lawyers or administrators of the older universities. Germany, importing French scientific talent under Frederick the Great, was the first to see clearly the role of the scientist in the modern industrialized state and to equip rich and large laboratories like those at the Vienna Technische Hochschule in 1815, Karlsruhe (1825), Dresden and Stuttgart (both 1829) and Darmstadt (1836).

These new laboratories, however, were housed in makeshift adaptations or in temporary buildings. By an ironic paradox, just when building requirements had reached these unprecedented levels of complexity, architecture had been demoted to a merely decorative art. By the time other countries, spurred perhaps by German success in the Franco-German War, awoke to the importance of science as a university subject and to the need for new universities in industrial centres like Manchester (1880), Birmingham (1900) or Liverpool (1903), architecture had ceased entirely to be a function of the activities it housed. It was regarded mainly as a symbol of prestige. The new universities, even those of the United States and the newly developed countries of the Commonwealth of Nations, imitated the colleges of Oxford and Cambridge with their ruling-class associations, irrespective of the institutional pattern they adopted. Examples of chemistry and physics laboratories modeled on medieval monastic refectories can still be found in Leeds and Manchester.

Modern Universities

Institutions on the continental noncollegiate pattern and the 19th-century industrial foundations, catering as they did mainly to local students, ceased to sponsor halls of residence. After the 1920s, however, interest in them revived, not only because of the shortage of other lodgings but also as a partial corrective of overspecialization. It was hoped that communal life with teachers, researchers and students studying different subjects would lead to understanding of the spirit and interrelation of the different branches of learning, and act as a civilizing influence. Unfortunately, many halls of residence built with such aims in view have imitated the Oxford and Cambridge precedents (especially in England, much less so in the United States) without considering factors such as the shortage and high cost of domestic labour, the modern reaction against most forms of paternalism and the fact that universities are now coeducational. Interesting experiments in which residence aims at making the student mature in an environment more akin to the extramural world have been made; groups of accommodation are much smaller and each has its own eating and recreational space in which students can live together without supervision. A good example is the University College of North Staffordshire, Keele, Eng. An even more progressive experiment has been made—nearly a century after the admission of women to the universities—at the Golden Gate Theological seminary, Marin County, Calif., where students ranging from young men and girls to families with children all prepare for missionary work. The group living experience, it is thought, can contribute to the educational preparation, and thus the seminary plan includes units domestic in character and scale, with patios, play yards and carefully detailed landscape.

Many modern universities encourage, with a fairly generous capital outlay, activities such as debating and amateur drama. Student unions form a centre for such activity, often including a central dining room for the large body of students who still remain nonresidential and sometimes a concert hall and a health centre.

The modern university still requires a large proportion of building with fairly unspecialized functions suitable for teaching "by talk and chalk." Old buildings can often be adapted and new ones need differ from them only in that they are more comfortable, although a growing number of universities reach large audiences by means of closed-circuit television. The major share of university capital, however, is invested in specialized laboratories and demonstration theatres for science and medicine, engineering and technology. This poses problems in housing of complicated equipment, movement of personnel, fire resistance, protection against radioactivity and disposal of radioactive waste. Finally, the pace of scientific and technological development demands that such buildings be capable of ready modification and enlargement.

Thus, there is no real validity in attempts to impose on buildings of this kind a recognizable academic stamp. Economic conditions and the pressure of demand insist that the fullest use be made of modern building techniques and consequently modern forms. At the beginning of the 1960s, however, even the most adventurous universities had only drawn abreast of the position reached by the vanguard of modern architecture in the 1930s. There was nothing in the university field to match the English prefabricated schools (*see* above) nor was there any obvious trend toward basing the concept of buildings on the fully considered needs, educational, humanistic and technical, of the people who live and work in them. In the national universities of South America the most extravagantly baroque tendencies of the modern movement have been allowed full play, while similar grandiose pretensions characterize the vast buildings for Moscow university on the Lenin hills, although there the style represents that curious bastard revivalism called "people's architecture" which marked the Stalinist era. Incomparably the best exceptions to this generally dismal scene are found in the United States (Brandeis university, Waltham, Mass.; Drake university, Des Moines, Ia.; Santa Barbara college, University of California); in Sweden (Chalmers university, Göteborg); in Denmark (Aarhus); and in Finland (Turku). In these places real attempts have been made to match the environment to the quietist and reflective aspects of the university ideal.

Layout and grouping are as important as the individual buildings. The modern university consists of numerous specialized teaching departments, which, apart from general matters of administrative policy, are largely self-contained. Nevertheless, there are strong practical reasons why different departments should not be too widely dispersed. First is that they use many services in common; second, economy dictates that they share central libraries, lecture theatres, eating places and social facilities; and third, even though a student may specialize in one department, he usually requires supplementary teaching from another.

Before 1939 the slow growth of universities frequently prevented coherent grouping or comprehensive planning. But after World War II their rate of building increased rapidly, either to keep pace with the developments of resurgent nationalism, as in Africa and Asia, or, as in the case of Great Britain where building

for six new universities was to be started in the 1960s, to meet the threat of competition from abroad. In these instances, aided by powerful state finance, new universities usually enjoy the benefit of one large site sufficient to contain the whole complex undivided. In this respect they are able to follow the American tradition rather than the European—the campus tradition first epitomized in the University of Virginia at Charlottesville, designed between 1817 and 1825 by its first rector, Thomas Jefferson, aided by Benjamin Latrobe. On either side of broad lawns, rows of pavilions for lectures and teachers' residences alternate with dormitories for students. Outside these, two ranges of dormitories and dining halls mark the ends of fine gardens. A rotunda, modeled upon the Pantheon, is the library, presiding over the whole "academical village." The plan assures variety within a closely knit community, and it affords good circulation, quiet, privacy, ventilation and safety from fire.

The demand for playing fields and other sports facilities further inflates the size of the new university campus. For the first time since the idea of universities originated, they have become forced growths on virgin sites of 150 ac. or more, situated either in open country or on a suburban fringe, withdrawn within themselves, remote from transport and services, shops, entertainments, housing and any cultural activity not of their own making.

Joseph Hudnut, dean of the Harvard Graduate School of Design, has pertinently written:

> Theories of esthetics, stylistic uniformities and sentimental associations are less trustworthy guides in our search for form than are those adaptations to service and techniques which anchor our buildings in a reality which, however harsh, is ever present and known. . . . Form is the medium through which those meanings we have discovered in buildings can be apprehended . . . active and persuasive in their consciousness . . . People who build universities usually believe in them, their need for form will not be satisfied by convenience in operation merely, . . . but by the way in which the university idea is given definition and eloquence. (*Architectural Record,* p. 161, Aug. 1957.)

The difficulty facing the universities in the second half of the 20th century is that many of them are being forced into emergency improvisations to counter the world shortage of scientists and technologists; as a result the university ideal has become blurred and indistinct.

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EDUCATIONAL PSYCHOLOGY is concerned with the psychological factors underlying the education of children and adults. It tries to show how the schools or other educational agencies can foster the full development of an individual's potentialities. It recognizes that the schools have a role in physical, social and moral development as well as in intellectual training. Psychology is fundamental to teaching in the way that physiology is to medicine. The teacher who tries to understand the thoughts and behaviour of children, to control them and to guide their learning is *ipso facto* applying educational psychology. Even if he has not studied the subject as a scientific discipline he will evolve his own amateur psychology largely on a basis of recollections of his own upbringing and by generalizing from practical experience.

That psychology can provide the "why" of teaching methods is more fully recognized in the United States than in any other country, and throughout the 20th century curricula and techniques have been notably influenced by psychologists' views. As a result educational psychology has been partly, though not wholly, responsible for many fashions in education, in particular the "child-centred" and other progressive movements, and it has been unduly blamed for the low standards of achievement that are popularly attributed to these movements. In Great Britain educational psychology has received less general acceptance. The course in principles of education at most training colleges for teachers is as much philosophical and historical as psychological, and few teachers are trained by lecturers who are competent exponents of modern psychological knowledge. Moreover, among teachers, administrators and parents there is a traditional distrust of the theoretician; hence a rejection of the idea that research can solve any of the practical problems of the classroom. Nevertheless, changes have occurred, though slowly. Especially in the infant school, for children aged five (or under) to seven, more attention is being paid to the psychological needs and capacities of children. In the junior school it is becoming recognized that psychologists can help in the remedial treatment of seriously backward or maladjusted pupils, and that psychological techniques provide the most reliable means of allocating pupils to suitable forms of secondary education. Both these trends, however, remain subject to constant attack in Britain.

It must be pointed out that the term "educational psychologist" is frequently used in Britain to refer specifically to a teacher who has been trained to carry out work with backward and other "problem" children and to advise individual schools or local education authorities on guidance and allocation of children—a teacher who is, in other words, a member of the Schools Psychological service. But it would be more accurate to label these people school psychologists (or perhaps, as in the United States, counselors), and to call educational psychologists persons who have been trained in general psychology and have then specialized in educational matters. School teaching experience is useful to them, but other experience with children or work with adult students may be equally relevant.

Educational psychology is not so much a distinct subject as a collection of relevant portions of child psychology and development, learning and motivation, social psychology, mental hygiene and counseling, the psychology of individual differences and mental measurement. (*See* also CHILD PSYCHOLOGY AND DEVELOPMENT; LEARNING; MOTIVATION; DIFFERENTIAL PSYCHOLOGY; PSYCHOLOGICAL TESTS AND MEASUREMENTS.) There is a plethora of textbooks on educational psychology in which these diverse topics are presented in simplified form. The more advanced student usually has to turn to separate treatises in each of the above-mentioned fields. On the other hand, some writers aver that psychology in the classroom is not merely an application of academic psychology. In any case it includes the study of a number of factors which are unlikely to be dealt with elsewhere, such as the processes involved in teaching reading, arithmetic and other school subjects; the measurement of educational aptitudes and attainments and their prediction; psychological factors in the teacher's own adjustment to his duties; and the characteristics of social groups in the school environment.

A history of educational psychology would likewise be mainly a history of psychologists who have made their major contributions in other fields, the only outstanding exception being E. L. Thorndike, whose three-volume treatise, *Educational Psychology,* was published in 1913. His chief precursors in the United States were William James, whose *Talks to Teachers* appeared in 1899, and Stanley Hall, who wrote on *Adolescence* in 1904. In England James Sully was one of the first to study children psychologically (*Studies of Childhood,* 1895), and James Ward began to lecture to student teachers in 1880. (*See* also PROGRESSIVE EDUCATION; ELEMENTARY EDUCATION; EDUCATION, HISTORY OF.)

Learning Theories.—A major difficulty in presenting educational psychology as a consistent discipline arises from its varied origins. As a result of its reflection at different times of the many

different schools of psychology, it has not infrequently given contradictory advice to teachers. Classical associationist theory, together with Hermann Ebbinghaus' work on memorizing nonsense syllables and Thorndike's experiments on animal learning and transfer of training, culminated in the connectionist view of learning. Education was conceived as the building up of connections in the mind between specific ideas or skills through repeated practice and the reward or reinforcement of correct associations. It was even stated that: "You learn what you learn. Nothing in the mind ever spreads." Thorndike aimed to break up the school curriculum into small steps which could be acquired cumulatively and to concentrate on items of knowledge which would be useful in adult life—the "social utility" approach. In part this was a reaction against the fallacies of 19th-century faculty psychology and theories of formal discipline, which had regarded education as the development of such faculties as reasoning, memory and imagination by the exercise of the mind, preferably with classical studies.

The connectionist approach certainly had some value; it was further elaborated in the light of Pavlovian conditioning and of C. L. Hull's, E. R. Guthrie's and B. F. Skinner's behaviouristic learning theories. It has led to the production of teaching machines, which appear to be remarkably efficient for courses ranging from engineering to foreign languages. The virtue of these machines lies in the skilful breakdown and organization of the course into a series of steps, the acquisition of each step being immediately reinforced by knowledge of progress, and the devolving of responsibility upon the individual student. They are sometimes criticized, however, for eliminating the social aspects of classroom learning.

More appealing, perhaps, to the teacher are the opposing group of field or Gestalt theories of learning (*e.g.*, those of Kurt Koffka, Max Wertheimer, E. C. Tolman), which stress the grasping of relationships and insight into meanings (*see* GESTALT PSYCHOLOGY). Even the learning of multiplication tables, it is claimed, depends more on the understanding of number relations than on rote memorizing; and the education of the dull as well as of the bright child should be envisaged as a process of discovery or problem-solving, with the teacher helping to guide his interpretations. It should aim, also, at maximum transfer; *i.e.*, at the development of concepts, skills and attitudes which can be applied to novel problems in the future. The early experiments, which influenced Thorndike's views, suggested that transfer is possible only insofar as specific elements of the previous training enter directly into the new task. But most investigations since then have shown appreciable transfer to occur, particularly among brighter children or when the teacher succeeds in bringing out the wider implications of the instruction.

Motivation.—From James and Thorndike onward, psychologists have stressed the importance of motivation to learn, pointing out that no amount of training will produce improvement without it. But it was, perhaps, mainly under Dewey's influence that education, in the United States at least, became conceived in terms of the child's own activity rather than of dictation by society. In England, William McDougall's theory of instincts as the fundamental sources of human motivation was widely accepted by educationists, and his views on sentiment formation provided an intelligible account of character development. In both countries there was early recognition of the value of psychoanalytic concepts in explaining the irrationalities in young children's behaviour and their dependence on the teacher as a parent substitute. With the realization that play is not just a relaxation from work but is the child's natural method of learning and sorting out his concepts of the world and of adults, a remarkable revolution occurred in the approach to young children. However, both Freudian theory and behaviourism undermined the notion of universal instincts, and behaviour is now explained more in terms of drives or needs and of culturally determined goals. There are, of course, the primary organic drives, which must be reasonably satisfied if the child is to be motivated to learn anything, but the secondary needs for psychological security and freedom from anxiety, for exploration and adventure, for exercise of and progress in bodily and mental skills and for acceptance by and contribution to the social group operate in most forms of society without having to be regarded as innate, causal agencies. It was the tradition for schools to ignore or repress such needs, whereas now they aim rather to enlist them in support of learning.

Maturation.—Not only is the child a dynamic being, not a mere stimulus-response mechanism, but also his learning depends on the stage of development or maturity of his perception, intelligence and temperament. Genetic factors rather than training determine when he can walk, and they play an important part in his capacity to make useful progress in reading or handwriting, in formal grammar or algebra and in appreciating art, literature and philosophic concepts, as well as in his sexual development. Therefore, too early an introduction to some skill such as reading may engender a dislike inhibiting progress at a later age. A. L. Gesell and many other workers have traced a fairly orderly sequence in the appearance of bodily and linguistic skills, despite variations in rate from child to child and marked variability in the day-to-day performance of the same child. However, this does not mean that optimum ages can be laid down for tackling successive stages in the school curriculum, although attempts at this have been made, as in C. Washburne's investigations of arithmetic learning. Apart from individual differences, too much depends on the method of presentation to make such schemes practicable, and it is probably expedient to introduce the tool subjects well before the age of maximum absorption. Tests of readiness to begin reading have been based on perceptual discrimination, vocabulary and intelligence, but they do not seem to be notably more predictive than teachers' observations of children's pre-reading activities and interests.

In the 1950s and 1960s the work of Jean Piaget at Geneva attracted great attention among European educational psychologists. His findings on the development of children's spatial and numerical concepts and their understanding of the world and of morals are as highly relevant to the work of the primary teacher as is his account of the emergence of more abstract or formal reasoning to the secondary teacher. His notion that distinct levels are reached at particular ages is not, however, accepted everywhere. Longitudinal studies in the United States lay more stress on individual patterns than on uniformities in growth curves. Moreover, the theoretical antithesis between maturation and learning is breaking down: a child's readiness for any school subject or any social learning is the cumulative product of genetic influences and experience.

Thorndike's finding that cognitive learning ability increases up to the age of 25 or 30 is important in adult education, even though it is probably untrue of many motor skills, including language pronunciation. It suggests that adults' difficulties in study are due more to their having to provide their own motivations than to any decline in their abilities, which does not become considerable until after the 40s.

Individual Differences in Abilities.—The development of methods for measuring intelligence and attainments was of major importance in breaking down the notion that all children of the same age can be taught at the same rate. Alfred Binet's device for expressing intellectual development in mental age units, and the analogous formulation of reading, arithmetical and other "ages", showed that the brighter children in a given age group may well be two or more years advanced beyond the average of the group, and the duller ones (even eliminating the mentally defective) two years below; it was shown also that this range widens with increasing age. The production of well standardized tests of intelligence or of such component factors as verbal comprehension, reasoning, spatial ability, etc., as also of tests of scholastic attainment, has become a major industry among educational psychologists in view of the demonstrable value of such tests for surveys, grading, diagnosis of difficulties, selection and guidance. The earlier notion that intelligence tests could measure a child's basic educability regardless of any effects of his upbringing is discredited, although, within a homogeneous cultural environment, these tests can be shown largely to reflect genetic differences between children. But, even when regarded as measures of general thinking capacity developed up to a given age, they are quite efficient for the prediction of future educational attainment and even of vocational level,

as illustrated by L. M. Terman's follow-up of high-scoring children over a period of 35 years.

There is still much controversy as to the bearing of mental measurement on school organization; *i.e.*, as to whether it is advisable to grade children by ability, so that those in any one class shall not differ too widely. This is common practice in England. Classes within each age group are usually graded, and approximately the brightest 20% are selected at 11 years of age for more advanced secondary education in grammar schools. But this system is widely criticized, both because children vary in their different abilities and change as they grow older and because of what are held by many to be the undesirable social effects of such grouping by ability. In the United States, on the other hand, where more attention has been paid to social than to intellectual "readiness," opinion is veering toward greater differentiation, either by accelerating bright children or by enriching their curricula.

There has been much testing of sex differences, rural-urban and racial differences, differences between socio-economic classes and of the effectiveness of particular teaching methods (*e.g.*, instructional films). Educational psychologists have also made notable contributions to the technique of examining (*see* EXAMINATIONS), having demonstrated the serious unreliability of conventional essay-type examinations, due to variations in standards and subjectivity in marking. The "objective" examination was developed in the United States; in it the student chooses one from a number of presented answers and scoring is wholly objective—often, indeed, being done by an electrical device. Well constructed tests are by no means confined to assessing knowledge of detailed facts; they are used for evaluating the achievement of broader educational objectives—understanding and application of principles, critical judgment, etc. However, like the conventional essay examinations, they have their dangers; for example, they often stimulate undesirable methods of study and coaching.

School Psychological Services.—Among the most notable applications of psychology in education are the attention given to deviant children (*e.g.*, the physically handicapped, the backward and feeble-minded and the emotionally maladjusted) and the help made available to normal pupils with vocational or other problems. There are child guidance clinics, staffed by psychologists, psychiatrists and social workers, for treatment of the maladjusted, besides specialized agencies such as schools for the deaf or for the low-grade mental defective. Most British local education authorities also provide diagnostic and remedial services for the backward in educational clinics, special classes or special schools. School-leavers are assisted in their choice of jobs by the Youth Employment service, by (relatively untrained) careers teachers or by psychologists of the National Institute of Industrial Psychology. In the United States it is more common to have trained counselors in each school, responsible for educational and vocational guidance conceived as a continuous process.

Methods of Learning.—It is difficult to select the most significant implications of the vast number of investigations, stemming from diverse theoretical standpoints, which have been made into various aspects of learning. Early experimenters concentrated particularly on the study of rote memorization, showing the effects of good distribution of learning periods upon acquisition and retention and of retroactive inhibition or interference by subsequent learning of similar material. They showed, too, the value of active reproduction or self-testing as contrasted with passive repetition; the effect of overlearning and of the pupil's awareness of his own progress; and some advantages of studying a lengthy task as a whole rather than in parts. Studies of manual skills drew attention to the irregularities of learning, to the existence of stale periods or "plateaus," to the effects of environmental conditions and to the importance of incentives. Later writers, however, were more interested in finding common features in the much wider range of learning that goes on in schools, pointing out that children are continually acquiring concepts and insights, techniques of thinking and sets and attitudes over and above the information or habits that are the immediate objects of instruction. They can learn, for example, habits of inattention; they can learn to co-operate with others, to compete with them or to cheat.

The general pattern of learning, as L. J. Cronbach points out, is as follows: faced with a new task or situation, the learner perceives or interprets certain features of it, depending on his motivation and on his "readiness" (*i.e.*, his aptitude as developed by relevant past experience). He makes a trial response to it, and if this is successful in the attainment of his goal it is followed by satisfaction and reinforcement. If it is unsuccessful he may reinterpret and make a new trial, or else behave nonadaptively, developing feelings of frustration and inferiority or giving up. The teacher's first function, therefore, is to set significant goals or purposes to the children, if possible arising out of their needs—in other words, to get them "ego-involved." Next, by good organization or structuring of the presented material they can be helped to perceive its essential features and to achieve insights. Mere exposure and practice, even when accompanied by approval or other rewards for success, are not enough. It is to be noted also that "attention" is not invoked as a power of the mind. To some extent attentiveness is part of readiness (*i.e.*, it depends upon intelligence and training); for the rest it follows on motivation to concentrate upon the significant elements in the situation.

Such principles have many applications in the planning of courses, from infant to university level, and there exist books on how to study, how to read effectively, how to take notes, etc. Comparisons of over-all teaching techniques (*e.g.*, the lecture with the discussion seminar) tend to give inconsistent findings from one teacher and learner to another. However, numerous studies have shown that instructional films or television can valuably supplement, sometimes replace, face-to-face instruction; and the extensive Pennsylvania State college researches have brought out many of the desirable characteristics of educational films. (*See* also AUDIO-VISUAL EDUCATION.)

Reading.—Photographic recordings show that the eyes of a mature reader do not move along the letters of a reading passage consecutively, but jump from one group of words to another, taking in a third of a line or more at a time. Less skilled readers need more fixations per line, often jump back or regress to earlier parts of a line or word and may articulate each word in turn. The reading process varies also with the complexity of the passage and with the reader's purpose. These findings, together with Gestalt views on perception, have been adduced in support of "look and say" or "word and sentence" methods of teaching reading as against phonic methods. However, follow-up evidence fails to show any clear superiority for whole word teaching methods; if anything, the opposite. The reason presumably is that words cannot be adequately distinguished by shape alone. Such methods have the advantage of enabling the child to know at the earliest stages that he is progressing, but they need to be supplemented by analytical training.

There has been much study of the psychological factors of backwardness in reading. Widespread inefficiency at this skill is to be found among older students and adults, largely because they have had no systematic training in reading for meaning, in skimming and in thinking about the subject matter. Courses for improving adult reading speed without loss of comprehension are now available, but their success probably depends more on the instilling of appropriate habits and motivation than on the training of the actual eye movements. There have also been investigations into the variations of typography to suit readers of different ages and into the assessment of the vocabulary and structural difficulties of different reading materials; *e.g.*, textbooks. (*See* also READING.)

Spelling and Writing.—Graded lists of commonly used regular or irregular words are available, and it is realized that the memorization of long and unusual words has no "disciplinary" value. Elaborate spelling rules also serve little purpose, although structural regularities should be established where possible. The main essentials at which to aim are an analytical interest in words rather than a phobia against them, and the provision of variety in the type of practice given; *e.g.*, in reading, in composition and in preparing dictionaries and wall charts, rather than mere memorizing in isolation.

The early handwriting movements are gross and ill co-ordinated; hence it is an advantage to begin by teaching the formation of large script letters. Later these movements become more fluid, integrated and automatic. Short, frequent practices are desirable. The teacher should aim at standards appropriate to the children's ages, rather than at perfection, and should realize that speed and ease are as important as accuracy. There is in general a more humane attitude nowadays toward the left-handed child, despite a lack of understanding among teachers of his special requirements. The origins of left-handedness and its relations to speech development are problems of considerable interest.

Fluent and expressive writing can hardly be expected until these skills of spelling and handwriting are sufficiently automatic to become a vehicle for thought. Extensive previous experience of oral composition is desirable, whereas training in formal grammar is hardly worthwhile until Piaget's propositional stage is reached.

Arithmetic.—Early research concentrated on analyses of curricula, *e.g.,* measuring the difficulty of successive operations, and on comparisons of techniques for teaching, for example, subtraction. The results of such work on the value of systematic practice still hold good, but there is now more awareness of the need to gear arithmetic to children's developing concepts of space, time, distance, classifying and ordering and to their emotional maturity. In order to avoid teaching arithmetic too early by purely rote methods without enlisting the children's understanding, concrete apparatus has become fashionable; *e.g.,* the blocks of L. W. Stern or G. Cuisenaire. How far these succeed in establishing number concepts has yet to be proved, but it is clearly important to tie numbers to situations arising out of the children's experience. The teacher's own confidence and interest in arithmetic also has an important influence.

Mechanical arithmetic is known to depend on mental abilities or factors somewhat distinct from general intelligence; but the ability to do problem arithmetic and mathematics goes much more closely with all-around intellectual development; hence the avoidance of these subjects by weaker students. The abstractions involved in algebra, for example, are difficult to grasp until a mental age of about 12 has been reached.

Social Studies and Natural Sciences.—These could profitably be introduced early in the primary school, in view of children's natural curiosity concerning the world around them and its peoples and their joy in discovery. But they should be taught inductively rather than in terms of information or ready-made concepts; *i.e.,* observation, experiment, discussion, generalization and application should be provided for. One of the main handicaps to the promotion of scientific ability and interest in children is the inadequacy of early number teaching; but despite this, and despite their primitive understanding of spatial and chronological relations until the age of 10 or 12, children can learn much about biology and the world of work and things, and they can be trained in attitudes of inquiry and open-mindedness rather than in stereotyped and irrational thinking. The availability of good educational films and television programs should help to make up for the inadequate foundation in experience of so many of the concepts taught verbally in schools.

Foreign Languages.—Fallacious notions of transfer of skills have probably done more harm in the field of foreign language teaching than in any other. The formal translation and grammar approach still holds sway in spite of the difficulty of supplying motivation by this method and despite its inefficiency in producing either fluent speech or appreciation of foreign cultures. There is also the problem of deciding at what age a child is best started on a foreign language, since on the one hand his optimum plasticity of speech seems to occur before the age of ten, while on the other he seems unlikely to make good progress in a new language until he has shown facility in his mother tongue. Useful work has been done in preparing minimum vocabularies and lists of grammatical structures in several languages, as also in the production of tests of aural comprehension and written attainment.

The Teacher.—Many teachers admit to choosing their career for inadequate reasons and some express great dissatisfaction with conditions of work, pay and status. There is evidence that the teacher of overdominant or unstable personality can have a bad, even if temporary, effect on the children he teaches. Careful selection of recruits to the profession, then, is desirable but is difficult to impose, both because of the shortage of candidates and because of the lack of reliable techniques. Innumerable researches have shown moderate correlations between intelligence tests or educational level and marks in courses on the theory of teaching, but they have shown scarcely any agreement with assessments of teaching practice, except possibly in the lower ranges of ability. Other studies often yield positive correlations with tests of emotional stability and extraversion, but so small that there would be no justification for accepting only candidates of one "type." The interview, in spite of its subjectivity, is therefore generally used in conjunction with previous school records; probably a trial period of teaching would be most predictive. It is also difficult to decide what constitutes good teaching, for though much is known of the qualities appreciated by tutors and heads of schools and by pupils themselves, there is poor agreement among those who do the rating. Nor have attempts to grade teachers according to what their pupils have learned yielded much. Less stress has therefore come to be laid on picking personalities "suitable" at the start and more on helping those candidates who present themselves to mature as people and to adjust to their double role both as parent substitutes and leaders of young children and as servants of their employers and of the community.

Teacher-Pupil Relationships.—Although the origins in a child of maladjustment or delinquency on the one hand or of harmonious internal controls or values on the other lie mainly in his home background and his own temperament, the school has a part to play as a socializing agency. Teachers often fail to realize how their criticism may affect a child's concept of himself; that oral or written tests and examinations may arouse considerable anxieties and inhibit clear thinking; or that when they alone control all class activities they are preventing the development of co-operation and responsibility and stimulating the formation of rebellious cliques. They should be aware, too, of the characteristic social interactions and attitudes to authority of children of different ages, social classes and sexes. K. Lewin's work on authoritarian, democratic and laissez-faire social climates and J. L. Moreno's sociometry have been widely, and perhaps uncritically, accepted, especially in the United States. However, several follow-up experiments such as the eight-year study of New York secondary schools and D. E. M. Gardner's comparisons of formal and progressive schools for English children up to the age of seven have demonstrated that social co-operation and intellectual resourcefulness can be fostered without any loss in standards of attainment.

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